PRATT & WHITNEY AIRCRAFT GROUP
Commercial Products Division

Plant M
Middletown, Conn. 06457

February 1, 1980

Subject: JT12A Maintenance Manual, Part Number 435107, Revision No. 41 dated February 1, 1980

The subject manual has been revised to reflect new data for the JT12A engine model.

Please insert subject revision pages and discard the superseded pages in accordance with the applicable List of Effective Pages.

To avoid any break in the continuity of revision service, please direct any change in address or revision requirements to the undersigned.

Sincerely,

Barbara M Burns

Barbara M. Burns
Supervisor, Distribution
Product Support Publications

BMB:kc

UNITED TECHNOLOGIES

JT12A-6, -6A, AND -8 TURBOJET ENGINES AND JFTD12A-4A, AND -5A FREE TURBINE ENGINES

MAINTENANCE MANUAL

PART NO. 435107

JT12A-6, -6A, AND -8,
AND JFTD12A-4A FAA APPROVED

OCTOBER 1/60

REVISED FEBRUARY 1/80

PRATT & WHITNEY AIRCRAFT GROUP

UNITED TECHNOLOGIES®

Commercial Products Division

Printed in United States of America

LIST OF REVISIONS

REV. NO.	DATE	REV NO	DATE	REV. NO.	DATE
This Manual Contains		Revisions 1 through 32		and the Following:	
33	Oct 15/74				
34	Dec 15/75				
35	June 15/76				
36	Dec 15/76				
37	June 15/77				
38	Dec 15/77				
39	Jun 15/78				
40	Aug 1/79				
41	Feb 1/80				

LIST OF EFFECTIVE PAGES

Please insert the revised pages into this manual and delete obsolete pages in accordance with the following List of Effective Pages. Revised pages are indicated by the letter "R", added pages by the letter "A", and deleted pages by the letter "D". Superseded pages shall be removed and destroyed.

The List of Effective Pages records not only each page of subject revision but also each previously issued page which is still current. Blank pages and pages which are no longer current do not appear on this list. If there is any question about the currency of the recipient's copy, it is recommended that each page of the manual be checked off against this List of Effective Pages. Any page which does not check out with this list, either by number or by date, shall be discarded.

LIST OF EFFECTIVE PAGES

CHAPTER/ SECTION	PAGE	DATE
Maintenance (cont'd)	2-51	Aug 1/79
	2-52	Nov 1/66
	2-52A/2-52B	Oct 15/74
	2-53	Jan 15/77
	2-54	Apr 1/70
	2-54A	Dec 15/75
	2-54B	Jun 15/76
	2-54C/2-54D	Jun 15/76
	2-55	Jun 15/76
	2-56	Nov 1/67
	2-56A	Dec 15/77
	2-56B	Dec 15/77
	2-56C/2-56D	Dec 15/77
	2-57	Dec 15/77
	2-58	Dec 15/77
	2-58A	Mar 15/67
	2-58B	Dec 15/76
	2-58B-1	Mar 15/67
	2-58B-2	Oct 15/74
	2-58B-3	Oct 15/74
	2-58B-4	Oct 15/74
	2-58B-5	Oct 15/74
	2-58B-6	Oct 15/74
	2-58B-6A/	
	2-58B-6B	Oct 15/74
	2-58B-7	Dec 1/69
	2-58B-8	Dec 1/69
	2-58B-9	Dec 1/69
	2-58B-10	Oct 15/74
	2-58B-10A	Oct 15/74
	2-58B-10B	Oct 15/74
	2-58B-10C	Oct 15/74
	2-58B-10D	Oct 15/74
	2-58B-11/	
	2-58B-12	Dec 1/69
	2-58B-13/	
	2-58B-14	Dec 1/69
	2-58C	May 1/68
	2-58D	Oct 1/72
	2-58D-1	Oct 1/63
	2-58D-2	Oct 1/72
	2-58E	Aug 1/79
	2-58F	Aug 1/79
	2-58F-1/	
	2-58F-2	Aug 1/79
	2-58F-2A/	
	2-58F-2B	Feb 15/71
	2-58F-3/	
	2-58F-4	Feb 15/71
	2-58F-5/	
	2-58F-6	Feb 15/71
	2-58F-9/	
	2-58F-10	Aug 1/69
	2-58F-11/	
	2-58F-12	Aug 1/69
	2-58F-13/	
	2-58F-14	Dec 1/69
	2-58F-15/	
	2-58F-16	Aug 1/69
	2-58G	Dec 1/69
	2-58H	May 1/68
	2-58H-1	Feb 15/71
	2-58H-2	Nov 15/68
	2-58H-2-1/	
	2-58H-2-2	Dec 1/69
	2-58H-3	May 1/68
	2-58H-4	Nov 15/68
	2-58H-5	May 1/68
	2-58H-6	May 1/68
	2-58H-7/	
	2-58H-8	Feb 15/71
	2-58J	Nov 15/68
	2-58K	Apr 1/63
	2-58K-1/	
	2-58K-2	Apr 1/70
	2-58K-3/	
	2-58K-4	Feb 15/71
	2-58L	Feb 15/71
	2-58M	Feb 15/71
	2-58M-1	Sep 1/70
	2-58M-2	Nov 15/68
	2-58N	Feb 15/71
	2-58P	Feb 15/71
	2-58Q	Jun 15/78
	2-58R	Dec 15/75
	2-58S/2-58T	Nov 15/68
	2-58T-1/	
	2-58T-2	Nov 15/68
	2-58U/2-58V	Apr 1/63
	2-58V-1/	
	2-58V-2	Nov 15/68
	2-58V-3/	
	2-58V-4	Feb 15/71
	2-58W/2-58X	Feb 15/71
	2-58X-1/	
	2-58X-2	Nov 15/68
	2-58Y	Jun 1/66
	2-58Z	Jul 1/62
	2-58Z-1/	
	2-58Z-2	Mar 1/69
	2-58AA	Sep 1/70
	2-58AB	Sep 1/70
	2-59	Feb 15/71
	2-60	Feb 15/71
	2-60A/2-60B	Feb 15/71
	2-60B-1/	
	2-60B-2	Feb 15/71
	2-60C/2-60D	Feb 15/71
	2-60D-1/	
	2-60D-2	Feb 15/71
	2-60E/2-60F	Jun 15/67
	2-60F-1/	
	2-60F-2	Feb 15/71
	2-60G/2-60H	Feb 15/71
	2-60H-1/	
	2-60H-2	Feb 15/71
	2-60J	Aug 1/69
	2-60K	Feb 15/71
	2-60L/2-60M	Feb 15/71
	2-60M-1/	
	2-60M-2	Feb 15/71
	2-60M-3/	
	2-60M-4	Feb 15/71
	2-61	Aug 1/79
	2-62	Aug 1/79
	2-63	Aug 1/79
	2-64	Aug 1/79
	2-65	Aug 1/79
	2-66	Aug 1/79
	2-67	Aug 1/79
	2-68	Aug 1/79
	2-69	Aug 1/79
	2-70	Aug 1/79
	2-71	Aug 1/79
	2-72	Aug 1/79
	2-73	Aug 1/79
	2-74	Aug 1/79
	2-75	Aug 1/79
	2-76	Aug 1/79
	2-77	Aug 1/79
	2-78	Aug 1/79
	2-79	Aug 1/79
	2-80	Aug 1/79
	2-81/2-82	Aug 1/79
	2-109/2-110	Apr 1/70
	2-111/2-112	Apr 1/70
	2-112A/2-112B	Apr 1/70
	2-112C/2-112D	Aug 1/79
	2-113/2-114	Apr 1/70
	2-115/2-116	Apr 1/70
	2-116A/2-116B	Sep 1/70
	2-117/2-118	Aug 1/79
	2-119/2-120	Aug 1/79
	2-125/2-126	Aug 1/79
	2-127/2-128	Apr 1/70

LIST OF EFFECTIVE PAGES

CHAPTER/ SECTION		PAGE	DATE
Maintenance (cont'd)		2-129/2-130	Apr 1/70
		2-130A/2-130B	Sep 1/70
		2-131/2-132	Oct 15/74
		2-133/2-134	Oct 15/74
		2-135/2-136	Apr 1/70
		2-136A	Aug 1/79
		2-136B	Aug 1/79
		2-136C/2-136D	Aug 1/79
		2-137/2-138	Apr 1/70
		2-139/2-140	Apr 1/70
		2-141/2-142	Aug 1/79
		2-143/2-144	Aug 1/79
		2-145	Aug 1/79
		2-146	Aug 1/79
		2-147/2-148	Aug 1/79
Tab Separator - Periodic Inspection			
	R/	3-1	Feb 1/80
		3-2	Jun 15/78
		3-3	Jun 15/78
		3-4	Jun 15/78
		3-5	Jun 15/78
		3-6	Jun 15/78
		3-7	Jun 15/78
		3-8	Jun 15/78
		3-9	Jun 15/78
		3-10	Jun 15/78
		3-11	Jun 15/78
		3-12	Jun 15/78
		3-13	Jun 15/78
		3-14	Jun 15/78
		3-15	Jun 15/78
		3-16	Jun 15/78
		3-17	Jun 15/78
		3-18	Jun 15/78
		3-19	Jun 15/78
		3-20	Jun 15/78
		3-21	Aug 1/79
		3-22	Aug 1/79
		3-22A/3-22B	Aug 1/79
		3-23	Jun 15/78
		3-24	Jun 15/78
		3-25	Jun 15/78
		3-26	Jun 15/78
		3-27	Jun 15/78
		3-28	Jun 15/78
		3-29	Aug 1/79
		3-30	Aug 1/79
		3-31	Jun 15/78
		3-32	Jun 15/78
		3-33	Jun 15/78
		3-34	Jun 15/78
Tab Separator - Preparation for Storage or Service			
		4-1	Jun 1/66
		4-2	Jun 1/66
		4-2A	Dec 15/75
		4-2B	Dec 15/75
		4-2C/4-2D	Dec 15/75
		4-3	Dec 15/75
		4-4	Dec 15/75
	R/	4-5	Feb 1/80
	R/	4-6	Feb 1/80
Tab Separator - Appendixes			
		1A-1	Jun 15/77
		1A-2	Dec 15/75
		1A-3	Dec 15/75
		1A-4	Dec 15/75
		2A-1	Jun 15/77
		2A-2	Jun 15/77
		2A-3	Oct 1/60
		2A-4	Oct 1/60
		2A-5/2A-6	Oct 1/60

CHAPTER/ SECTION	PAGE	DATE
	Index-1	Aug 1/79
	Index-2	Aug 1/79
	Index-3/	
	Index-4	Aug 1/79
	Index-5	Aug 1/79
	Index-6	Aug 1/79

ALPHABETICAL INDEX

Contents	Paragraph

Pratt & Whitney Aircraft
JT12A MAINTENANCE MANUAL

APLHABETICAL INDEX (continued)

ALPHABETICAL INDEX (continued)

Contents — Paragraph

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 35, DATED JUNE 15, 1976

Pages which have been revised are outlined below together with the highlights of the revision. Recipients of PRINTED MANUALS shall refer to the List of Effective Pages for filing instructions.

To avoid any break in continuity of revision service, please direct any change in address or revision requirements to: Supervisor - Distribution, Technical Publications, Product Support Department, Pratt & Whitney Aircraft, P.O. Box 611, Middletown, Connecticut, 06457.

HIGHLIGHTS

Page	Disposition	Reason For Revision
Title	Replace	*
List of Revisions	Replace	*
A, B	Replace	*
2-37	Replace	Gasket lubricant (Gredag) added.
2-38	Replace	Added Standard Practices data.
2-38-1, 2-38-2, 2-38-3/2-38-4	Add	Added Standard Practices data.
2-42	Replace	Added Standard Practices data.
2-42-1, 2-42-2, 2-42-3/2-42-4	Add	Added Standard Practices data
2-54B, 2-54C/2-54D	Replace	Revised Nomenclature to combustion chamber outer case
2-55	Replace	Deleted military specification for anti-seize compound.
2-60P, 2-60R	Replace	Added torque check for reuse of self-locking nuts.
2-60S, 2-60T	Add	Old page 2-60S/2-60T is deleted.
2-62, 2-62-1	Add	Added figure for installing components of ignition system. Old Page 2-62-1/2-62-2 is deleted.
2-62-2	Add	*

*Editorial Requirement

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 35 DATED JUNE 15, 1976

TEMPORARY REVISION INDEX

INACTIVE

The following Temporary Revisions are now inactive and should be removed from your PRINTED MANUALS and from the file of Temporary Revisions used in conjunction with MICROFILM.

Temp. Rev. No.	Filed Adjacent To	Remarks
None.		

ACTIVE

Temp. Rev. No.	Filed Adjacent To	Remarks
None.		

Active Temporary Revisions must be retained in PRINTED MANUALS and in the MICROFILM Temporary Revision File until otherwise directed by subsequent filing instructions.

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 34, DATED DECEMBER 15, 1975

Pages which have been revised are outlined below together with the highlights of the revision. Recipients of PRINTED MANUALS shall refer to the List of Effective Pages for filing instructions.

To avoid any break in continuity of revision service, please direct any change in address or revision requirements to: Supervisor - Distribution, Technical Publications, Product Support Department, Pratt & Whitney Aircraft, P.O. Box 611, Middletown, Connecticut, 06457.

HIGHLIGHTS

Page	Disposition	Reason For Revision
Title	Replace	*
List of Revisions	Replace	*
A, B, C/D	Replace	*
1	Replace	*
1-2B	Replace	Inlet case replacement tools added.
1-2C/1-2D	Replace	*
1-3	Replace	Turbine blade stretch gage added.
1-6, 1-6A/1-6B	Replace	Tools added to numerical list.
2-48	Replace	*
2-48A/2-48B	Replace	Provided instructions for engines not having dump valve overboard drain and signal lines.
2-49, 2-51		
2-54A	Replace	Compressor inlet case removal added.
2-54B	Replace	Compressor inlet case installation added.
2-54C/2-54D	Add	*
2-55	Replace	Added requirement to inspect combustion chambers to ensure installation of correct combustion chamber in the No. 1 and No. 8 combustion chamber locations.
2-58Q, 2-58R	Replace	Oil tank level checking and servicing procedures revised.
2-62A/2-62B	Replace	Revised Ref. No. 149.
2-63	Replace	Revised Ref. No. 151.
2-64, 2-64A/2-64B, 2-65	Replace	Revised compressor disk life cycle limits.
2-67, 2-68	Replace	Specified minimum clearance for external tubes.
2-112C/2-112D, 2-118A/2-118B	Add	Specified minimum clearance for external tubes.
2-134A/2-134B	Replace	Free turbine speed-sense cable adjustment procedure revised.
2-136A/2-136B	Add	Specified minimum clearance for external tubes.
3-4	Replace	Revised oil change recommendations.
3-6A	Replace	Increased number of reparable inlet vanes for JFTD12A Model.
3-6B, 3-6C	Replace	Alternate adhesives added for bleed valve strap cushion replacement.
3-6D	Replace	*
3-6E/3-6F	Add	Bleed valve strap cushion replacement revised.

*Editorial Requirement

HIGHLIGHTS (continued)

Page	Disposition	Reason For Revision
3-8A	Replace	Clarified combustion chamber outlet duct crack limit.
3-9	Replace	Described use of second stage turbine blade stretch gage incorporating a gage positioning pin.
3-13	Replace	Free turbine case weld repair clarified.
4-2A	Replace	Added PWA 13489 adapter information for supporting engine horizontally in PWA 13060 stand. Adapter supports engine at diffuser case mounts and features fore and aft engine supports. Selection of the fore or aft engine support is governed by assembly/ disassembly requirements.
4-2B	Replace	*
4-2C/4-2D	Add	*
4-3, 4-4, 4-5	Replace	Provided preservation/depreservation instructions for engines not having dump valve overboard drain and signal lines.
4-6	Replace	*
1A-1	Replace	Adhesives added to consumable materials list.
1A-2	Replace	*
1A-3	Replace	Adhesive primers added to comsumable materials list.
1A-4	Add	*

*Editorial Requirement

[illegible]

[illegible] POWER CHECK - PRIOR TO ADJUSTMENT

[illegible] CP RPM ______ % CP RPM ______ °C CP F/F ______ [illegible]
[illegible] °C [illegible] TB #1 ______ #2 ______ #3 ______ TB SPREAD
[illegible] % TB PTS ______ °[illegible] TB PTS/Tank ______ OIL PRESS. ______

LAST POWER CHECK - AFTER ADJUSTMENT

11. [illegible] CP RPM ______ % CP RPM ______ °C CP F/F ______ [illegible]
12. [illegible] °C AVERAGE TB #1 ______ #2 ______ #3 ______ TB SPREAD
13. RPM ______ % TB PTS ______ [illegible] TB PTS/Tank ______ OIL PRESS. ______

TAKE OFF POWER CHECK

[illegible] [illegible] CP RPM ______ % CP RPM ______ °C CP F/F ______ [illegible] CP
[illegible] RGT ______ °C AVERAGE TB #1 ______ #2 ______ #3 ______ TB SPREAD
[illegible] RPM ______ % TB PTS ______ °[illegible] TB PTS/Tank ______ OIL PRESS ______

[illegible] RECEIVED:

AFTER [illegible]

[illegible] [illegible] SPEED
[illegible] [illegible] FACTOR ______ RPM ______ % [illegible] ______
[illegible] ______ ______
[illegible] SPEED ______
[illegible] P.S.I. ______ RPM ______
______ RPM ______
______ RPM ABOVE/BELOW [illegible] ______

[illegible]

In Reply Please Refer To:
RGB:JFS:mrb Svc. Engrg.

Pratt & Whitney Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION

August 13, 1965

Attention:

Subject: JT12 Engine Overtemperature in Jetstar Operation

Gentlemen:

There have been instances of JT12 engine overtemperature occurring during ground operation at intended idle speeds. At times the engine idle speeds have been reported to be below target and in other instances the actual engine idle speed has not been observed. The subject received considerable discussion during our JT12 Engine Symposium in the latter part of May of this year. At the time, we did not have an answer to the problem but were working on it.

We have continued our intensive efforts to determine the cause and possible cure for the engine overtemperature problem, and have had success in reproducing the phenomenon. The fuel controls, one Holley and one Hamilton Standard, involved in reported instances were obtained from the operating aircraft and attempts made to duplicate the overtemperature condition on our test facilities.

Both controls were thoroughly bench checked as received from the operators and found to be well within production limits. These controls were then installed on test engines and attempts made to duplicate the overtemperature at conditions simulating those in the actual aircraft. Initial attempts with standard idle speed settings and with and without accessory loads were unsuccessful. Tests were then run at varying combinations of accessory loads, idle speed setting and idle power lever angle setting. Accelerations, decelerations and steady state operation were included. We were able to reproduce the overtemperature phenomenon.

Final test results show that the overtemperature problem is due to a combination of items, none of which will cause it by themselves. The combination which appears to be critical with either control consists of the power lever being at an angle below the idle range, and having the idle speed low with application of accessory loads. As this problem is in a marginal operating regime, no absolute limiting values of these effects can be defined, however all are contributing factors.

We have coordinated this with Lockheed and wish to advise of the following procedural recommendations:

(a) Set idle speed at 44 per cent to 45 per cent with no accessory loading on the engine during trimming. In our letter of May 20, 1965, we advised that idle be final adjusted with accessory load applied. Engine idle speeds will vary depending on the number of engines carrying the aircraft accessory requirement. Therefore, to obtain uniformity setting idle to as near 45 per cent unloaded on a standard day will provide desirable and uniform idle speeds when all four engines are carrying the accessory load requirements for the aircraft. We do not believe it appropriate for stabilized engine idle speeds to be permitted to be below 42 per cent under the most adverse conditions of temperature and accessory loading.

(b) Power lever rigging should be done so that under the worst conditions of accumulated tolerances or system backlash the fuel control power lever pointer cannot retard below the idle mark of the fuel control. At the present time, the manual calls for rigging of the Holley control to be done so that idle position represents a control power lever angle of between 13° and 16°. This is satisfactory. The instructions for the Hamilton Standard control are to be revised to call for rigging to result in the power lever pointer indicating an angle between the "Idle" mark and a point 3° above (approximately .026" at the pointer tip). The object is to prevent the possibility of the power lever entering the start of cut-off which can occur at an angle as high as $9\ 1/2^\circ$.

The above will assure that the engines will maintain operation at a high enough idle speed so they are able to carry the accessory load and be able to accelerate satisfactorily. We have confidence that adherence to these recommendations will result in satisfactory operation and prevent overtemperature during ground idle.

Yours very truly,

PRATT & WHITNEY AIRCRAFT

R. G. Bentzinger
Chief, Technical Services

RGB:JFS:mrb

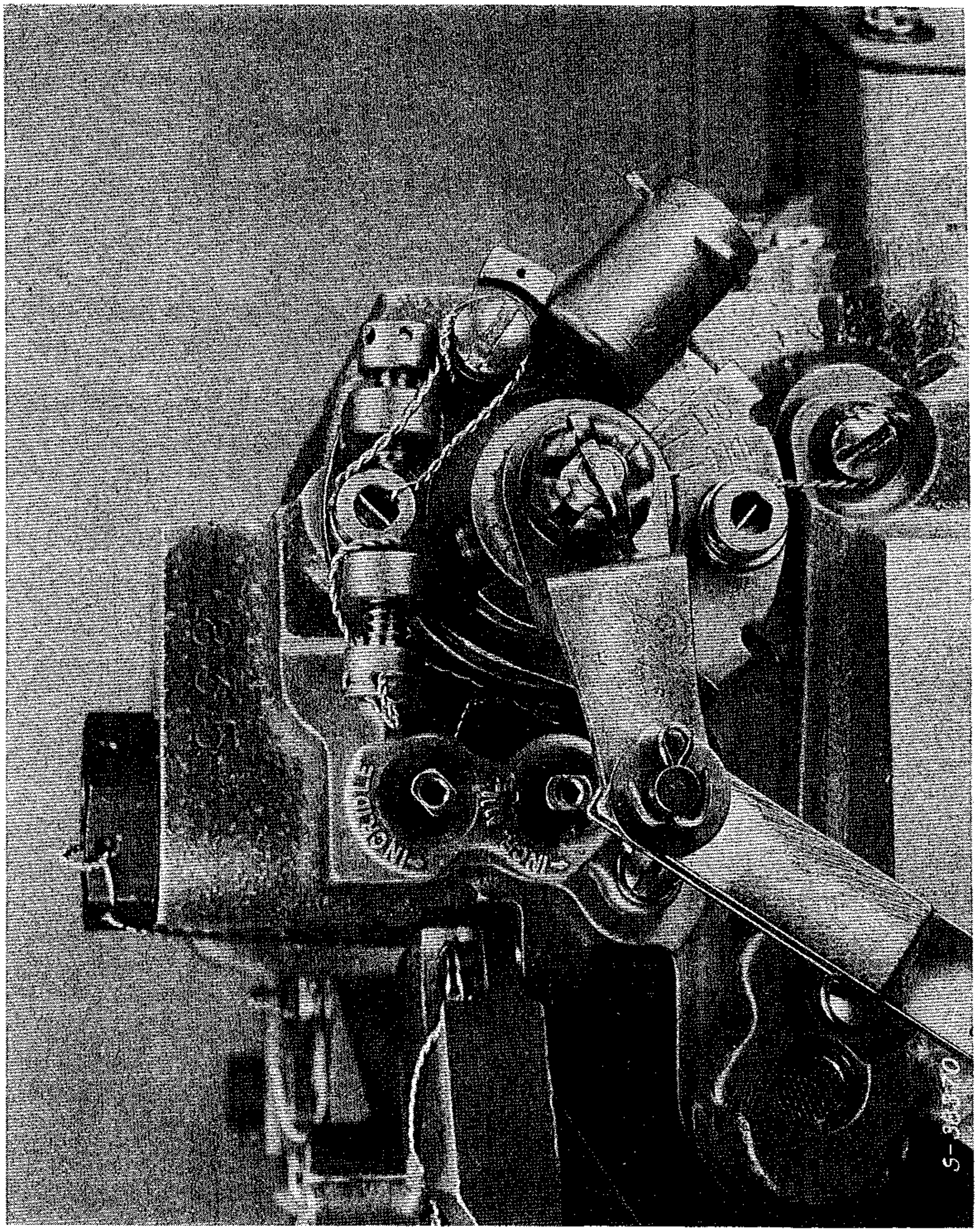

Figure I - Use of JFC46 Fuel Control Rigging Tool (P/N GS11836)

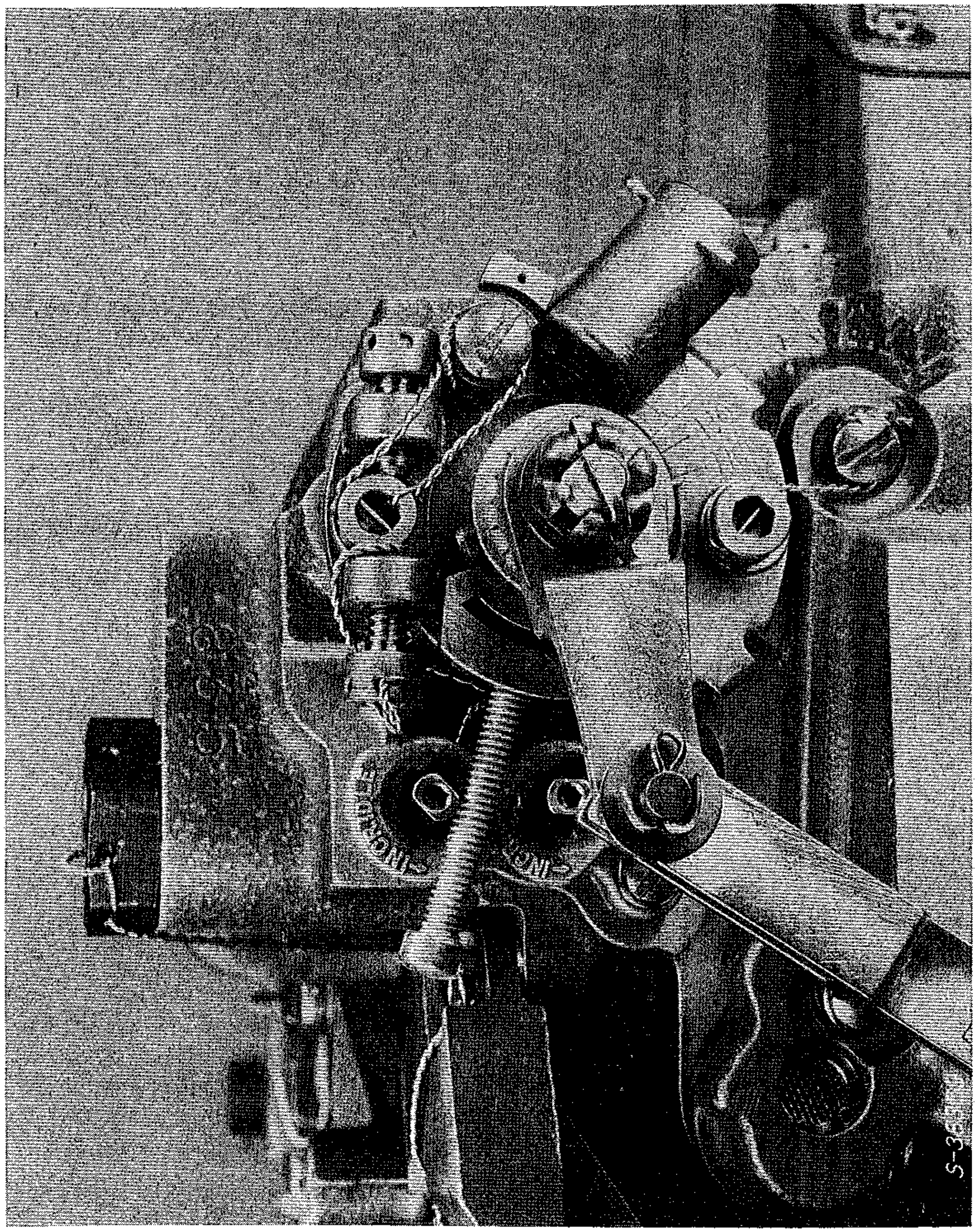

Figure II - Use of JFC46 Fuel Control Rigging Tool (P/N GS11836)

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL. PART NO. 435107

REVISION NO. 34 DATED DECEMBER 15, 1975

TEMPORARY REVISION INDEX

INACTIVE

The following Temporary Revisions are now inactive and should be removed from your PRINTED MANUALS and from the file of Temporary Revisions used in conjunction with MICROFILM.

Temp. Rev. No.	Filed Adjacent To	Remarks
1	Page 1-3	Incorporated
2	Page 1-6A	Incorporated

ACTIVE

Temp. Rev. No.	Filed Adjacent To	Remarks
None		

Active Temporary Revisions must be retained in PRINTED MANUALS and in the MICROFILM Temporary Revision File until otherwise directed by subsequent filing instructions.

Subject: JT12A and JFTD12A Engines Maintenance Manual,
Part No. 435107, Revision No. 33 Dated October 15/74.

Please insert these pages into your copy of subject manual in accordance with List of Effective Pages, and record the insertions on the Record of Revisions Sheet.

List of Revised Pages

Page	Disposition	Reason For Revision
Title	Replace	*
List of Revisions	Replace	*
A, B, C	Replace	*
1-2	Replace	Tools added
2-44C, 2-44D	Replace	Ignition exciter assembly revised and figure added.
2-53	Replace	Main oil pressure relief valve inspection and repair added.
2-57	Replace	Fuel manifold lockwire instructions revised.
2-58B-2	Replace	Inspection of free turbine speed sensing flexible shaft revised.
2-58B-3	Replace	Figure of free turbine speed sensing flexible shaft - square drive ends added.
2-58B-5, 2-58B-6	Replace	Installation of free turbine speed sensing flexible shaft-oil pressure lubricated, added.
2-58B-10A thru 2-58B-10C	Add	Figures of fuel control flexible shaft assembly, bevel gearshaft, and manifold assembly installation added.
2-58B-10D	Add	Figure of intake and exhaust danger area relocated.

List of Revised Pages

Page	Description	Reason For Revision
2-67, 2-68	Replace	Ref. No. 1004, 1005, 1006, 1007, 1008, 1035 added.
2-131/2-132	Replace	Figure revised.
2-133/2-134	Replace	Figure revised.
2-134A/2-134B	Add	Figure revised.
3-6-1	Replace	Cycle for JFTD12A added.

*Editorial Requirement

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 41, DATED FEBRUARY 1, 1980

HIGHLIGHTS

Pages which have been revised are outlined below together with the highlights of the revision. Recipients of printed manuals shall refer to the List of Effective Pages for filing instructions.

To avoid any break in continuity of revision service, please direct any change in address or revision requirements to: Supervisor - Distribution, Technical Publications, Product Support Department, Pratt & Whitney Aircraft, P.O. Box 611, Middletown, Connecticut 06457.

Section	Page No.	Description of Change
Title		Revised
List of Revisions		Revised
List of Effective Pages		Revised
Periodic Inspection	3-1	Revised paragraph 3-2 to add reference to overhaul manual for repair and inspection of items not covered in this section
Preparation for Storage or Service	4-5, 4-6	Consolidated paragraphs 4-15 and 4-17 into one paragraph dealing with fuel controls and fuel system components preservation; added a Note to paragraph 4-16, step g.

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 41, DATED FEBRUARY 1, 1980

TEMPORARY REVISION HIGHLIGHTS

INACTIVE

The following Temporary Revisions are now inactive and should be removed from your printed manual and from the MICROFILM Temporary Revision File.

Temp. Rev.	Filed Adjacent To	Remarks

There were no outstanding Temporary Revisions as of December 5, 1979.

ACTIVE

The following Temporary Revisions, and any issued after December 5, 1979, are active and should be retained in your printed manual and in the MICROFILM Temporary Revision File until otherwise directed by subsequent filing instructions.

Temp. Rev.	Filed Adjacent To	Remarks

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 39, DATED JUNE 15, 1978

Pages which have been revised are outlined below together with the highlights of the revision. Recipients of printed manuals shall refer to the List of Effective Pages for filing instructions.

To avoid any break in continuity of revision service, please direct any change in address or revision requirements to: Supervisor - Distribution, Technical Publications, Product Support Department, Pratt & Whitney Aircraft, P.O. Box 611, Middletown, Connecticut 06457.

HIGHLIGHTS

Section	Page No.	Description of Change
Title		Revised.
List of Revisions		Revised.
List of Effective Pages		Revised.
Table of Contents		Revised.
Maintenance	2-50B	Revised procedure for assembling fuel de-icing heater to specify that the sleeve spacer, installed in the lower mounting lug, have the ring groove located toward the front.
	2-50B-1/ 2-50B-2, 2-50C/2-50D	Pages deleted.
	2-50C, 2-50D	Editorial requirement, pages added.
	2-58Q	Specified that oil level check be made within one hour of engine shutdown.
Periodic Inspection	All	Section III was revised in its entirety to improve numbering of pages, paragraphs and figures. The procedure for bonding the bumper on oil tank bracket was revised to provide a high strength adhesive (Page 3-14); revised procedure for bonding cushions to the compressor bleed valve strap (Page 3-18).
Index		Revised.

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 38 DATED DECEMBER 15, 1977

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HIGHLIGHTS

Section	Page No.	Description of Change
Title		Revised.
List of Revisions		Revised.
List of Effective Pages		Revised.
Table of Contents		Revised.
Maintenance	2-48A, 2-48B, 2-49, 2-50, 2-50-1, 2-50-2	Incorporated Temporary Revision No. 3.
	2-56A, 2-56B 2-56C/2-56D, 2-57, 2-58	Provided quantitative fuel nozzle flow check as an alternate to the visual flow check.
Index		Revised.

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HIGHLIGHTS

Page	Disposition	Reason for Revision
Title	Replace	*
List of Revisions	Replace	*
List of Effective Pages A, B, (C/D blank)	Replace	*
1-1	Replace	Added Tool Group 2C.
1-2	Replace	*
1-6A/1-6B	Replace	Added Tool PWA 13708 and PWA 39027.
2-28B	Replace	Added JFTD12A-5A overspeed protective system data.
2-28C/2-28D	Replace	*
2-34	Replace	Added EPR increase problem to table.
2-34A/2-34B	Replace	*
2-53	Replace	Added rivet data for four additional valve assemblies.
2-62A	Replace	Replaces Page 2-62A/(2-62B blank). Revised data on torque indicating devices and revised Figure 2-52.

Page	Disposition	Reason for Revision
2-62B	Added	Relocated Table of Limits data from Page 2-62A/(2-62B blank) and revised Note for Ref. No. 146.
3-2	Replace	Changed asbestos tape to ceramic fiber tape.
3-6-3/3-6-4	Replace	Changed asbestos wool to bulk ceramic fiber.
3-6B	Replace	Changes asbestos to bulk ceramic fiber. Added data on bleed strap cushion replacement.
3-6C	Replace	Added data on bleed strap cushion replacement.
3-6E	Replace	Was Page No. 3-6E/(3-6F blank).
3-6F	Added	Added repair for combustion chamber No. 6 liner.
3-8C/3-8D	Added	Added Figure 3-12-1 and key.
3-12	Replace	Added reference to Tool Group 2C.
3-13	Replace	Revised procedure for replacement of bushing. Replaced asbestos with bulk ceramic fiber.
1A-1	Replace	Added ceramic fiber data to table.
2A-1	Replace	Revised lockwiring data.
2A-2	Replace	Revised Figure 2A-1 to require 8-10 turns instead of 7-10 turns.
Index-1	Replace	Added Repair for combustion chambers.

*Editorial Requirement

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 37 DATED JUNE 15, 1977

TEMPORARY REVISION INDEX

INACTIVE

The following Temporary Revisions are now inactive and should be removed from your PRINTED MANUALS and from the file of Temporary Revision used in conjunction with MICROFILM.

Temp. Rev. No.	Filed Adjacent To	Remarks
None		

ACTIVE

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Temp. Rev. No.	Filed Adjacent To	Remarks
None		

4813
1164
154

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 36 DATED DECEMBER 15, 1976

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HIGHLIGHTS

Page	Disposition	Reason for Revision
Title	Revised	
List of Revisions	Revised	
List of Effective Pages A, B	Revised	
2-38, 2-38-3/ 2-38-4	Added table for assembly of flexible type fittings.	
2-58B	Revised table numbers.	
2-64 2-64A/2-64B, 2-65	Added symbol for disks with no further potential for life extension.	

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 36 DATED DECEMBER 15, 1976

TEMPORARY REVISION INDEX

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None		

In Reply Please Refer To:
RGB:FPL:js Svc. Engrg.

Pratt & Whitney Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION

Alert Letter No. 26

May 16, 1966

The Ethyl Corporation
330 So. Fourth Street
Richmond, Virginia

Attention: Mr. R. T. Cavedo
Chief Pilot

Subject: Lifting Instructions on the Engine Shipping Box and Mount Assembly P/N P-24984

Gentlemen:

There has been one reported instance of lifting ring failure when hoisting loaded container. You are advised not to lift the subject container by lifting rings when full. If you have containers on hand with stencil "Caution: Use all four lifting rings ______" recommend this be changed to read "Do not use lifting rings ______". Also change "______ Lifting container with top rings" to "______ Lifting empty container with top rings".

Very truly yours,

PRATT & WHITNEY AIRCRAFT

R. G. Bentzinger
Chief, Technical Services

RGB:FPL:js
cc: F. C. Alderman (P&WA Repr.)

TO: RECIPIENTS OF THE JT12A MAINTENANCE MANUAL, PART NO. 435107

REVISION NO. 38 DATED DECEMBER 15, 1977

TEMPORARY REVISION INDEX

INACTIVE

The following Temporary Revisions are now inactive and should be removed from your printed manual and from the MICROFILM Temporary Revision File.

Temp. Rev.	Filed Adjacent To	Remarks
No. 3	Page 2-50	Incorporated

ACTIVE

The following Temporary Revisions, and any issued after November 1, 1977, are active and should be retained in your printed manual and in the MICROFILM Temporary Revision File until otherwise directed by subsequent filing instructions.

Temp. Rev.	Filed Adjacent To	Remarks
None		

INTRODUCTION

1. This publication comprises the maintenance instructions for the models JT12A-6, JT12A-6A, and JT12A-8 turbojet engines and JFTD12A-4A and JFTD12A-5A free turbine engines (Figures 1 through 21) manufactured by Pratt & Whitney Aircraft, Division of United Technologies Corporation, East Hartford, Connecticut 06108, U. S. A. This manual, as it may be supplemented by P&WA service bulletins, constitutes the authoritative statement of Pratt & Whitney Aircraft's approved and recommended maintenance procedure for the JT12A and JFTD12A engines.

2. These engines are still undergoing intensive improvements in design. Consequently, it is anticipated that the appearance of certain parts, and the replacement, repair, and adjustment procedures, as they appear in this manual, may soon be affected by design changes materializing too late for incorporated in this publication. The latest available information concerning parts and procedures so affected will be included in subsequent changes to this manual.

3. The descriptive and operational illustrations in this manual were prepared from basic engines. However, the service operations illustrated are those generally applicable in procedure, if not in appearance, to the current models.

4. 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 engine in a horizontal position and with the accessory section at the bottom of the engine.

5. The engine is made up of the following sections: compressor, diffuser, combustion, turbine, and accessory sections.

6. The combustion chambers are numbered one to eight in a clockwise direction. The top combustion chamber to the right of the vertical centerline of the engine is designated No. 1.

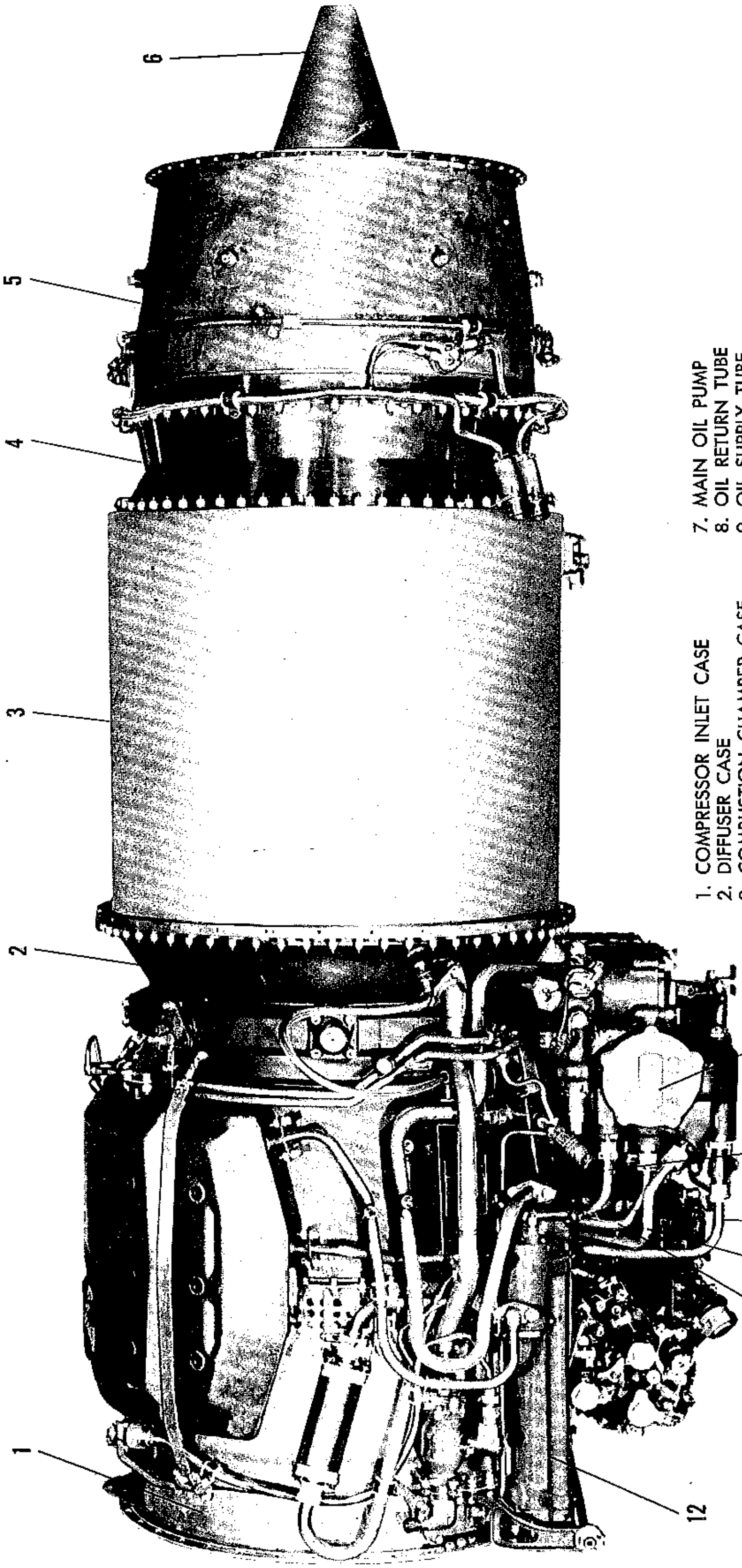
7. Table 1 lists the major differences of the engine models covered in this manual.

TABLE 1. MODEL DIFFERENCES

		JT12A-6 and JT12A-8		JFTD12A-4A, and JFTD12A-5A (Free Turbine)
	JT12A-6	Lockheed (L)	N. American (N)	
Nose Cone	Standard	Standard	Optional	Standard
Oil Tank	Side Mounted	Side Mounted	Saddle	Saddle
Tachometer Drive	At Main Oil Pump	At Main Oil Pump	On Gearbox	On Gearbox
Top Engine Mount	Combustion Case	Combustion Case	Inlet Case	Free Turbine Case

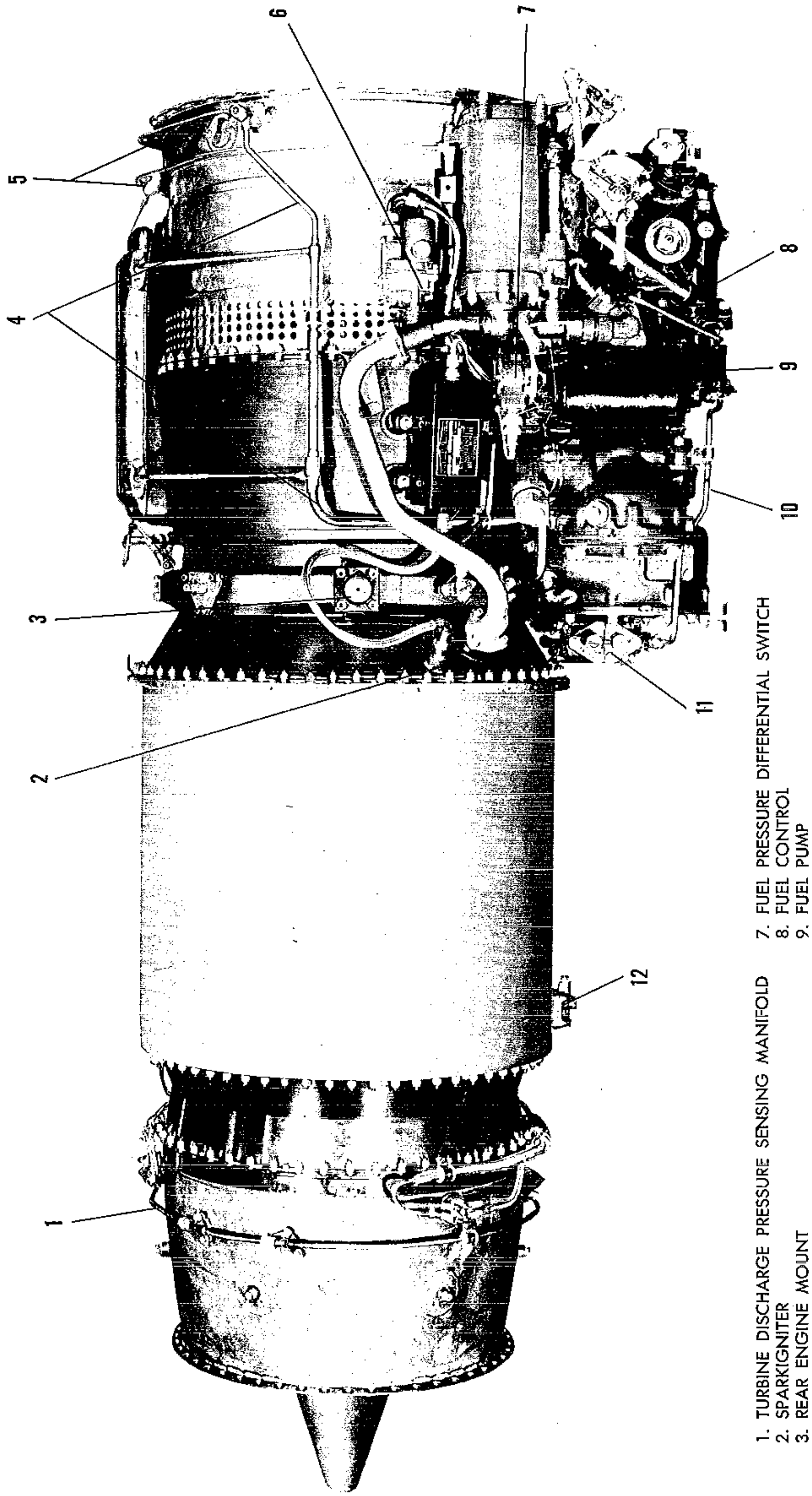
8. The use of abbreviations has been avoided as much as practicable in this manual. In some instances however, such considerations as spacer limitations and common usage have made use of abbreviations preferable to use of the applicable longer terms. Abbreviations used are defined as follows:

Abbreviation	Definition
assy.	Assembly
C	Centigrade
dia.	diameter
dim.	dimension
EPR	engine pressure ratio
F	Fahrenheit
FIR	full indicator reading
ID	inside diameter
in.	inch
lb. in.	pound-inch
LH	left-hand
max.	maximum
min.	minimum
No.	number
OD	outside diameter
PD	pitch diameter
P/N	part number
psi	pounds per square inch absolute
psig	pounds per square inch gage
PWA	Pratt & Whitney Aircraft
ref.	reference
RH	right-hand
rpm	revolutions per minute
sq. ft.	square feet
thd.	thread
vs.	versus



1. COMPRESSOR INLET CASE
2. DIFFUSER CASE
3. COMBUSTION CHAMBER CASE
4. TURBINE CASE
5. TURBINE EXHAUST CASE
6. TAIL CONE
7. MAIN OIL PUMP
8. OIL RETURN TUBE
9. OIL SUPPLY TUBE
10. NO. 3 BEARING OIL SCAVENGE TUBE
11. NO. 1 BEARING OIL SCAVENGE TUBE
12. FUEL COOLANT OIL COOLER

Figure 1A. Left Side View of Engine (JT12A-6A[N])



1. TURBINE DISCHARGE PRESSURE SENSING MANIFOLD
2. SPARKIGNITER
3. REAR ENGINE MOUNT
4. BREATHER MANIFOLD
5. FRONT ENGINE MOUNT
6. FUEL DE-ICING AIR SHUT-OFF VALVE
7. FUEL PRESSURE DIFFERENTIAL SWITCH
8. FUEL CONTROL
9. FUEL PUMP
10. FUEL SIGNAL TUBE
11. FUEL PRESSURIZING AND DUMP VALVE
12. COMBUSTION CHAMBER FUEL DRAIN VALVE

Figure 1B. Right Side View of Engine (JT12A-6A[N])

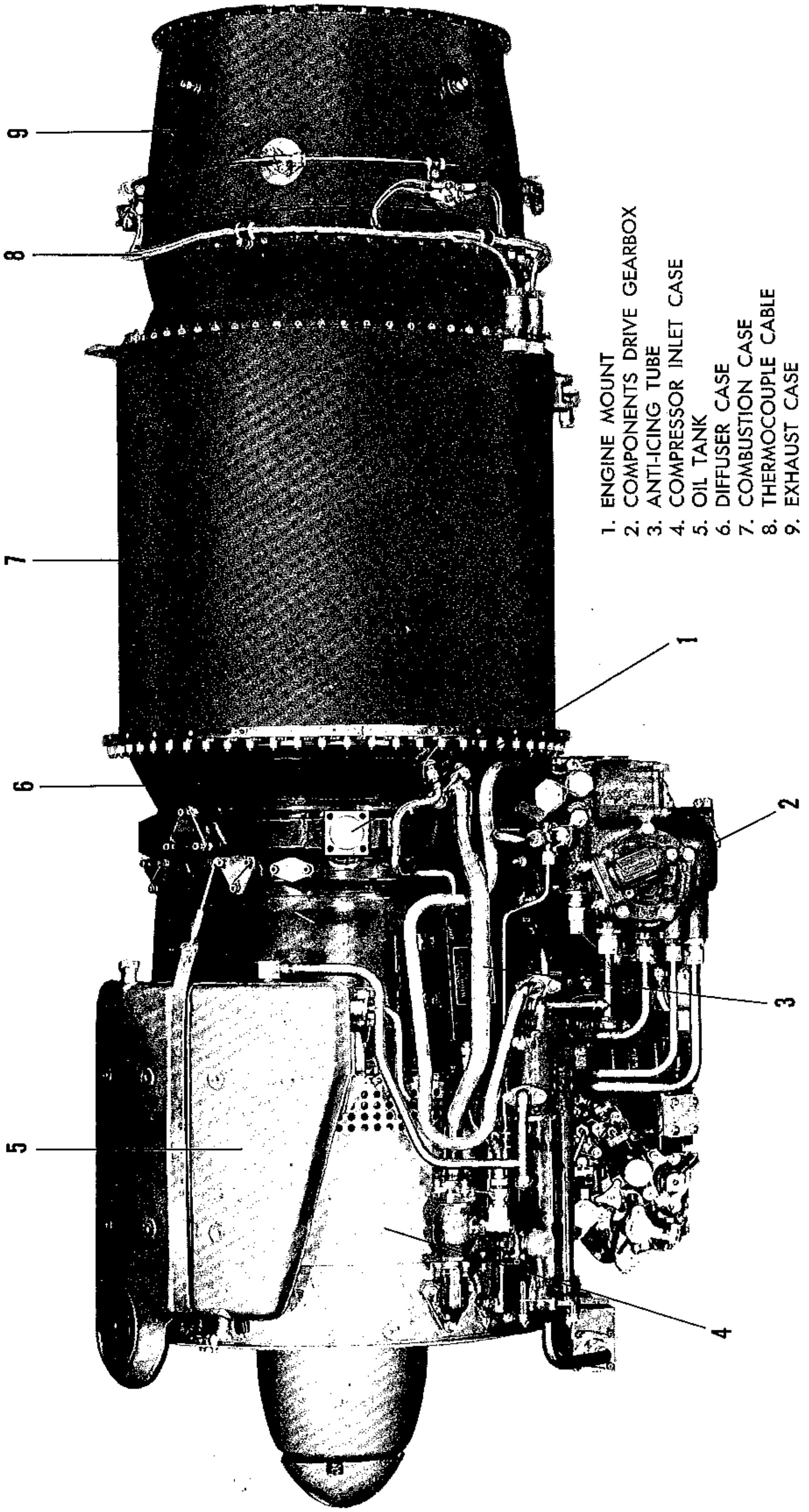


Figure 1. Left Side View of Engine (JT12A-6, JT12A-6A[L] and JT12A-8[L])

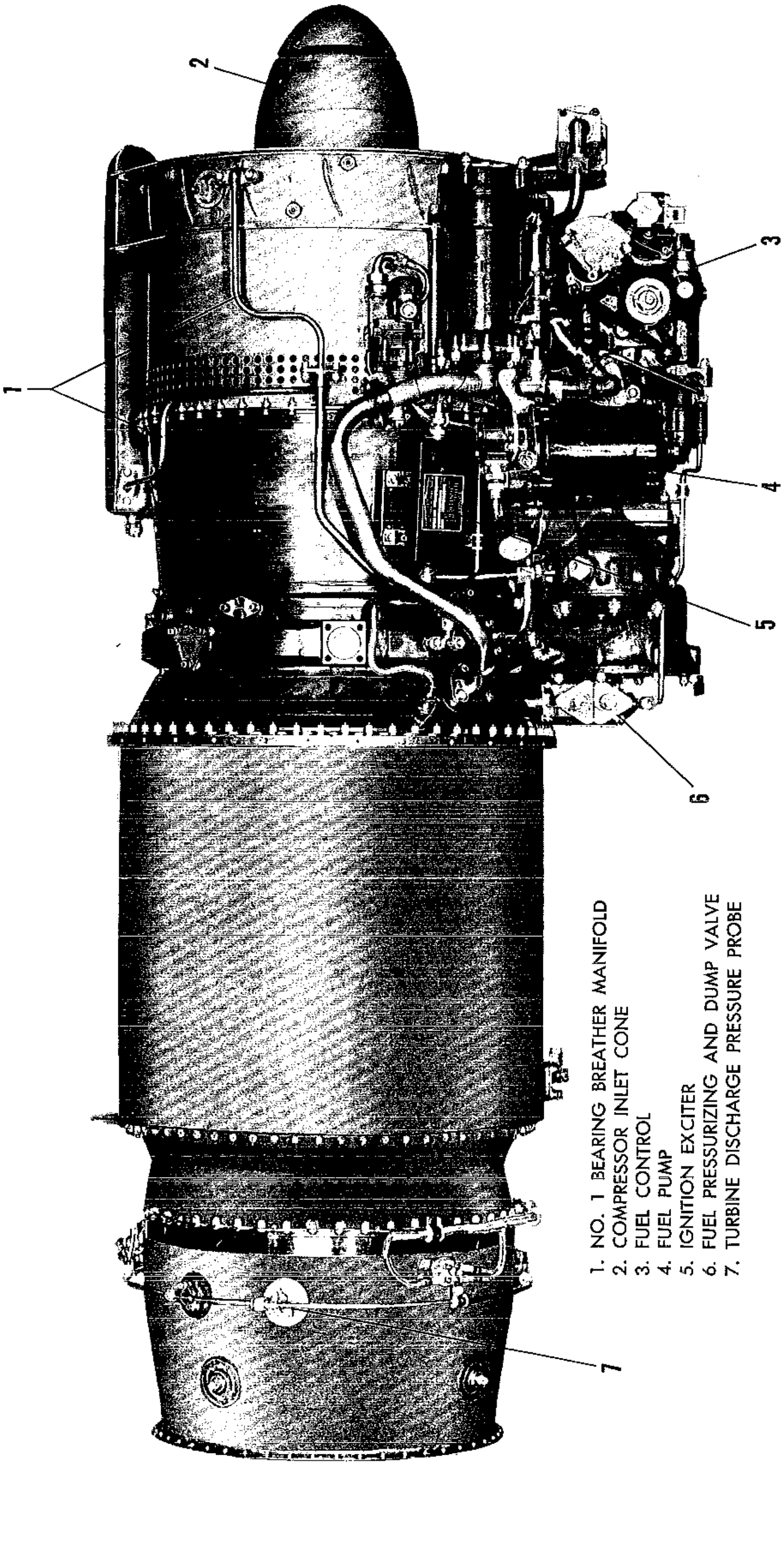
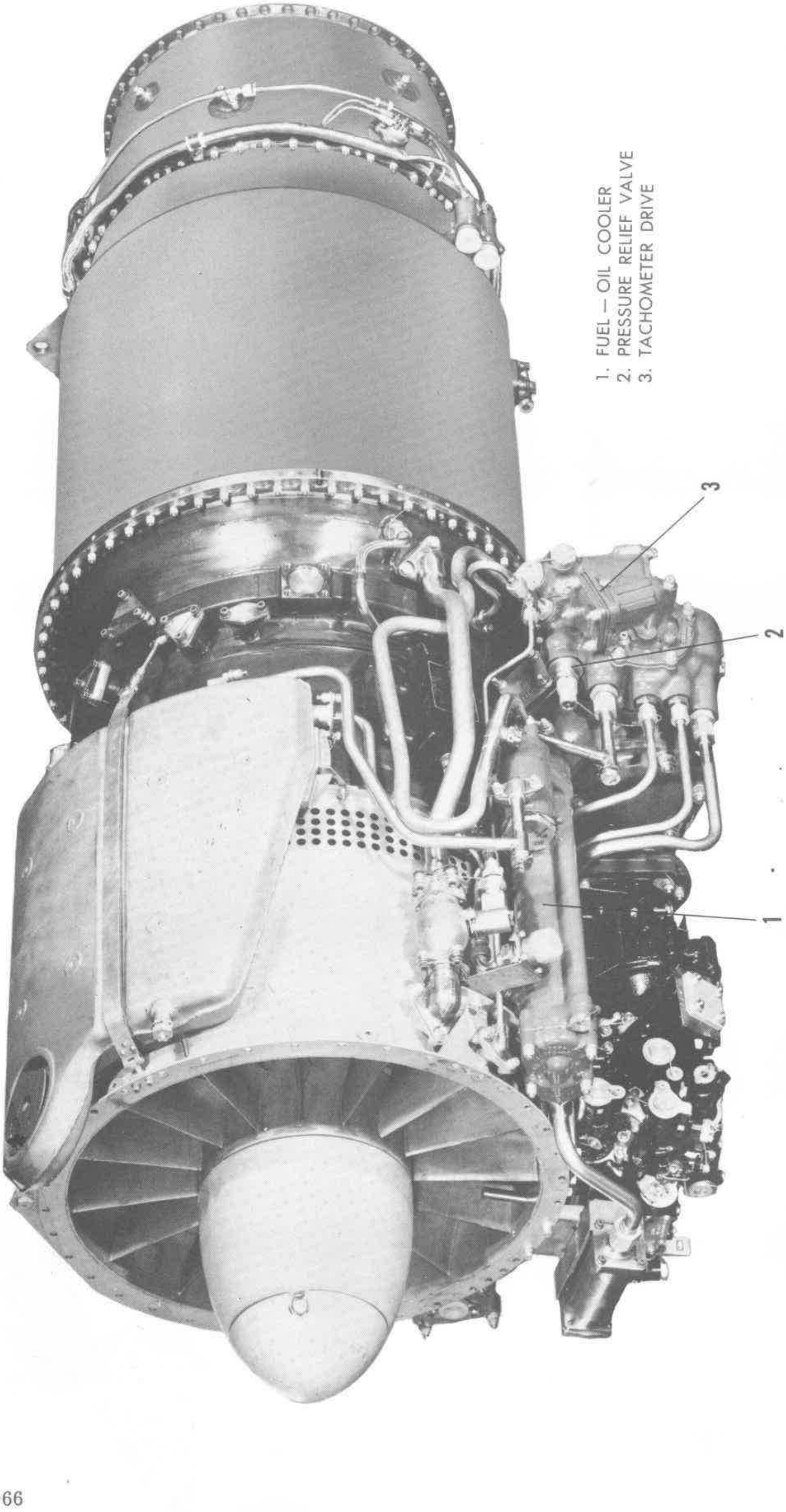


Figure 2. Right Side View of Engine (JT12A-6, JT12A-6A[L]and JT12A-8[L])



1. FUEL — OIL COOLER
2. PRESSURE RELIEF VALVE
3. TACHOMETER DRIVE

Figure 3. Left Front View of Engine (JT12A-6, JT12A-6A[L]and JT12A-8[L])

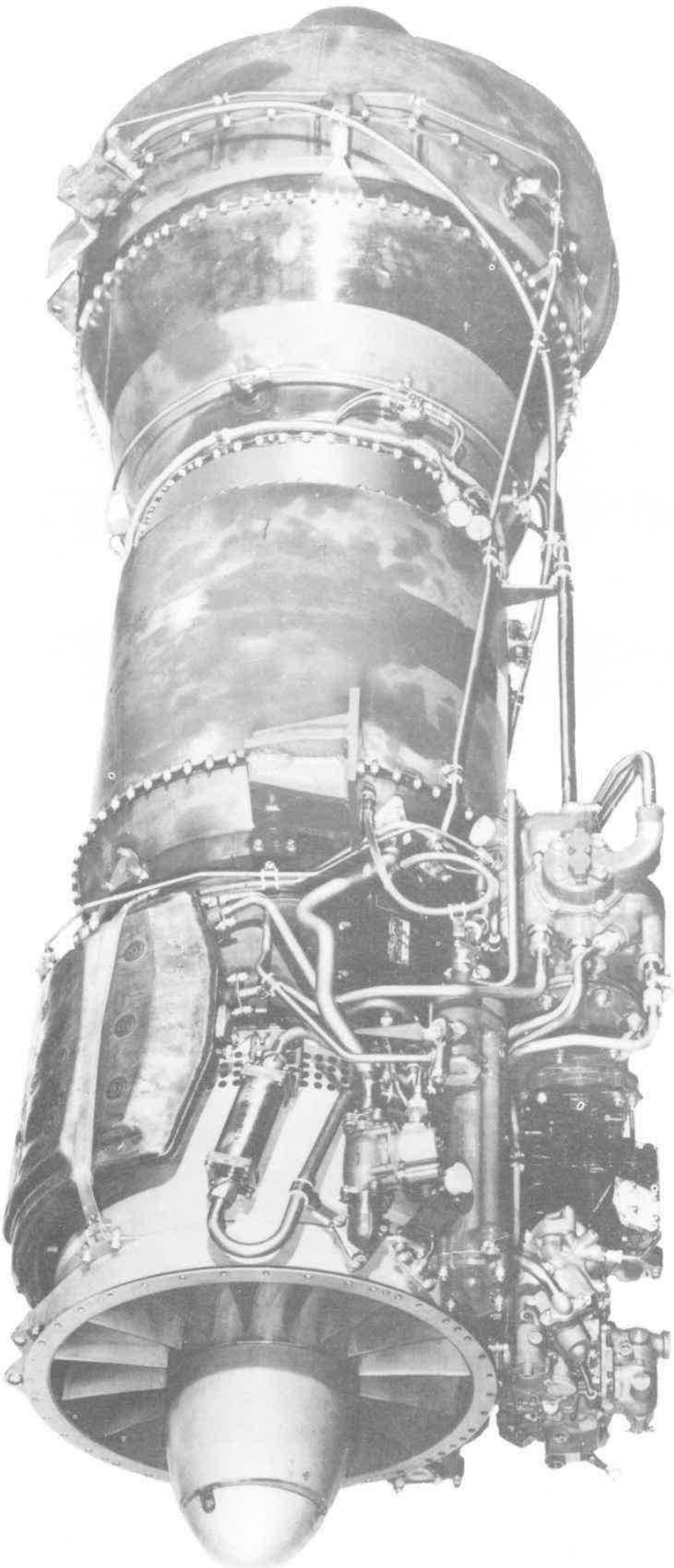
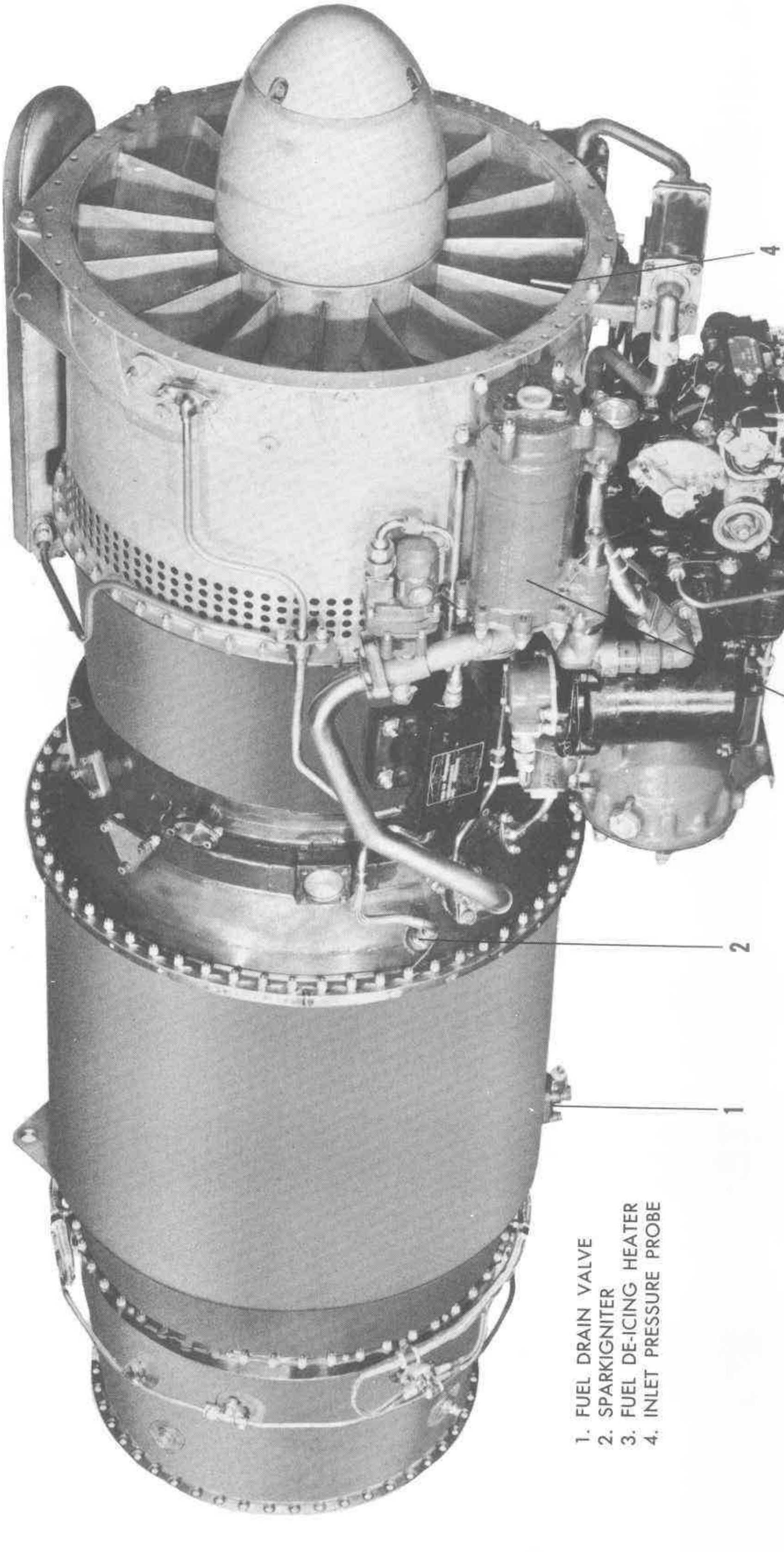


Figure 3C. Left Front View of Free Turbine Engine



1. FUEL DRAIN VALVE
2. SPARKIGNITER
3. FUEL DE-ICING HEATER
4. INLET PRESSURE PROBE

Figure 3C. Left Front View of Free Turbine Engine

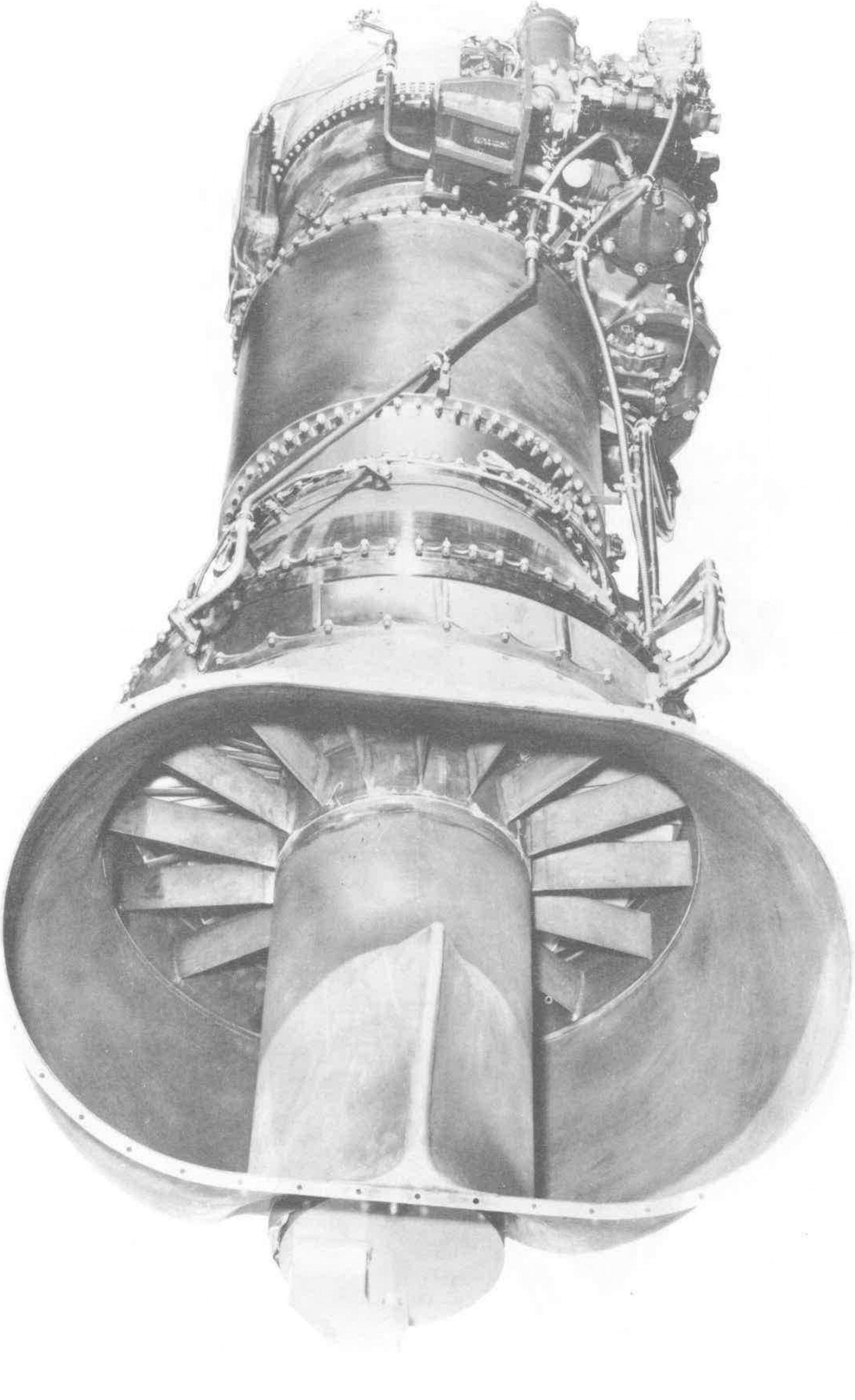


Figure 4B. Right Rear View of Free Turbine Engine

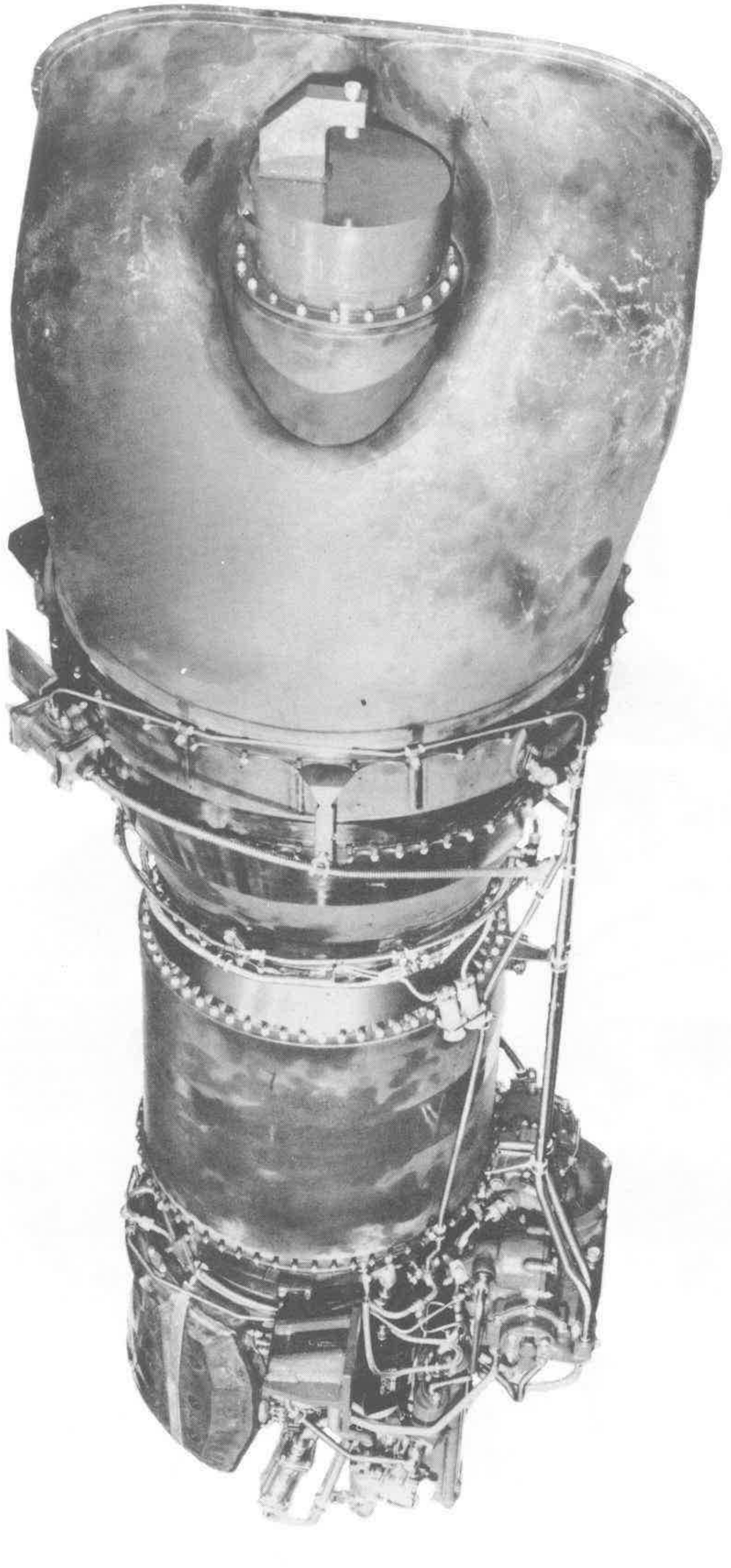
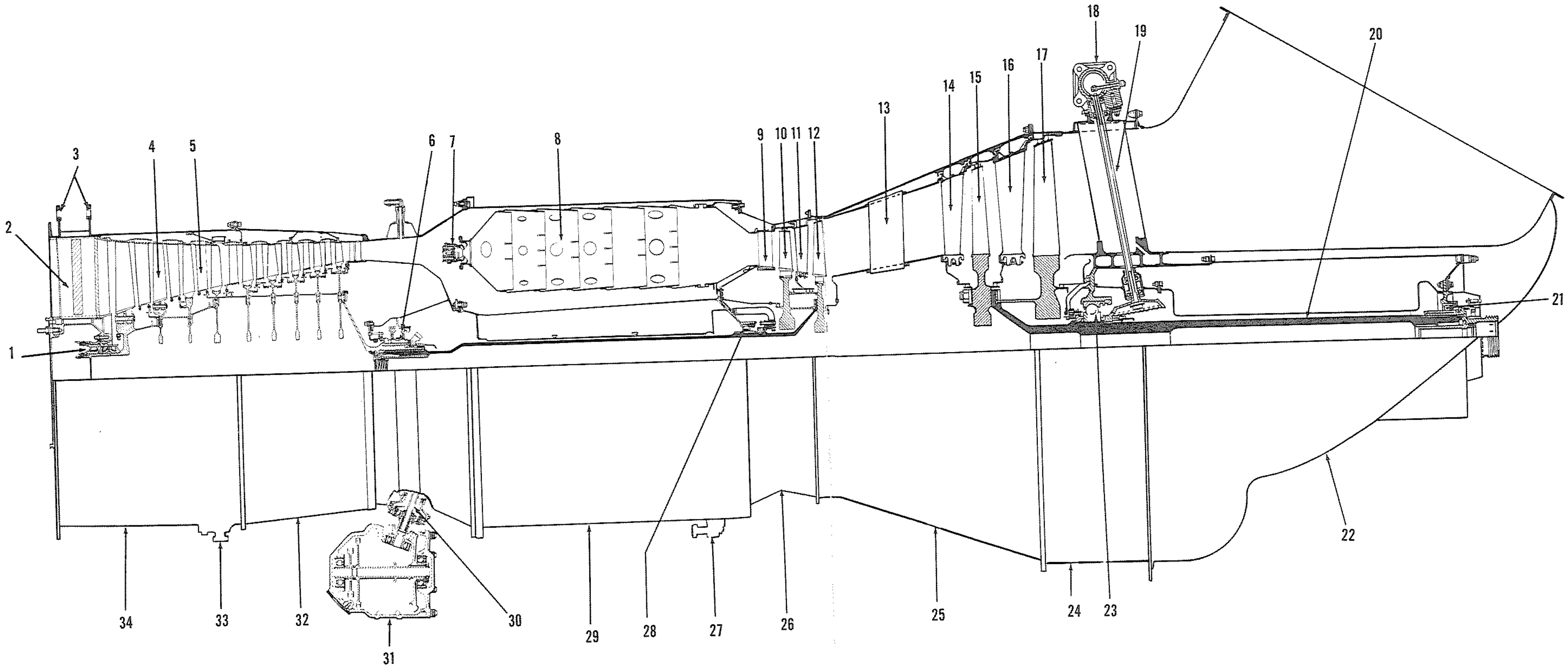
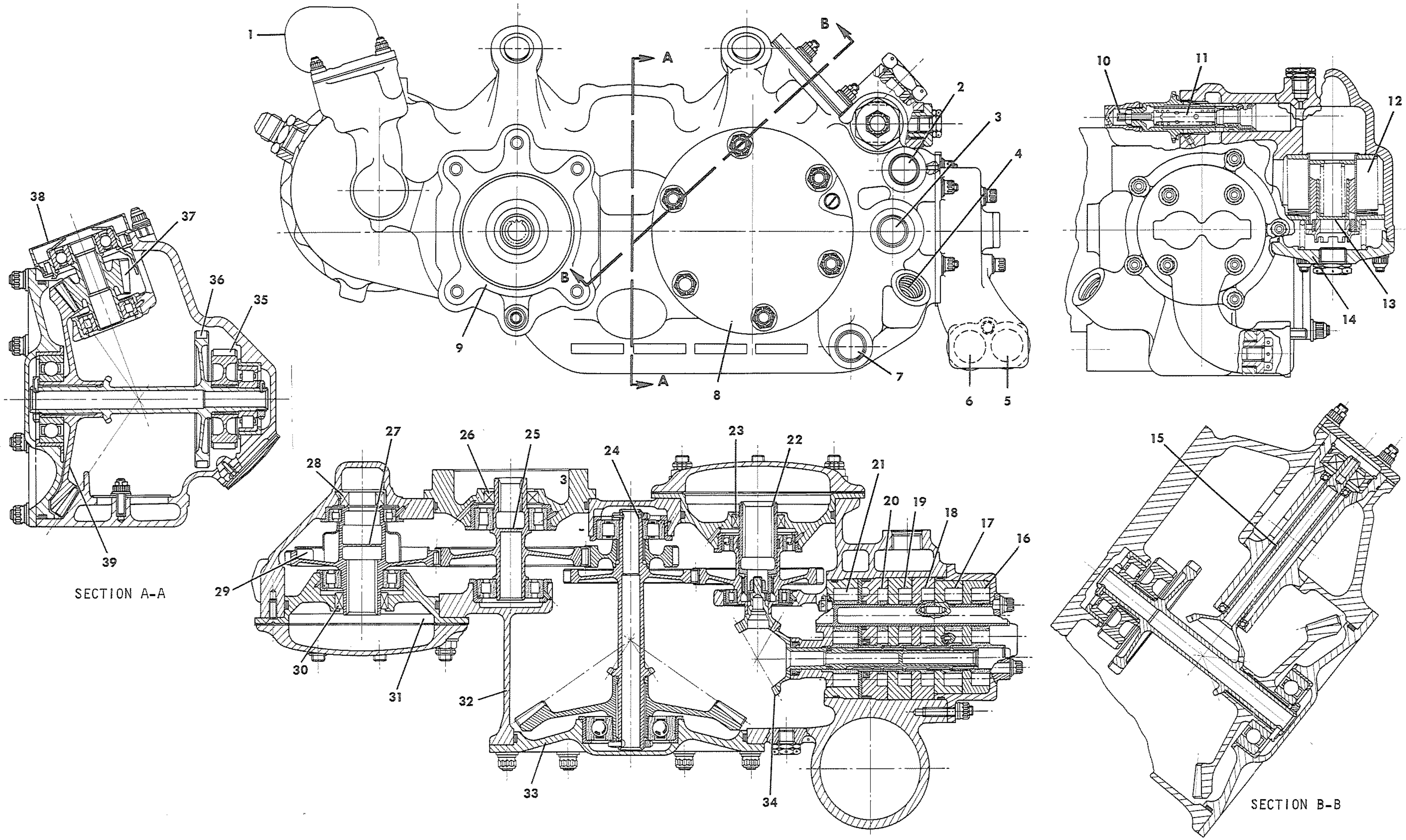


Figure 4C. Left Rear View of Free Turbine Engine



1. NO. 1 BEARING (ROLLER)
2. COMPRESSOR INLET VANE
3. FRONT ENGINE MOUNT
4. COMPRESSOR BLADE
5. COMPRESSOR VANE
6. NO. 2 BEARING (BALL)
7. FUEL NOZZLE
8. COMBUSTION CHAMBER
9. FIRST STAGE TURBINE VANE
10. FIRST STAGE TURBINE BLADE
11. SECOND STAGE TURBINE VANE
12. SECOND STAGE TURBINE BLADE
13. FREE TURBINE INLET VANE
14. FREE TURBINE FIRST STAGE VANE
15. FREE TURBINE FIRST STAGE BLADE
16. FREE TURBINE SECOND STAGE VANE
17. FREE TURBINE SECOND STAGE BLADE
18. FREE TURBINE ACCESSORY DRIVE GEARBOX
19. FREE TURBINE ACCESSORY DRIVE SHAFT
20. FREE TURBINE SHAFT
21. NO. 5 BEARING (ROLLER)
22. FREE TURBINE EXHAUST CASE
23. NO. 4 BEARING (BALL)
24. FREE TURBINE CASE
25. FREE TURBINE INLET CASE
26. TURBINE CASE
27. COMBUSTION CHAMBER FUEL DRAIN VALVE
28. NO. 3 BEARING (ROLLER)
29. COMBUSTION CHAMBER CASE
30. MAIN COMPONENT DRIVE TOWER SHAFT
31. COMPONENT DRIVES GEARBOX
32. DIFFUSER CASE
33. COMPRESSOR AIR BLEED VALVE
34. COMPRESSOR INLET CASE

Figure 6B. Cross Sectional View of Free Turbine Engine



1. Breather air outlet elbow
2. Oil return to tank
3. No. 1 bearing oil return
4. No. 3 bearing oil return
5. No. 5 bearing oil return
6. No. 4 bearing oil return
7. Oil supply
8. Starter-generator mount pad
9. Fuel control mount pad
10. Oil pressure adjusting screw
11. Oil pressure relief valve
12. Oil strainer screws and spacers
13. Main oil strainer by-pass valve
14. Main oil strainer cover
15. Tachometer drive shaft
16. No. 5 bearing scavenge pump
17. No. 4 bearing scavenge pump
18. No. 3 bearing scavenge pump
19. Gearbox scavenge pump
20. No. 1 bearing scavenge pump
21. Oil pressure pump
22. Starter-generator drive shaft
23. Starter-generator drive oil seal
24. Gearbox gearshaft
25. Fuel control drive gearshaft
26. Fuel control drive oil seal
27. Hydraulic pump gearshaft
28. Gearbox breather seal
29. Hydraulic pump rotary breather
30. Hydraulic pump oil seal
31. Hydraulic pump mount pad
32. Component drive gearbox housing
33. Component drive gearbox cover
34. Oil pump drive gearshaft
35. Fuel control drive gear
36. Main component drive gearshaft
37. Main component drive gearshaft gear
38. Gearbox main bearing support
39. Main component drive bevel gear

Figure 6C. Cross Sectional View of Component Drive Gearbox (JFTD12A)

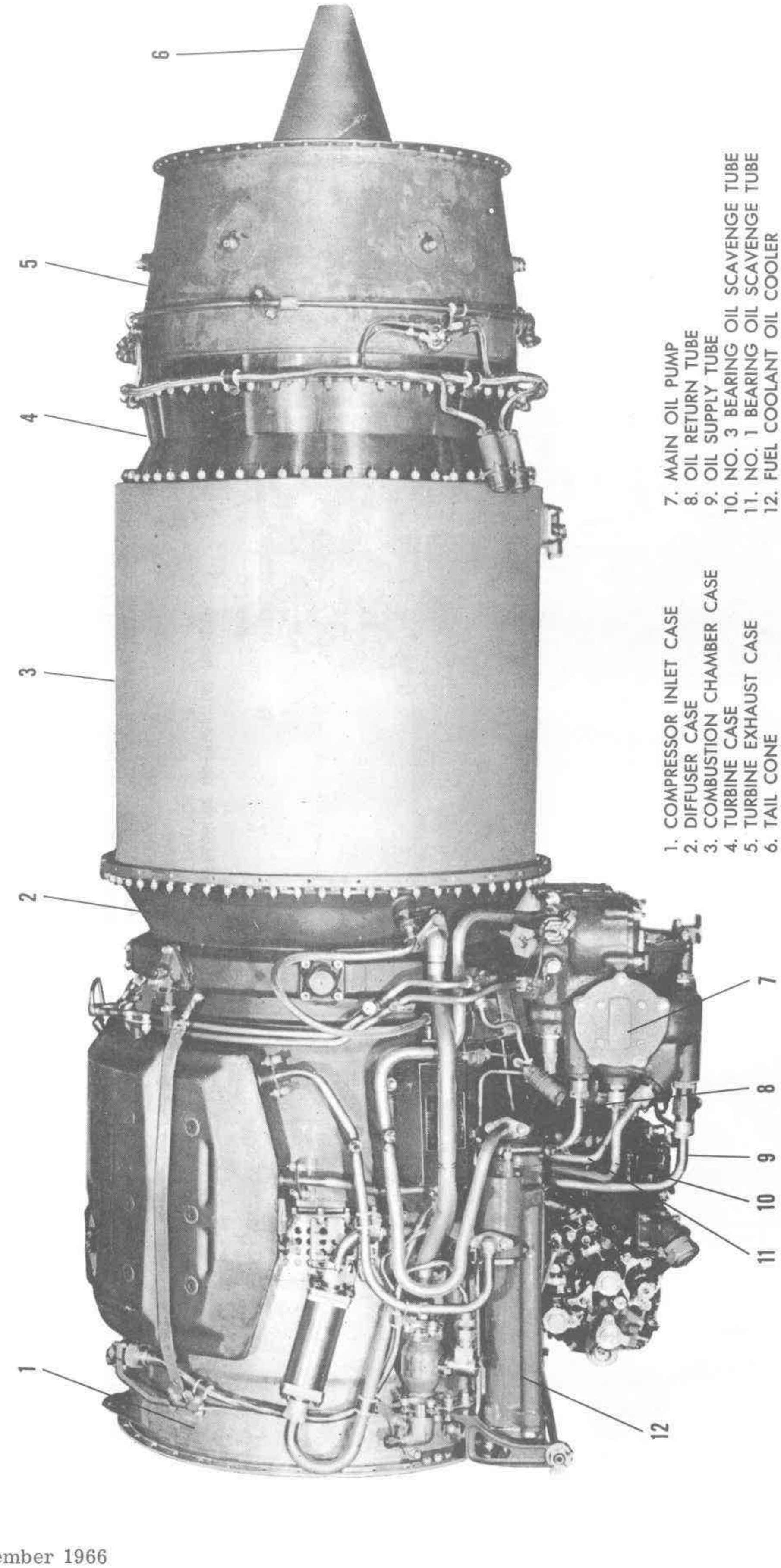
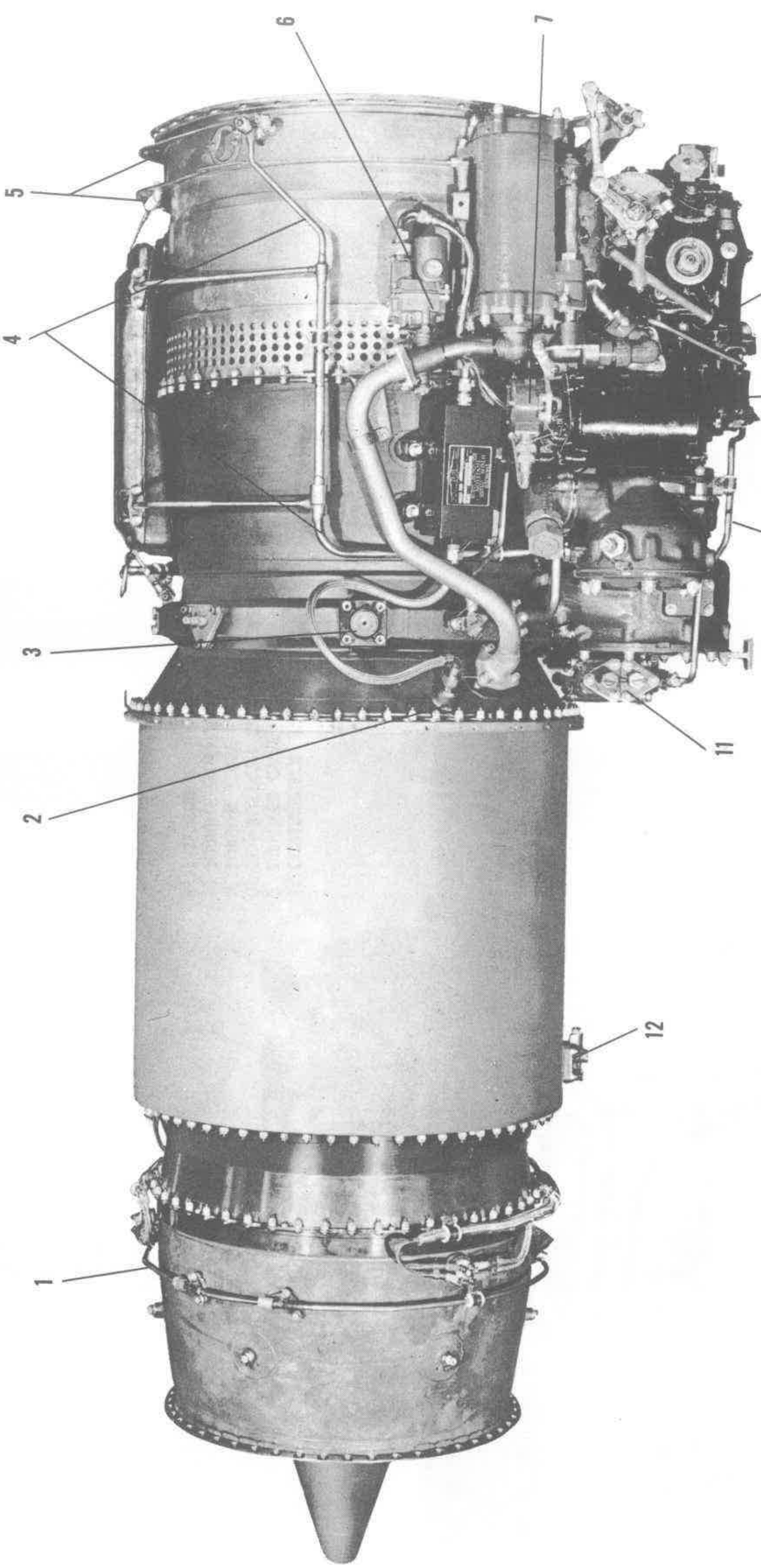
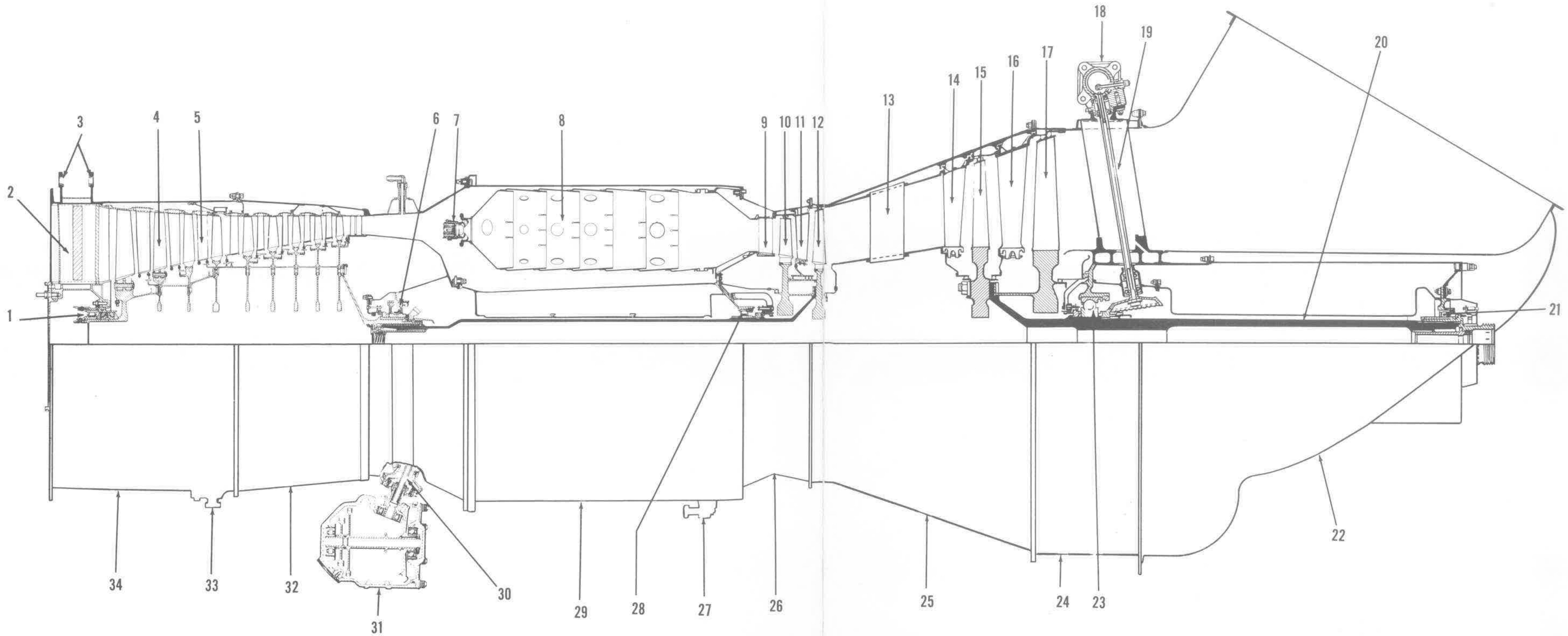


Figure 7. Left Side View of Engine (JT12A-6A[N] and JT12A-8[N])



1. TURBINE DISCHARGE PRESSURE SENSING MANIFOLD
2. SPARKIGNITER
3. REAR ENGINE MOUNT
4. BREATHER MANIFOLD
5. FRONT ENGINE MOUNT
6. FUEL DE-ICING AIR SHUT-OFF VALVE
7. FUEL PRESSURE DIFFERENTIAL SWITCH
8. FUEL CONTROL
9. FUEL PUMP
10. FUEL SIGNAL TUBE
11. FUEL PRESSURIZING AND DUMP VALVE
12. COMBUSTION CHAMBER FUEL DRAIN VALVE

Figure 8. Right Side View of Engine (JT12A-6A[N] and JT12A-8[N])



1. NO. 1 BEARING (ROLLER)
2. COMPRESSOR INLET VANE
3. FRONT ENGINE MOUNT
4. COMPRESSOR BLADE
5. COMPRESSOR VANE
6. NO. 2 BEARING (BALL)
7. FUEL NOZZLE
8. COMBUSTION CHAMBER
9. FIRST STAGE TURBINE VANE
10. FIRST STAGE TURBINE BLADE
11. SECOND STAGE TURBINE VANE
12. SECOND STAGE TURBINE BLADE
13. FREE TURBINE INLET VANE
14. FREE TURBINE FIRST STAGE VANE
15. FREE TURBINE FIRST STAGE BLADE
16. FREE TURBINE SECOND STAGE VANE
17. FREE TURBINE SECOND STAGE BLADE
18. FREE TURBINE ACCESSORY DRIVE GEARBOX
19. FREE TURBINE ACCESSORY DRIVE SHAFT
20. FREE TURBINE SHAFT
21. NO. 5 BEARING (ROLLER)
22. FREE TURBINE EXHAUST CASE
23. NO. 4 BEARING (BALL)
24. FREE TURBINE CASE
25. FREE TURBINE INLET CASE
26. TURBINE CASE
27. COMBUSTION CHAMBER FUEL DRAIN VALVE
28. NO. 3 BEARING (ROLLER)
29. COMBUSTION CHAMBER CASE
30. MAIN COMPONENT DRIVE TOWER SHAFT
31. COMPONENT DRIVES GEARBOX
32. DIFFUSER CASE
33. COMPRESSOR AIR BLEED VALVE
34. COMPRESSOR INLET CASE

Figure 6B. Cross Sectional View of Free Turbine Engine

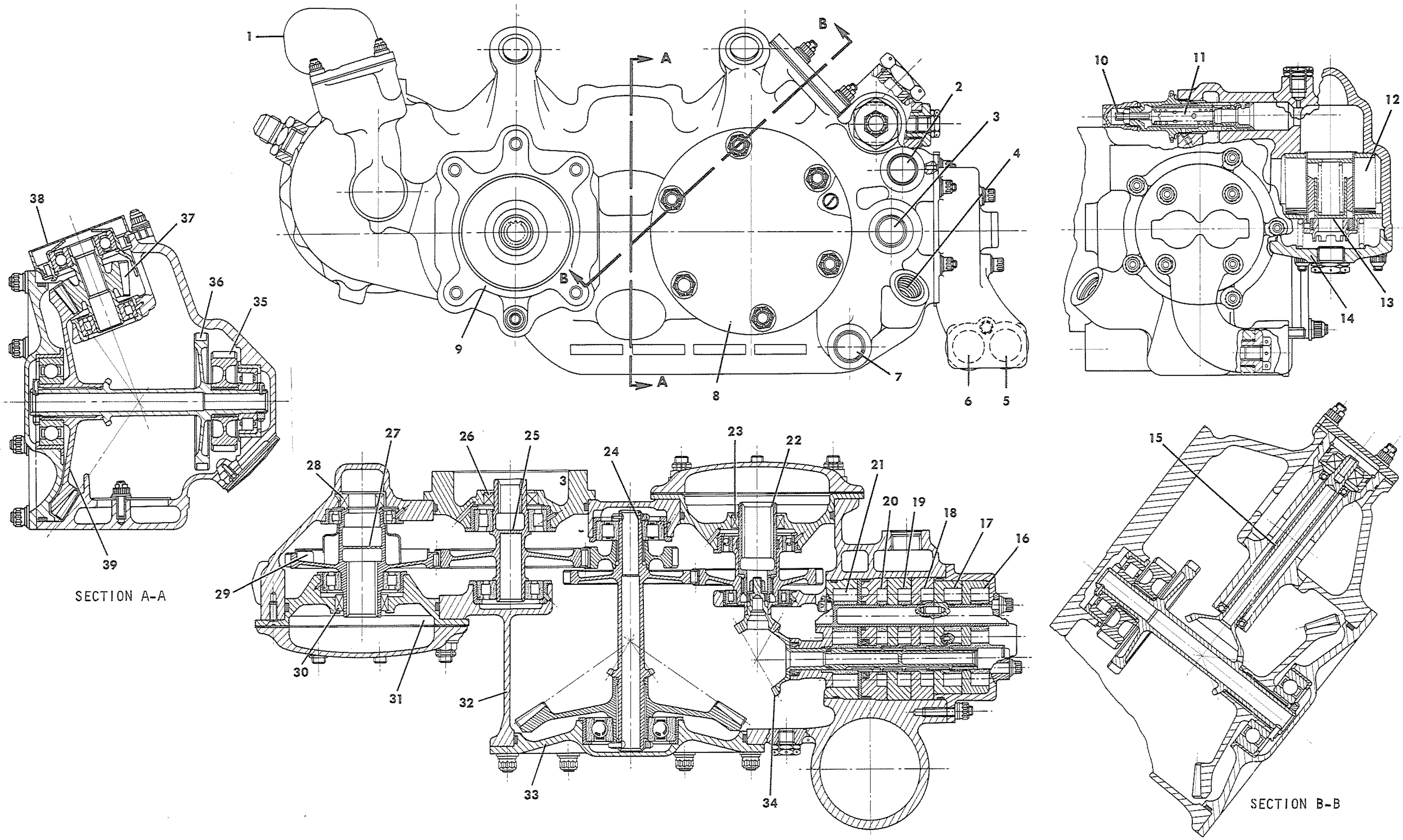
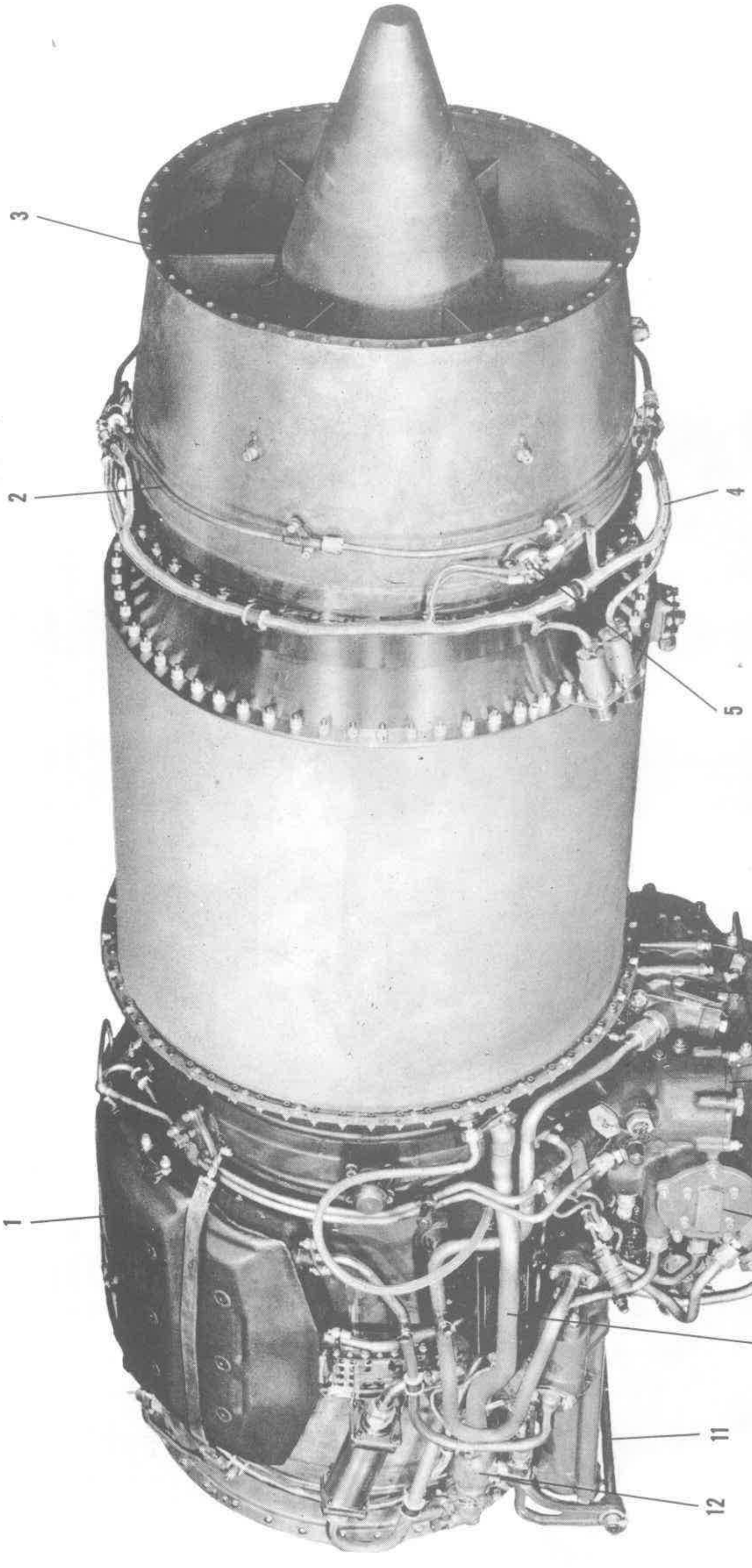


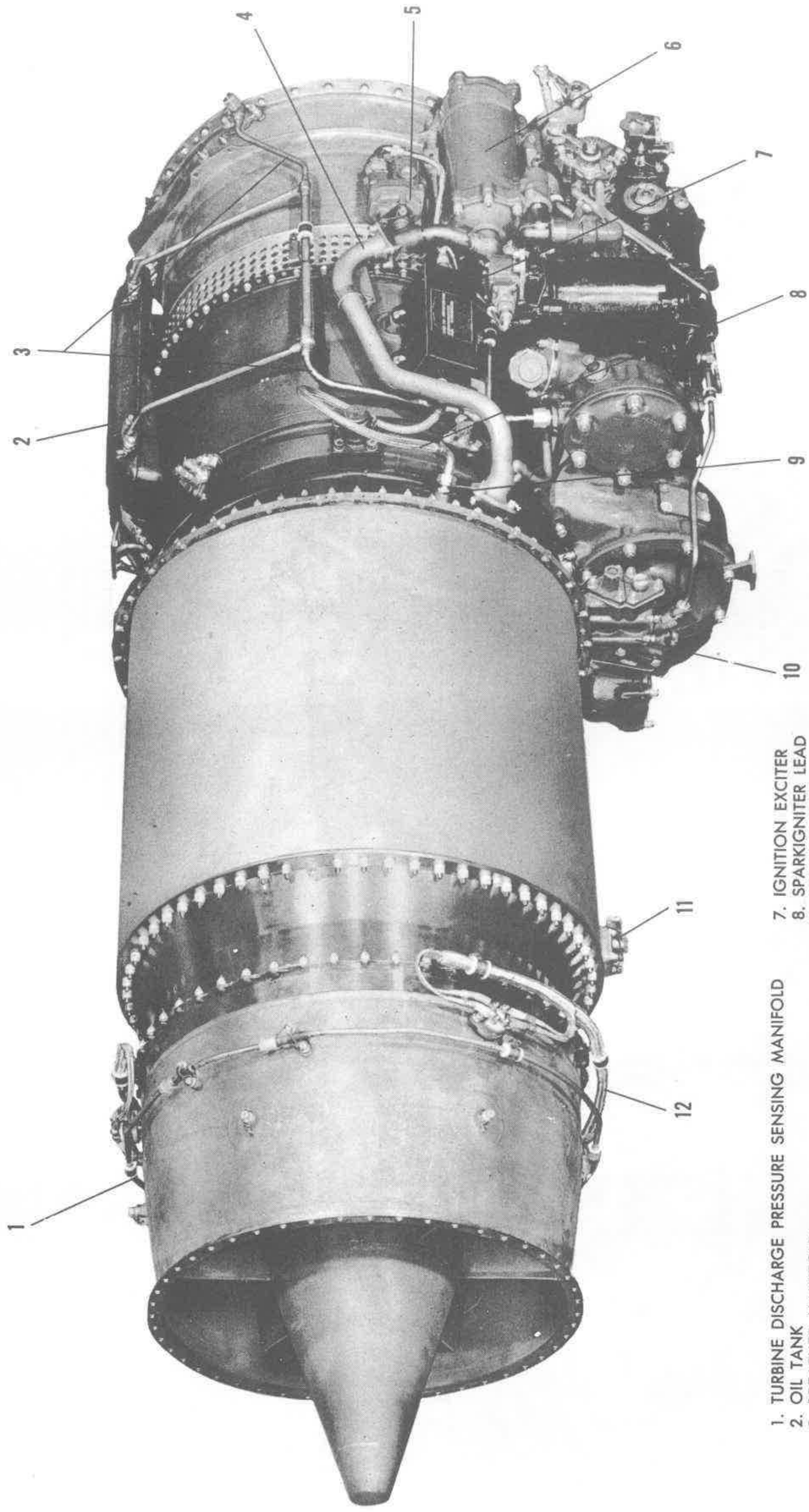
Figure 6C. Cross Sectional View of Component Drive Gearbox (JFTD12A)

1. Breather air outlet elbow
2. Oil return to tank
3. No. 1 bearing oil return
4. No. 3 bearing oil return
5. No. 5 bearing oil return
6. No. 4 bearing oil return
7. Oil supply
8. Starter-generator mount pad
9. Fuel control mount pad
10. Oil pressure adjusting screw
11. Oil pressure relief valve
12. Oil strainer screws and spacers
13. Main oil strainer by-pass valve
14. Main oil strainer cover
15. Tachometer drive shaft
16. No. 5 bearing scavenge pump
17. No. 4 bearing scavenge pump
18. No. 3 bearing scavenge pump
19. Gearbox scavenge pump
20. No. 1 bearing scavenge pump
21. Oil pressure pump
22. Starter-generator drive shaft
23. Starter-generator drive oil seal
24. Gearbox gearshaft
25. Fuel control drive gearshaft
26. Fuel control drive oil seal
27. Hydraulic pump gearshaft
28. Gearbox breather seal
29. Hydraulic pump rotary breather
30. Hydraulic pump oil seal
31. Hydraulic pump mount pad
32. Component drive gearbox housing
33. Component drive gearbox cover
34. Oil pump drive gearshaft
35. Fuel control drive gear
36. Main component drive gearshaft
37. Main component drive gearshaft gear
38. Gearbox main bearing support
39. Main component drive bevel gear



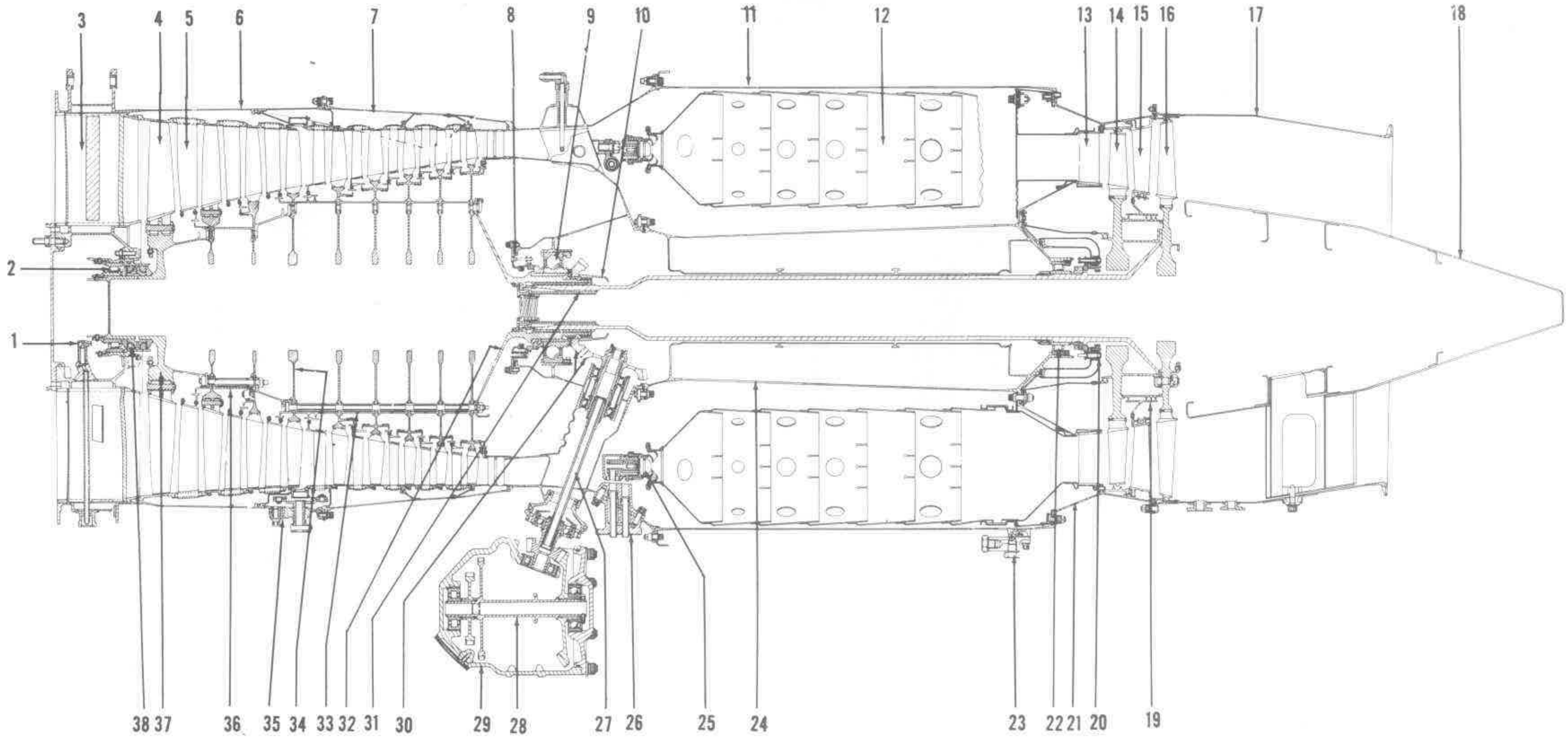
1. OIL TANK
2. TURBINE DISCHARGE PRESSURE SENSING MANIFOLD
3. EXHAUST CONE STRUT
4. TURBINF TEMPERATURE SENSING CABLE
5. TURBINE TEMPERATURE SENSING THERMOCOUPLE
6. FUEL PRESSURIZING AND DUMP VALVE
7. MAIN OIL STRAINER COVER
8. COMPONENT DRIVES GEARBOX
9. MAIN OIL PUMP
10. ANTI-ICING AIR TUBE
11. POWER LEVER CROSS SHAFT
12. ANTI-ICING AIR SHUT-OFF VALVE

Figure 9. Left Rear View of Engine (JT12A-6A[N] and JT12A-8[N])



1. TURBINE DISCHARGE PRESSURE SENSING MANIFOLD
2. OIL TANK
3. BREATHER MANIFOLD
4. FUEL DE-ICING AIR TUBE
5. FUEL DE-ICING AIR SHUT-OFF VALVE
6. FUEL DE-ICING HEATER
7. IGNITION EXCITER
8. SPARKIGNITER LEAD
9. SPARKIGNITER
10. FUEL PRESSURIZING AND DUMP VALVE
11. COMBUSTION CHAMBER FUEL DRAIN VALVE
12. TURBINE TEMPERATURE SENSING CABLE

Figure 10. Right Rear View of Engine (JT12A-6A[N] and JT12A-8[N])



1. No. 1 bearing oil nozzle
2. No. 1 bearing (roller)
3. Compressor inlet vane
4. Compressor rotor blade
5. Compressor stator vane
6. Compressor inlet case
7. Diffuser case
8. No. 2 bearing seal
9. No. 2 bearing (ball)
10. No. 2 bearing oil scoop
11. Combustion chamber case
12. Combustion chamber
13. First stage turbine vane
14. First stage turbine
15. Second stage turbine vane
16. Second stage turbine
17. Exhaust case
18. Exhaust cone and strut
19. Turbine rotor inner seal
20. No. 3 bearing seal
21. Turbine case
22. No.3 bearing (roller)
23. Combustion chamber fuel drain valve
24. Combustion chamber inner case
25. Fuel nozzle
26. Fuel manifold
27. Component drive tower shaft
28. Component drive gearbox main gearshaft
29. Component drive gearbox
30. Main component drive gears
31. Turbine shaft locking bolt
32. Compressor rear hub
33. Compressor rotor tierod
34. Compressor rotor disk
35. Compressor air bleed valve
36. Compressor tiebolt
37. Compressor front hub
38. No. 1 bearing seals

Figure 11. Cross Sectional View of Engine (JT12A-6A[N] and JT12A-8[N])

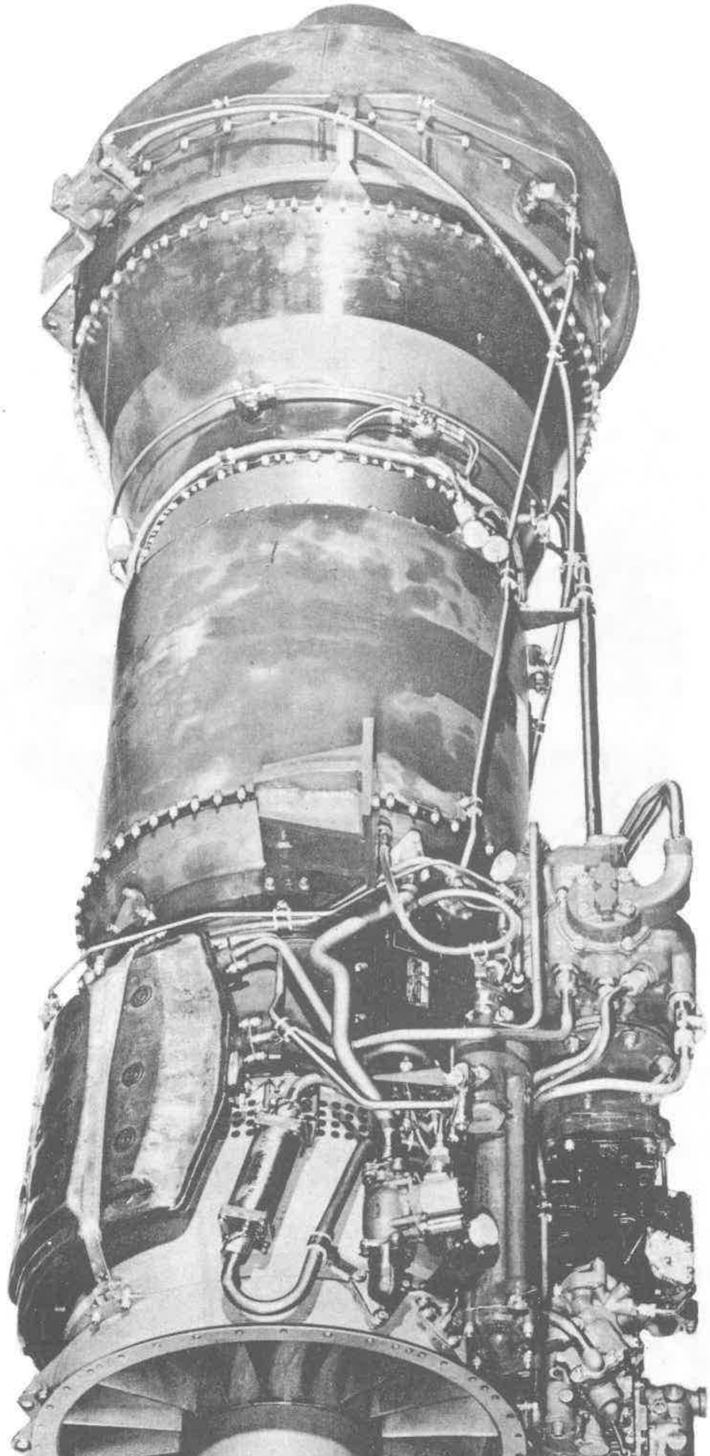


Figure 13. Left Front View of Free Turbine Engine (JFTD12A-1)

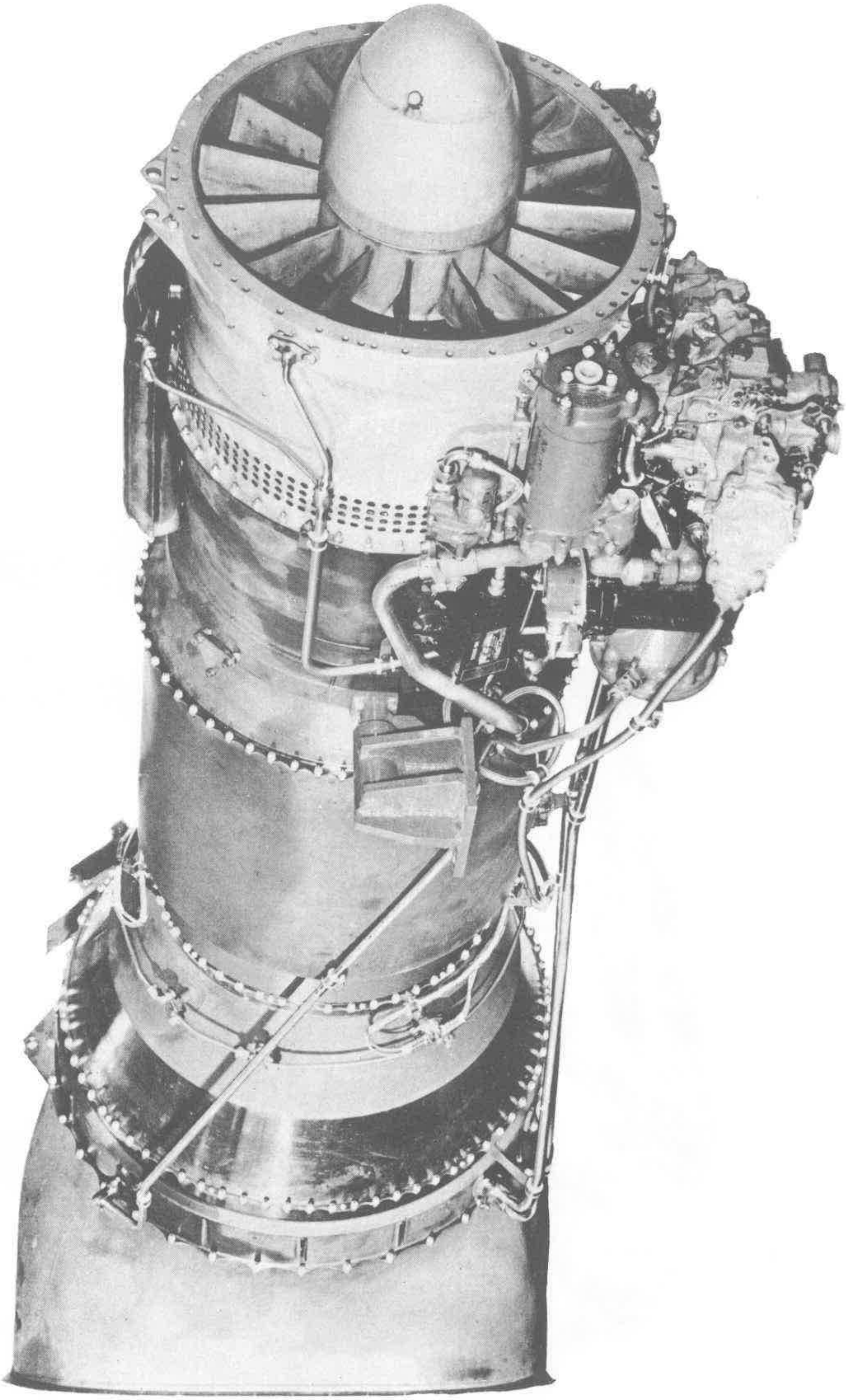


Figure 14. Right Front View of Free Turbine Engine (JFTD12A-1)

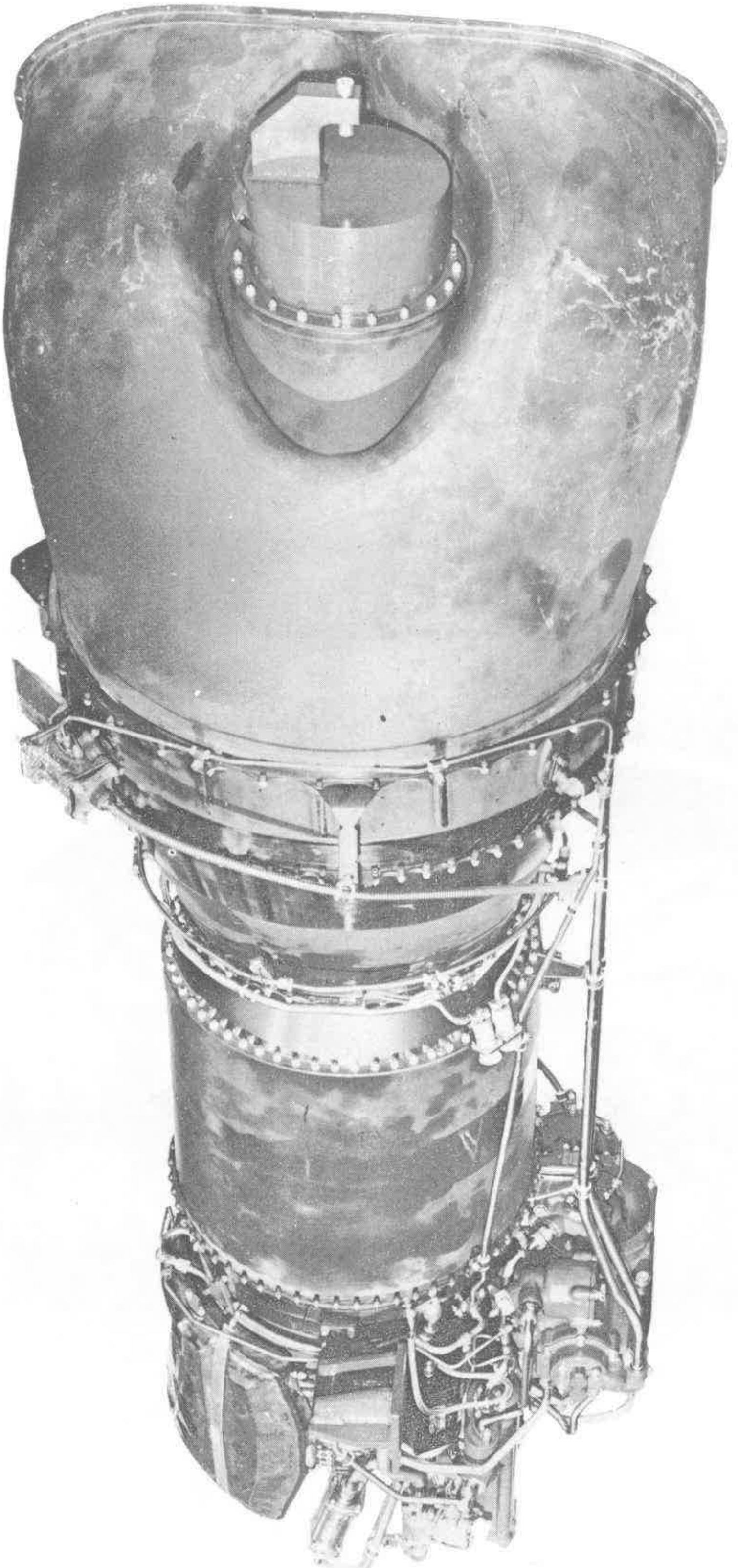


Figure 15. Left Rear View of Free Turbine Engine (JFTD12A-1)

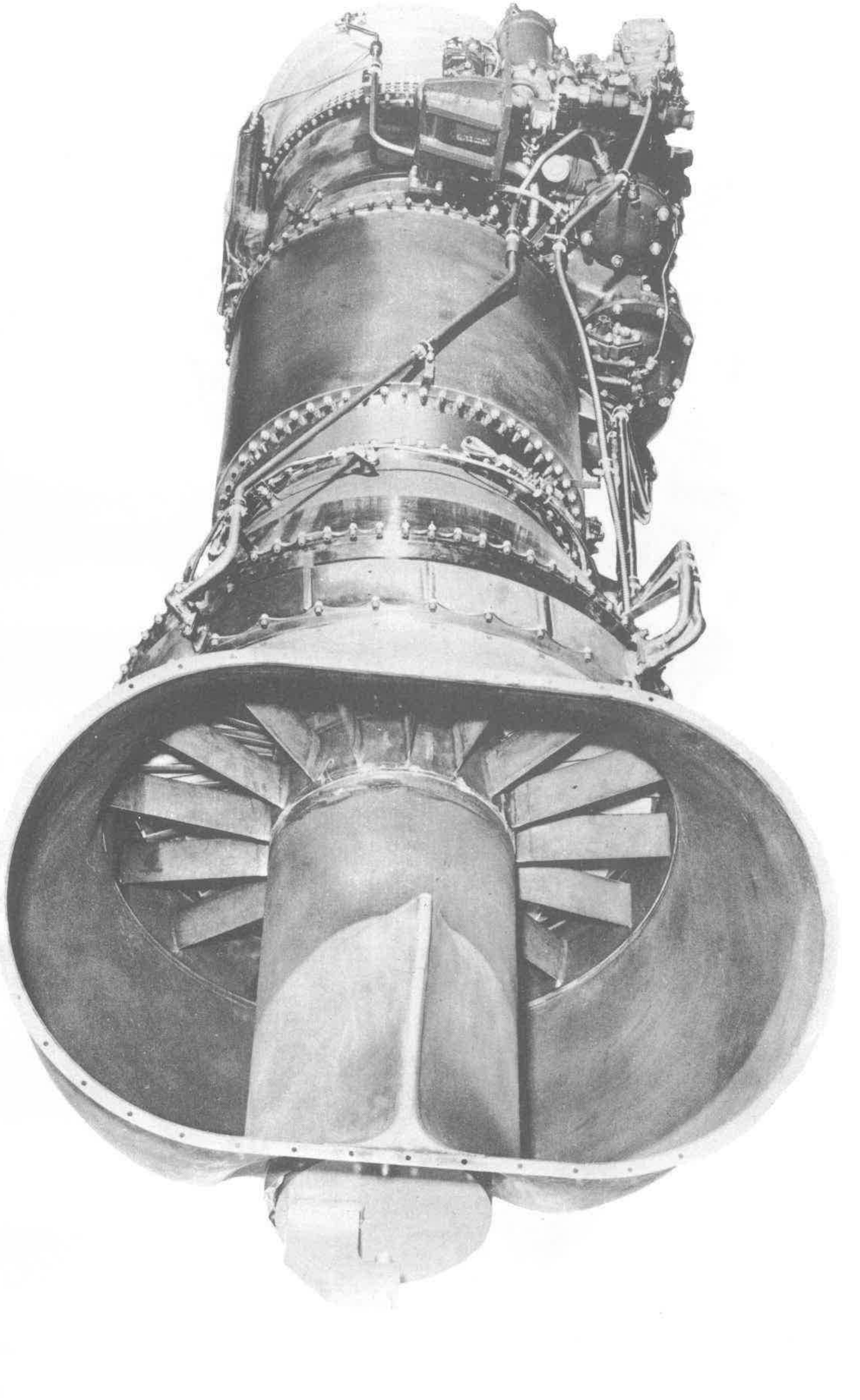
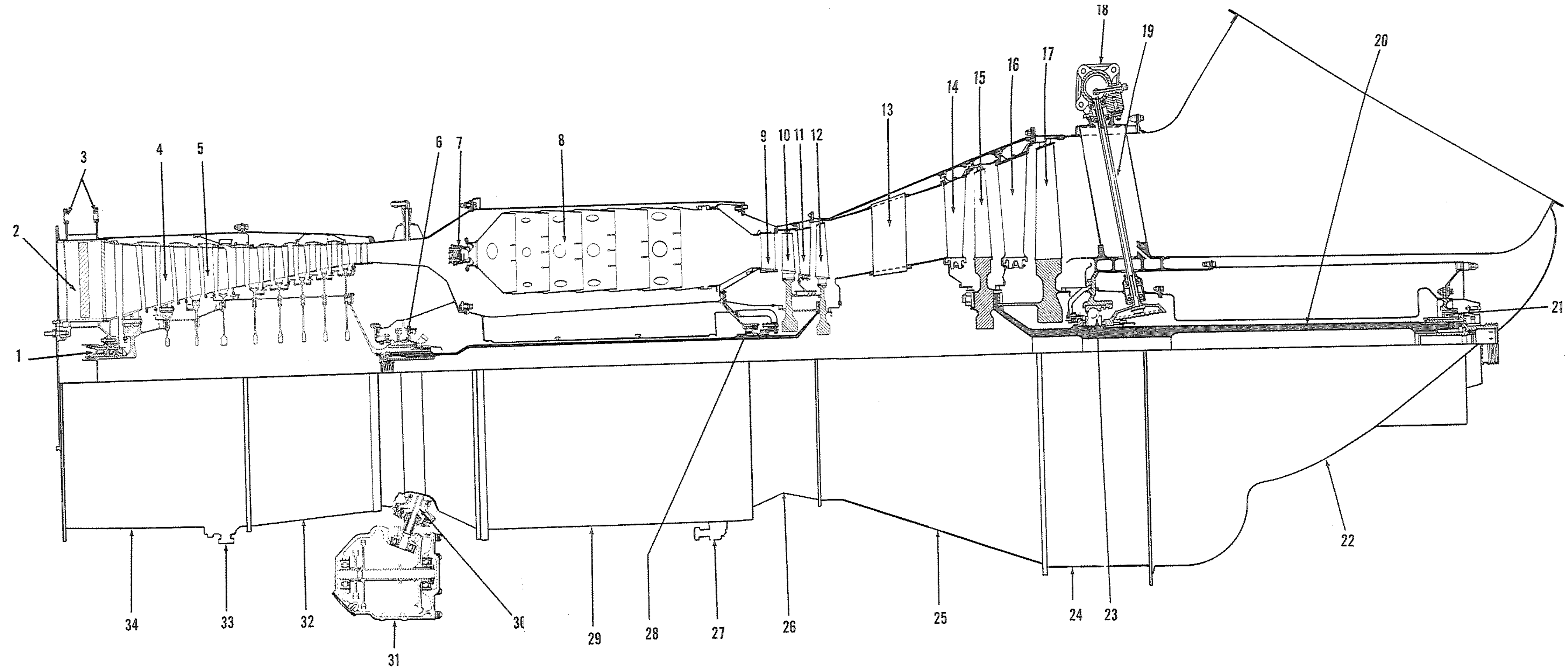


Figure 16. Right Rear View of Free Turbine Engine (JFTD12A-1)



1. No. 1 bearing (roller)
2. Compressor inlet vane
3. Front engine mount
4. Compressor Blade
5. Compressor vane
6. No. 2 bearing (ball)
7. Fuel nozzle
8. Combustion chamber
9. First stage turbine vane
10. First stage turbine blade
11. Second stage turbine vane
12. Second stage turbine blade
13. Free turbine inlet vane
14. Free turbine first stage vane
15. Free turbine first stage blade
16. Free turbine second stage vane
17. Free turbine second stage blade
18. Free turbine accessory drive gearbox
19. Free turbine accessory driveshaft
20. Free turbine shaft
21. No. 5 bearing (roller)
22. Free turbine exhaust case
23. No. 4 bearing (ball)
24. Free turbine case
25. Free turbine inlet case
26. Turbine case
27. Combustion chamber fuel drain valve
28. No. 3 bearing (roller)
29. Combustion chamber case
30. Main component drive tower shaft
31. Component drives gearbox
32. Diffuser case
33. Compressor air bleed valve
34. Compressor inlet case

Figure 17. Cross Sectional View of Free Turbine Engine (JFTD12A-1)

1. Breather air outlet elbow
2. Oil return to tank
3. No. 1 bearing oil return
4. No. 3 bearing oil return
5. No. 5 bearing oil return
6. No. 4 bearing oil return
7. Oil supply
8. Starter-generator mount pad
9. Fuel control mount pad
10. Oil pressure adjusting screw
11. Oil pressure relief valve
12. Oil strainer screws and spacers
13. Main oil strainer bypass valve
14. Main oil strainer cover
15. Tachometer driveshaft
16. No. 5 bearing scavenge pump
17. No. 4 bearing scavenge pump
18. Gearbox and No. 2 bearing scavenge pump
19. No. 3 bearing scavenge pump
20. No. 1 bearing scavenge pump
21. Oil pressure pump
22. Starter-generator driveshaft
23. Starter-generator drive oil seal
24. Gearbox gearshaft
25. Fuel control drive gearshaft
26. Fuel control drive oil seal
27. Hydraulic pump gearshaft
28. Gearbox breather seal
29. Hydraulic pump rotary breather
30. Hydraulic pump oil seal
31. Hydraulic pump mount pad
32. Component drive gearbox housing
33. Component drive gearbox cover
34. Oil pump drive gearshaft
35. Fuel control drivegear
36. Main component drive gearshaft
37. Component drive gearshaft
38. Gearbox main bearing support
39. Main component drive bevel gear

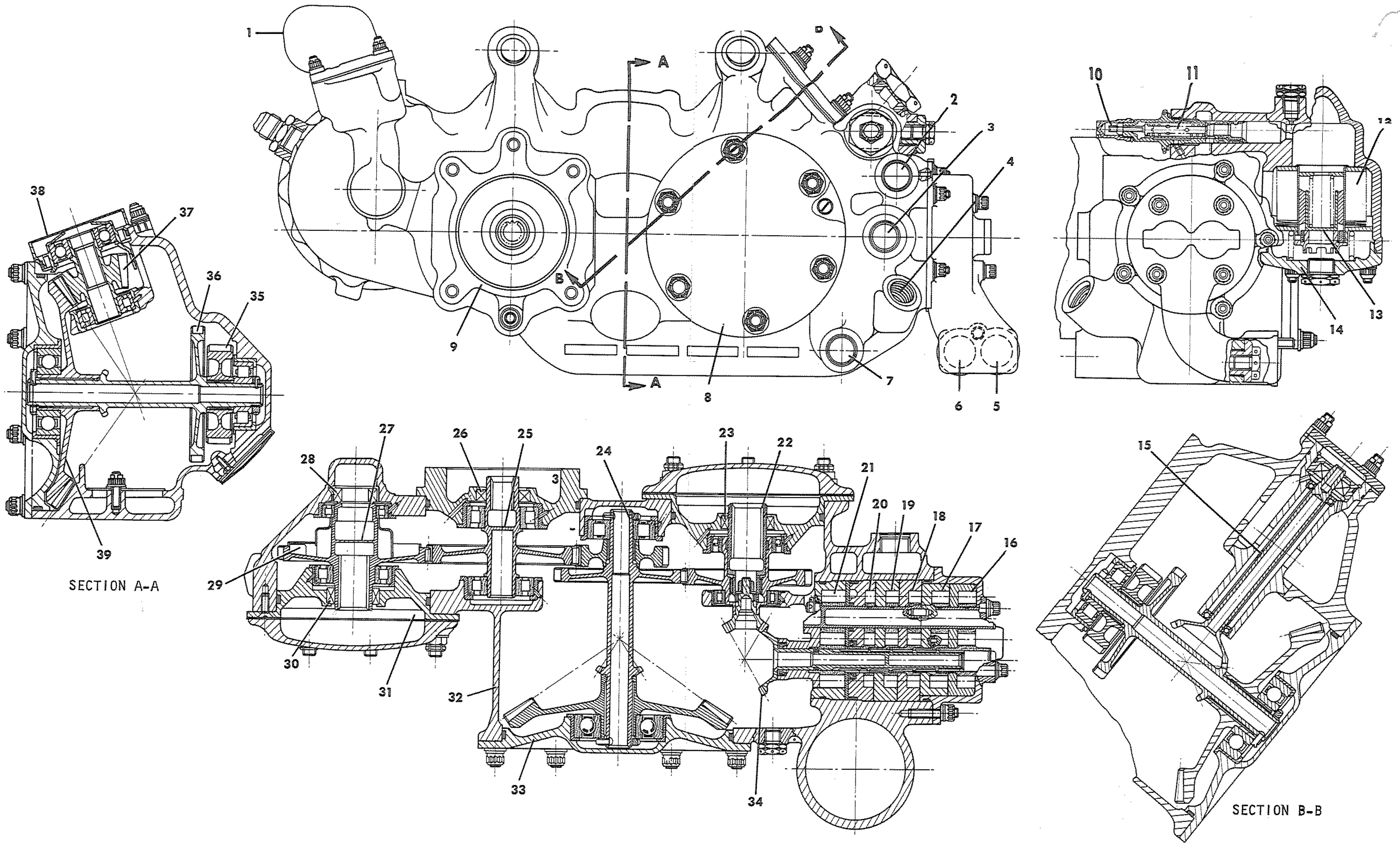
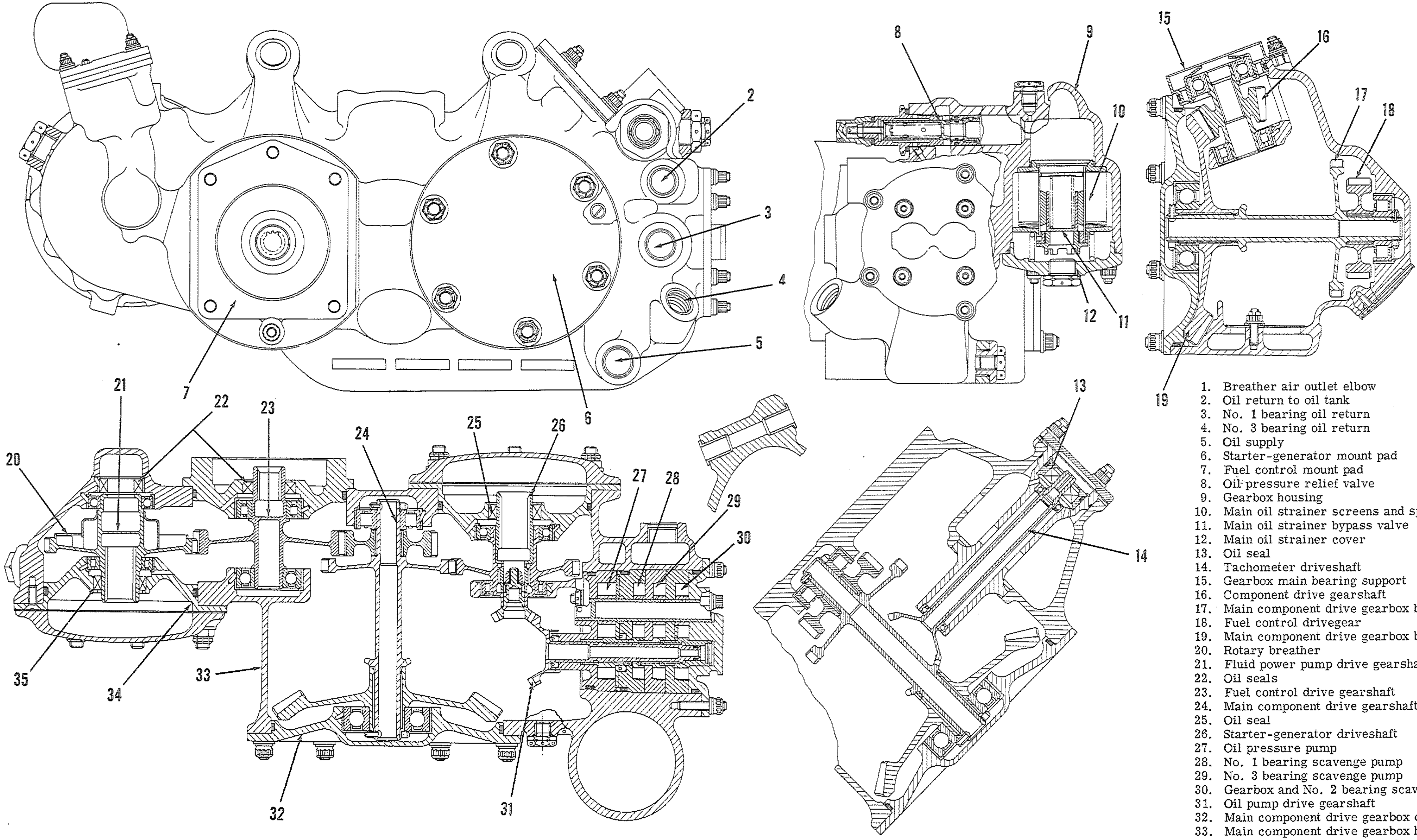


Figure 18. Cross-Sectional View of Component Drive Gearbox (JFTD12A-1 and -4A)



1. Breather air outlet elbow
2. Oil return to oil tank
3. No. 1 bearing oil return
4. No. 3 bearing oil return
5. Oil supply
6. Starter-generator mount pad
7. Fuel control mount pad
8. Oil pressure relief valve
9. Gearbox housing
10. Main oil strainer screens and spacers
11. Main oil strainer bypass valve
12. Main oil strainer cover
13. Oil seal
14. Tachometer driveshaft
15. Gearbox main bearing support
16. Component drive gearshaft
17. Main component drive gearbox bevel gear
18. Fuel control drivegear
19. Main component drive gearbox bevel gear
20. Rotary breather
21. Fluid power pump drive gearshaft
22. Oil seals
23. Fuel control drive gearshaft
24. Main component drive gearshaft
25. Oil seal
26. Starter-generator driveshaft
27. Oil pressure pump
28. No. 1 bearing scavenge pump
29. No. 3 bearing scavenge pump
30. Gearbox and No. 2 bearing scavenge pump
31. Oil pump drive gearshaft
32. Main component drive gearbox cover
33. Main component drive gearbox housing
34. Fluid power pump mount pad
35. Oil seal

Figure 12. Cross-Sectional View of Component Drive Gearbox (JT12A-6A[N] and JT12A-8[N])

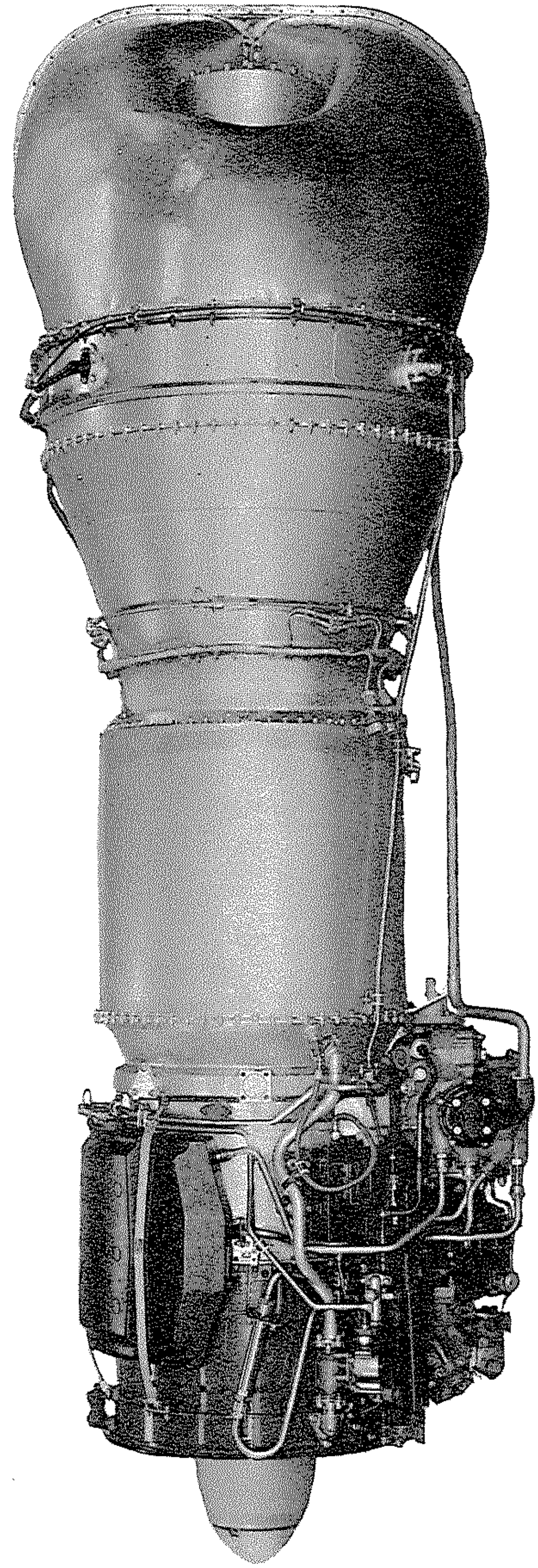


Figure 19. Left Side View of Free Turbine Engine (JFTD12A-4A)

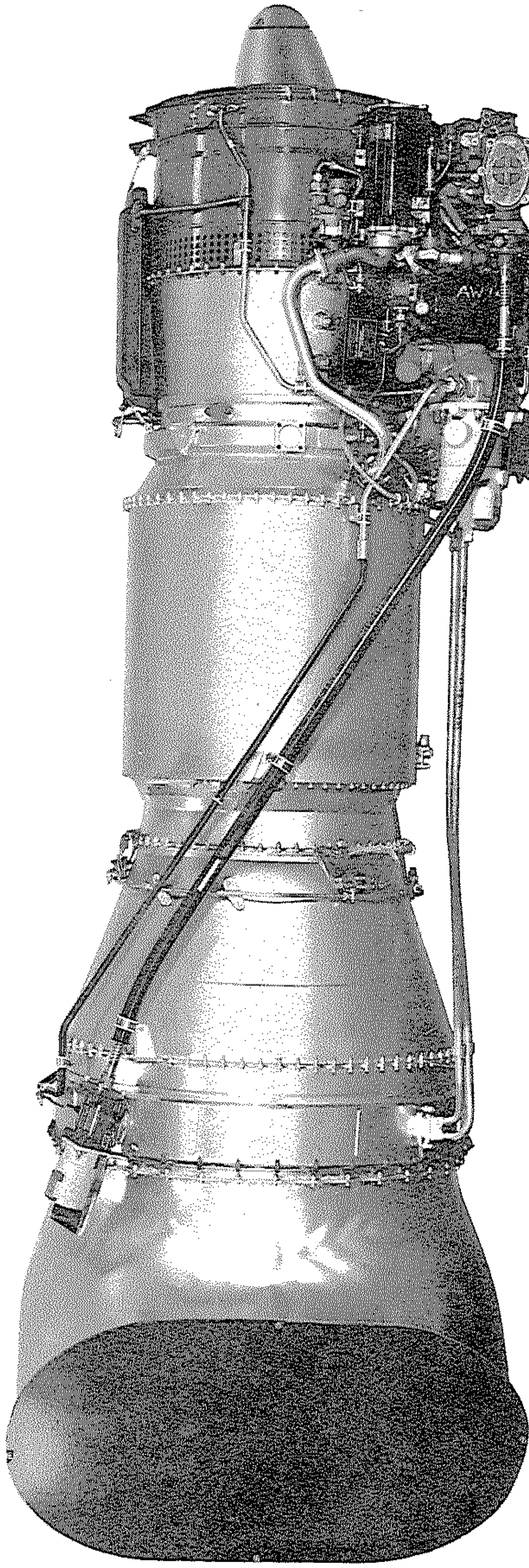
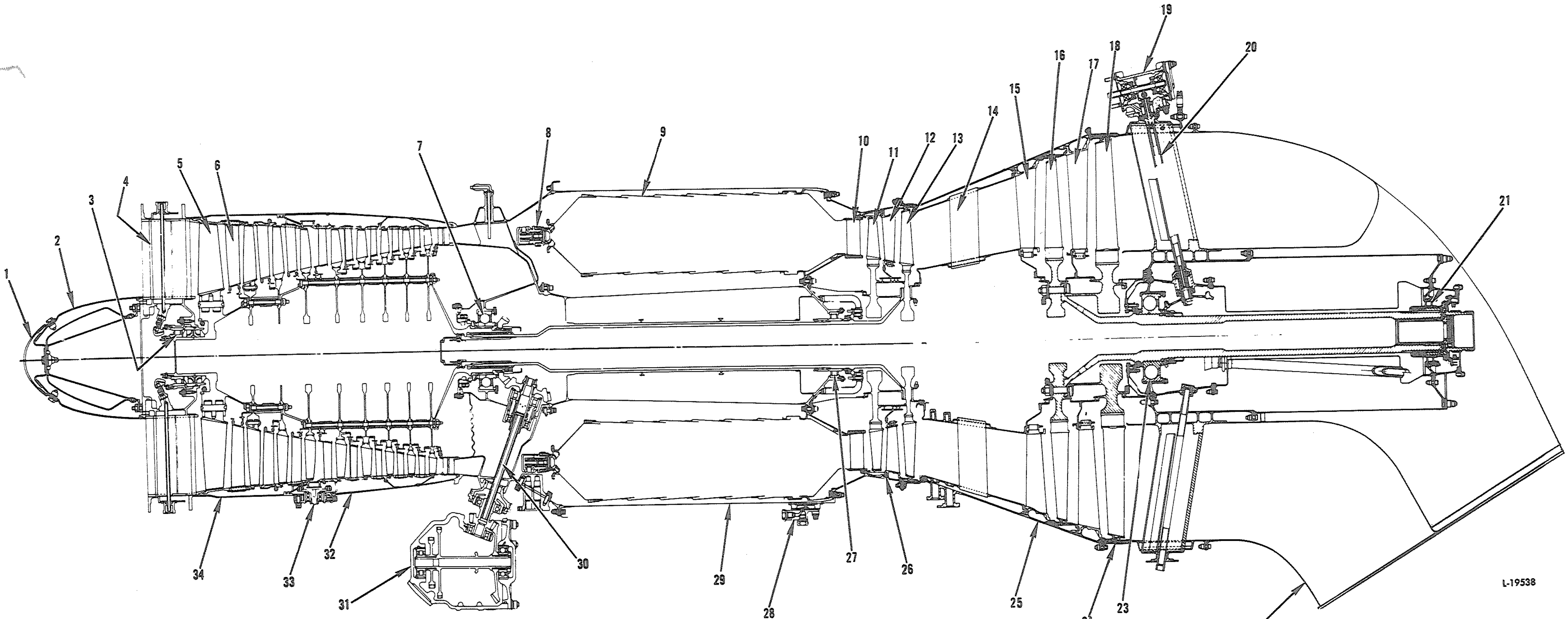


Figure 20. Right Side View of Free Turbine Engine (JFTD12A-4A)



1. Compressor inlet outer front cone
2. Compressor inlet outer rear cone
3. No. 1 bearing (roller)
4. Compressor inlet vane
5. Compressor blade (1st stage)
6. Compressor vane (1st stage)
7. No. 2 bearing (ball)
8. Fuel nozzle
9. Combustion chamber
10. 1st stage turbine vane
11. 1st stage turbine blade
12. 2nd stage turbine vane
13. 2nd stage turbine blade
14. Free turbine inlet vane
15. Free turbine 1st stage vane
16. Free turbine 1st stage blade
17. Free turbine 2nd stage vane
18. Free turbine 2nd stage blade
19. Free turbine accessory drive gearbox N_2
20. Free turbine accessory driveshaft
21. No. 5 bearing (roller)
22. Free turbine exhaust case
23. No. 4 bearing (ball)
24. Free turbine case
25. Free turbine inlet case
26. Turbine case
27. No. 3 bearing (roller)
28. Combustion chamber fuel drain valve
29. Combustion chamber case
30. Main component drive tower shaft
31. Component drives gearbox
32. Diffuser case
33. Compressor air bleed valve
34. Compressor inlet case

Figure 21. Cross-Sectional View of Free Turbine Engine (JFTD12A-4A and -5A)

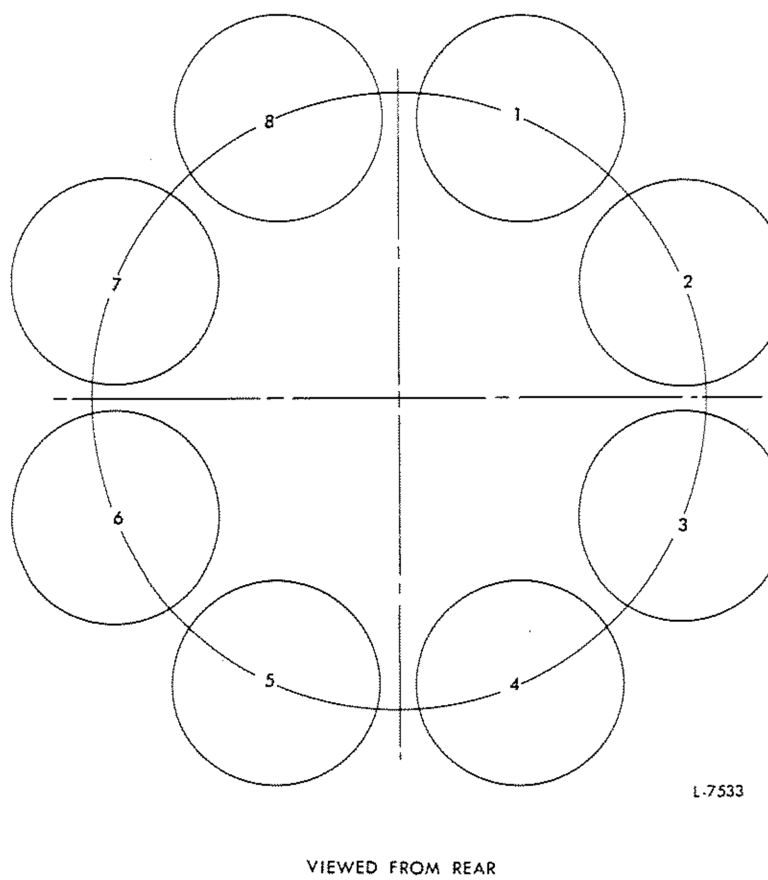


Figure 22. Combustion Chamber Numbering

SECTION I

TOOLS

1-1. GENERAL.

1-1A. This section lists by function and numerical order the special tools applicable to the work prescribed in this manual. Reference to the tools in other sections of this manual is by the group number in the functional tool list.

1-2. FUNCTIONAL TOOL LIST.

Group No.	Tool Nomenclature	Tool No.	Figure No.
1.	Breather Oil Seal		
	Breather seal drift	PWA-13023	1-7A
	Breather seal puller	PWA-13024	1-7A
1A.	Combustion Chamber Outlet Duct Repair		
	First stage guide vane support aligning pin (three required)	PWA-13184	
	Turbine case support (three required)	PWA-13183	
1B.	Component Drive Gearbox Installation		
	Starter shaft turning adapter	PWA-13041	
2.	Compressor Air Bleed Valve Linkage Installation		
	Bleed valve linkage torque adapter (Holley)	PWA-13376	1-12
	Bleed valve linkage torque adapter (Hamilton)	PWA-13551	
	Bleed valve linkage torque adapter handle (Hamilton)	PWA-13417	
2A.	Compressor Air Bleed Valve Strap Installation		
	Extension tube	PWA-13448	
2A-1.	Engine Ferrying		
	Starter drive gearbox lock	PWA-13722	
2B.	Engine Test - Preparation For		
	Accessory housing vibration pickup bracket	PWA-13252	
	Air inlet pressure probe (five required)	PWA-13014	
	Anti-icing elbow thermocouple	PWA-13169	
	Burner cover vibration pickup bracket	PWA-13575	
	Engine test bellmouth	PWA-13000	
	Engine test front mount	PWA-13268	
	Engine test rear left mount	PWA-13004	
	Engine test rear right mount	PWA-13005	
	Engine test screen assembly	PWA-13001	
	Fuel pump inlet adapter	PWA-13168	
	Inlet temperature thermocouple harness	PWA-14558	
	Inlet vibration pickup bracket (horizontal)	PWA-13574	
	Inlet vibration pickup bracket (vertical)	PWA-13574	
	Rear engine test mount adapter (two required)	PWA-13007	
2C.	Exhaust Strut Bolt And Bushing Replacement		
	Drift-exhaust case boss bushing	PWA 13708	
	Puller-exhaust case bushing (optional to PWA 13708)	PWA 39027	

Group No.	Tool Nomenclature	Tool No.	Figure No.
3.	First Stage Turbine Vane Installation		
	Engine build and transport stand	PWA-13060	1-10A
	Turbine vane retaining pin installation drift	PWA-13285	
4.	First Stage Turbine Vane Removal		
	Engine build lift and turn plate	PWA-13061	1-10B
	Engine complete horizontal stand	PWA-13330	
	Engine lift and trunnion sling	PWA-13067	1-10D
	First stage guide vane support aligning pin (three required)	PWA-13184	
	Inlet case to front plate adapter	PWA-13181	1-10E
	Left rear engine test mount	PWA-13004	1-2A
	Right rear engine test mount	PWA-13005	1-2B
	Turbine case support	PWA-13183	1-11
5.	Fluid Power Pump Oil Seal		
	Fluid power pump driveshaft seal base	PWA-13026	
	Fluid power pump driveshaft seal drift	PWA-13028	
	Fluid power pump driveshaft seal drift	PWA-13617	
	Fluid power pump driveshaft seal guide	PWA-13030	
	Fluid power pump pad puller	PWA-13022	
5A.	Free Turbine Section Installation		
	Engine build lift and turn plate	PWA-13061	
	Engine complete front support	PWA-13349	
	Free turbine assembly aligning pin	PWA-13353	
	Free turbine assembly sling	PWA-13352	
	Free turbine assembly storage stand	PWA-13450	
5B.	Free Turbine Section Removal		
	Engine build lift and turn plate	PWA-13061	
	Engine complete front support	PWA-13349	
	Free turbine assembly sling	PWA-13352	
	Free turbine assembly storage stand	PWA-13450	
5C.	Free Turbine Speed Sensing Flexible Shaft Installation		
	Drift - bearing	PWA-39008	
	Drift - snapring	PWA-39009	
	Drift - seal	PWA-39010	
	Base - flange-shaft	PWA-39013	
6.	Fuel Control Drive Oil Seal		
	Fuel control driveshaft seal base	PWA-13049	
	Fuel control driveshaft seal drift	PWA-13029	
	Fuel control driveshaft seal drift	PWA-13618	

Group No.	Tool Nomenclature	Tool No.	Figure No.
6.	Fuel Control Drive Oil Seal (continued)		
	Fuel control driveshaft seal guide	PWA-13027	
	Fuel control driveshaft seal puller.	PWA-13022	
6-1.	Fuel Control (Holley) Inlet Filter Removal		
	Fuel control fuel filter puller	AT-1853	
6-2.	Fuel Control (Holley) Flushing Procedure		
	Adapter - inlet fitting	AT-1747	
6A.	Fuel Manifolds		
	Fuel manifold holding fixture (two required)	PWA-13271	
7.	Fuel Nozzles		
	Fuel nozzle retaining nut tablock crimper	PWA-13264	1-14
	Fuel nozzle retaining nut torquing holder	PWA-13159	
	Fuel nozzle retaining nut wrench.	PWA-13978	1-7
7A.	Fuel Nozzle Visual Flow Check		
	Adapter	PWA-13181	
	Adapter	PWA-17446	
	Engine complete horizontal stand	PWA-13330	
	Engine lift and turn plate	PWA-13061	1-10B
	Engine lift and turn sling	PWA-13067	
	Engine rear test mount (left)	PWA-13004	
	Engine rear test mount (right)	PWA-13005	
	Fuel nozzle visual flow check cover	PWA-13441	
	Gage.	PWA-17114	
	Turbine case support (three required)	PWA-13183	
8.	Fuel Nozzles and Manifolds Pressure Check		
	Burette and valve assembly	PWA-7441	1-1
	Fuel manifold leak check adapter	PWA-13319	
	Fuel nozzle sealing clamp	PWA-13979	1-5
9.	Fuel Pressurizing and Dump Valve Pressure Check		
	Fuel nozzle sealing clamp (eight required)	PWA-13979	1-5
	Fuel pressurizing and dump valve drain adapter	PWA-13013	1-4
	Fuel pressurizing and dump valve inlet adapter	PWA-13012	1-3

Group No.	Tool Nomenclature	Tool No.	Figure No.
9.	Fuel Pressurizing and Dump Valve Pressure Check (continued)		
	Fuel pressurizing and dump valve secondary drain adapter	PWA-13151	
	Fuel pressurizing and dump valve signal adapter	PWA-10723	1-2
9A.	Engine - Installation of Covers		
	Inlet case cover	PWA-13393	
	Turbine exhaust case cover	PWA-13389	
9B.	Inlet Case Installation and Removal		
	Heater - compressor inlet case	PWA 13320	
10.	Installing the Engine Horizontally in the Build and Transport Stand		
	Engine build lift and turn plate	PWA-13061	1-10B
	Engine build and transport stand	PWA-13060	1-10A
	Engine complete front support	PWA-13314	1-15
	Engine horizontal support	PWA-13064	1-10C
	Engine lift and trunnion sling	PWA-13067	1-10D
	Left rear engine test mount	PWA-13004	
	Right rear engine test mount	PWA-13005	
10A.	Installing the Engine Horizontally in the Build and Transport Stand (Optional Rear or Front Support)		
	Adapter (to stand-horizontal)	PWA 13489	
	Engine build and transport stand	PWA 13060	
	Engine build lift and turn plate	PWA 13061	
	Engine lift and trunnion sling	PWA 13067	
	Left rear engine test mount	PWA 13004	
	Right rear engine test mount	PWA 13005	
11.	Installing the Engine Vertically in the Build and Transport Stand		
	Bleed valve cover	PWA-13298	1-14C
	Engine build lift and turn plate	PWA-13061	1-10B
	Engine build and transport stand	PWA-13060	1-10A
	Inlet case to front plate adapter	PWA-13181	1-10E
	Left rear engine test mount	PWA-13004	
	Right rear engine test mount	PWA-13005	

Group No.	Tool Nomenclature	Tool No.	Figure No.
12.	Installing the Engine in the Shipping Box		
	Engine lift and trunnion sling	PWA-13067	1-10D
13.	Main Oil Pump Removal		
	Main oil pump puller.	PWA-13251	
	Main oil pump puller (pumps incorporating internally threaded bolts)	PWA-13387	
13A.	Main Oil Pump Removal (Free Turbine Engines)		
	Main oil pump puller.	PWA-13386	
14.	Main Oil Strainer		
	Oil screen assembly holder	PWA-13036	1-10
	Oil screens and spacers retaining nut wrench	PWA-13035	1-9
14-1.	Main Oil Strainer Installation and Removal		
	Clamp - main oil strainer	PWA-13943	
14A.	Oil Pressure Transmitter Boss Helical Coil Repair		
	Counterbore - gearbox oil pressure transmitter boss repair . . .	PWA-16752	
	Fixture - gearbox oil pressure transmitter boss repair	PWA-13707	
15.	Removing the Engine from the Shipping Box		
	Bleed valve cover.	PWA-13298	
	Engine build lift and turnplate.	PWA-13061	1-10B
	Engine lift and trunnion sling	PWA-13067	1-10D
	Inlet case to front plate adapter	PWA-13181	1-10E

Group No.	Tool Nomenclature	Tool No.	Figure No.
16.	Sparkigniter Boss Inspection		
	Sparkigniter boss tap	PWA-13032	1-8
17.	Starter - Generator Drive Oil Seal		
	Drift - starter generator drive oil seal	PWA-13718	
	Starter - generator driveshaft seal base	PWA-13026	
	Starter - generator driveshaft seal drift	PWA-13028	
	Starter - generator driveshaft seal drift	PWA-13617	
	Starter - generator driveshaft seal guide	PWA-13030	
	Starter - generator driveshaft seal puller	PWA-13022	
18.	Tachometer Drive Oil Seal		
	Puller - seal housing	PWA-13051	
	Base - seal installation	PWA-13020	
	Drift - seal installation	PWA-13048	
	Drift - seal installation	PWA-13619	
19.	Turbine Blade Inspection		
	Gage - stretch (first stage)	PWA-13351	
	Gage - stretch (second stage)	PWA-39025	

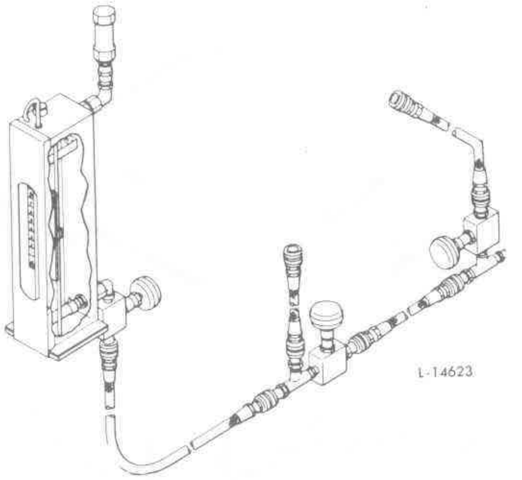


Figure 1-1. PWA-7441 Burette

Figure 1-1A. Deleted

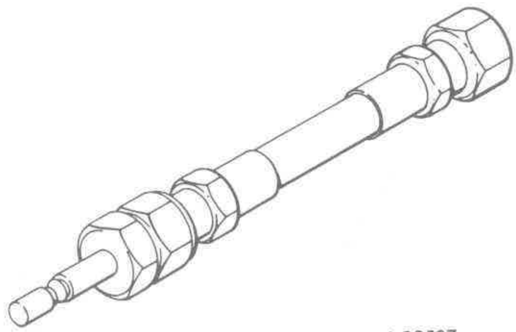


Figure 1-2. PWA-10723 Adapter

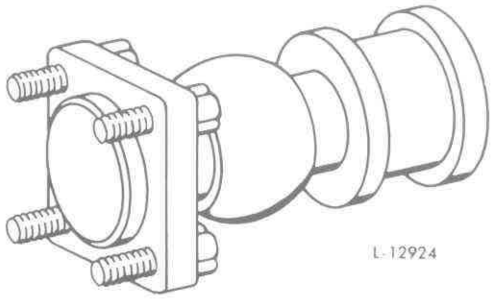


Figure 1-2A. PWA-13004 Mount

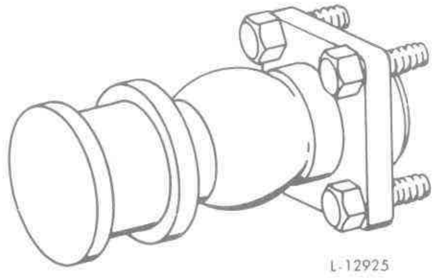


Figure 1-2B. PWA-13005 Mount

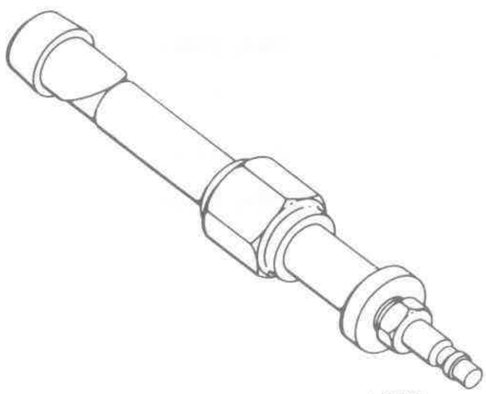


Figure 1-3. PWA-13012 Adapter

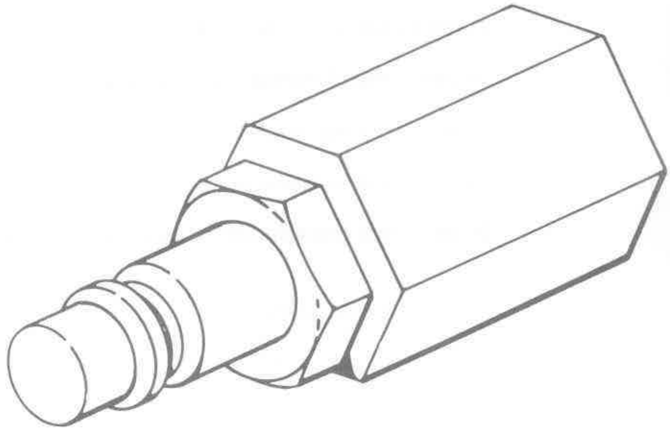


Figure 1-4. PWA-13013 Adapter

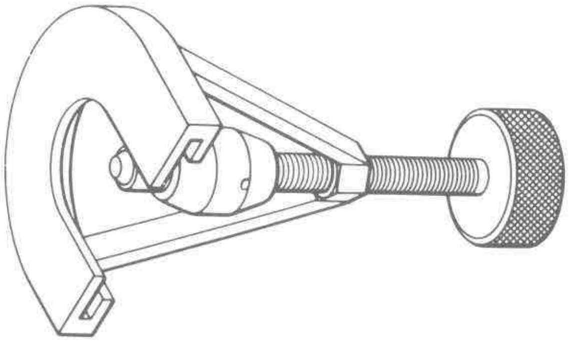


Figure 1-5. PWA-13979 Clamp

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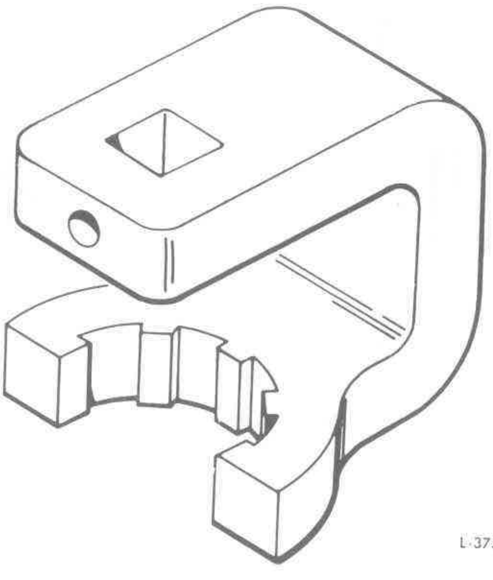


Figure 1-7. PWA-13978 Wrench

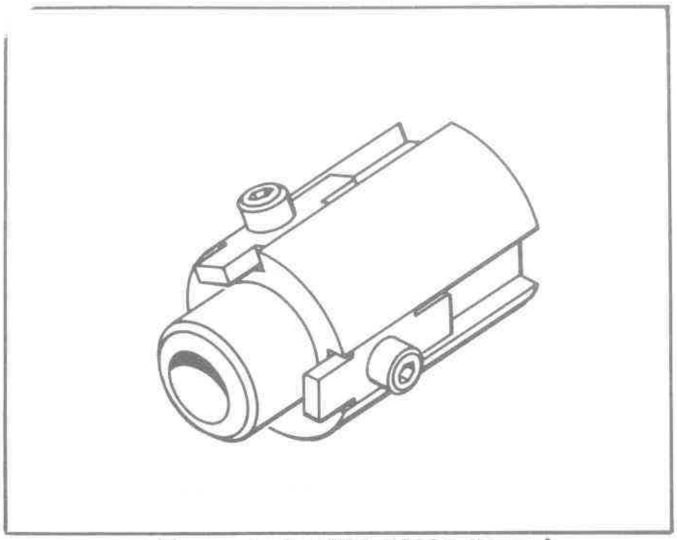


Figure 1–9. PWA-13035 Wrench

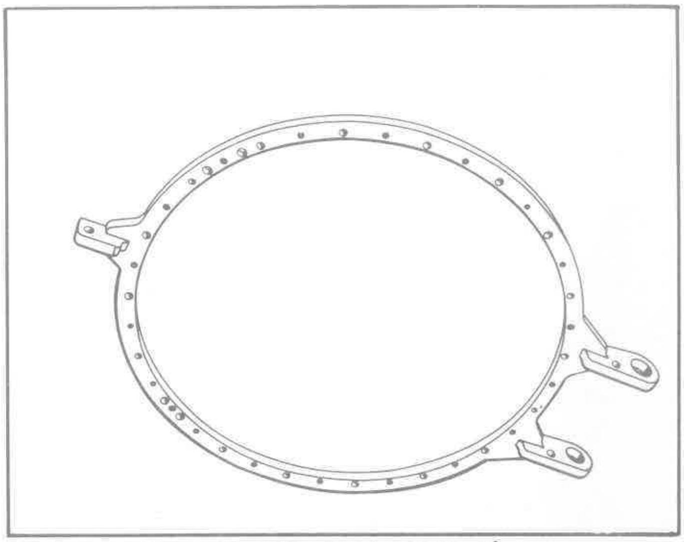


Figure 1–10B. PWA-13061 Plate

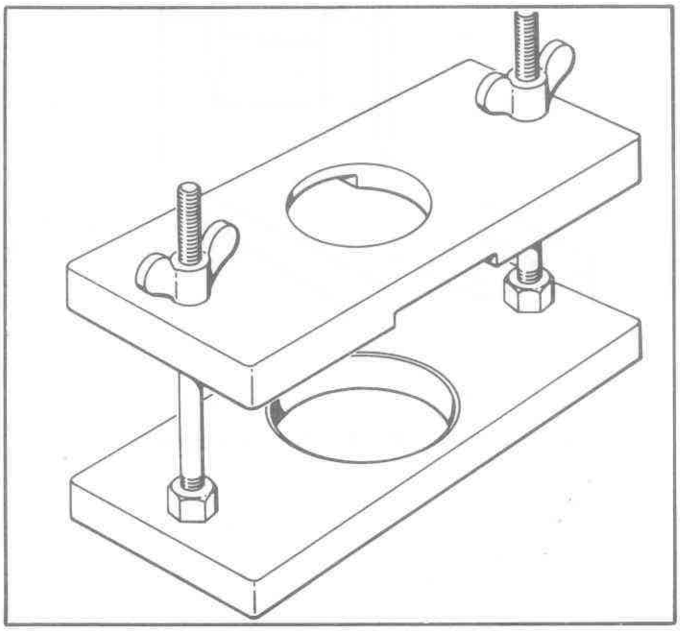


Figure 1–10. PWA-13036 Holder

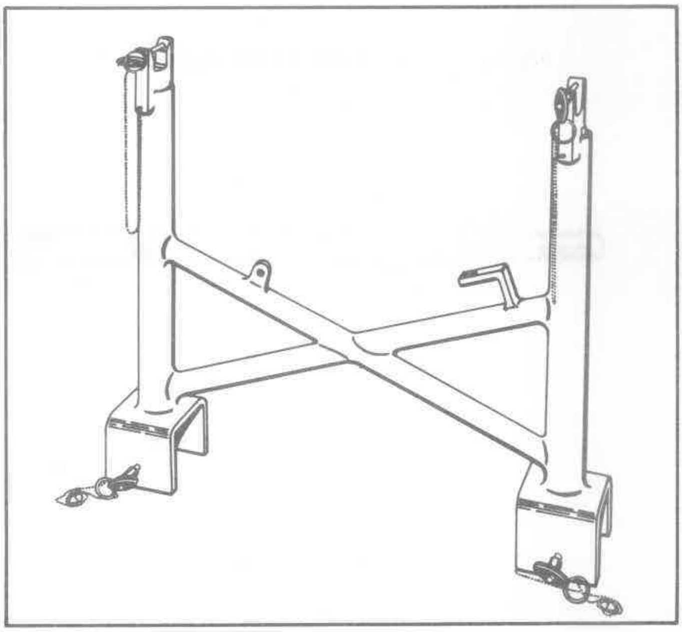


Figure 1–10C. PWA-13064 Support

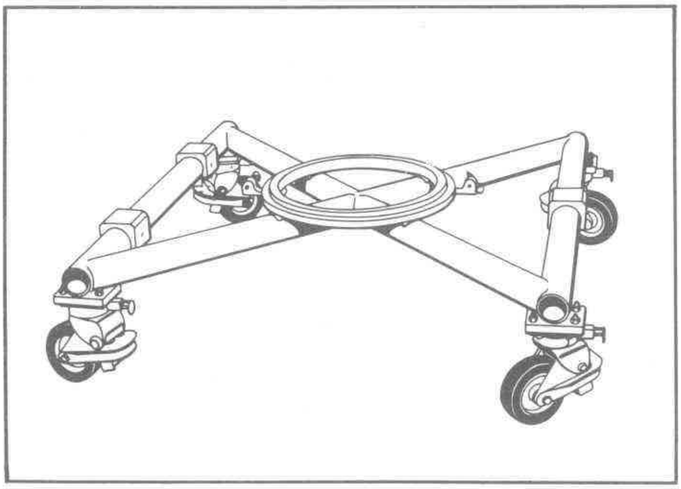


Figure 1–10A. PWA-13060 Stand

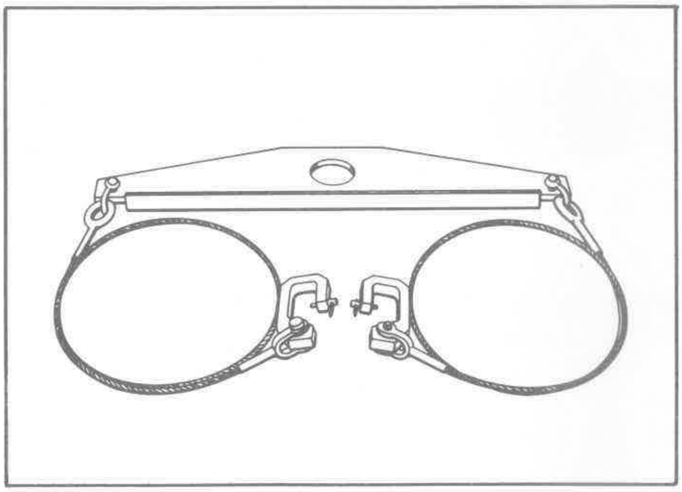


Figure 1–10D. PWA-13067 Sling

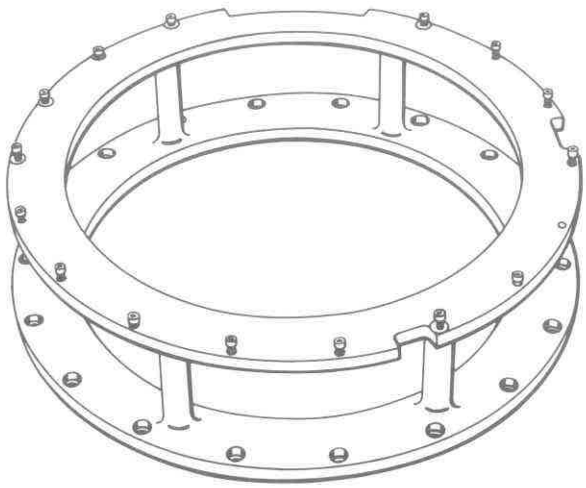


Figure 1—10E. PWA-13181 Adapter

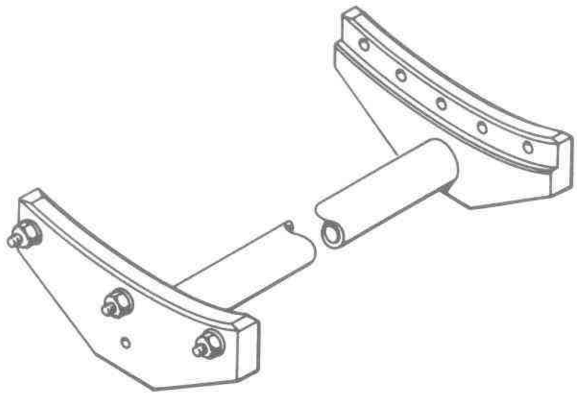


Figure 1—11. PWA-13183 Support

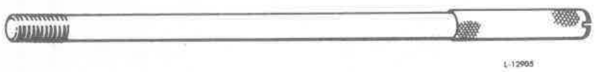


Figure 1—11A. PWA-13184 Pin

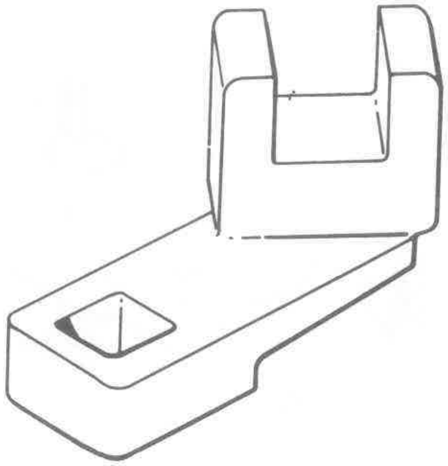


Figure 1—12. PWA-13187 Adapter

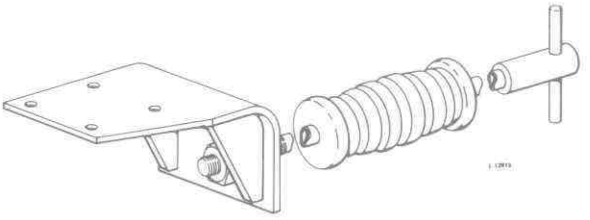


Figure 1–13. PWA-13251 Puller

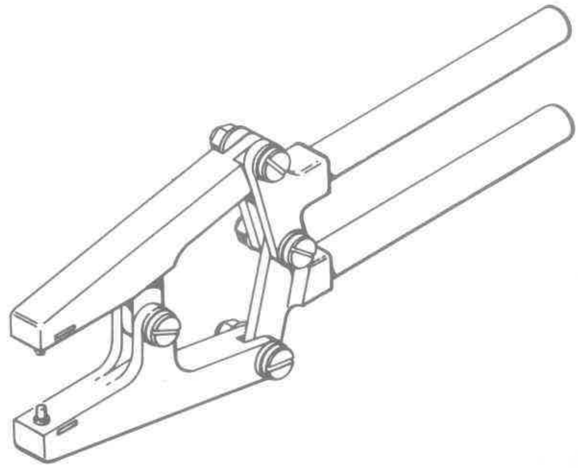


Figure 1–14. PWA-13264 Crimper

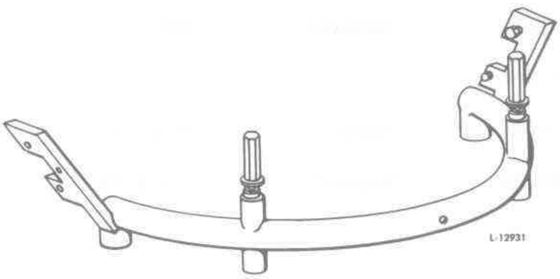


Figure 1–14A. PWA-13271 Fixture

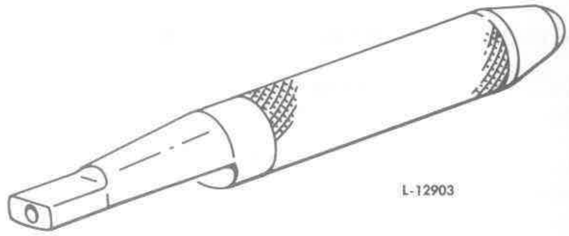


Figure 1–14B. PWA-13285 Drift

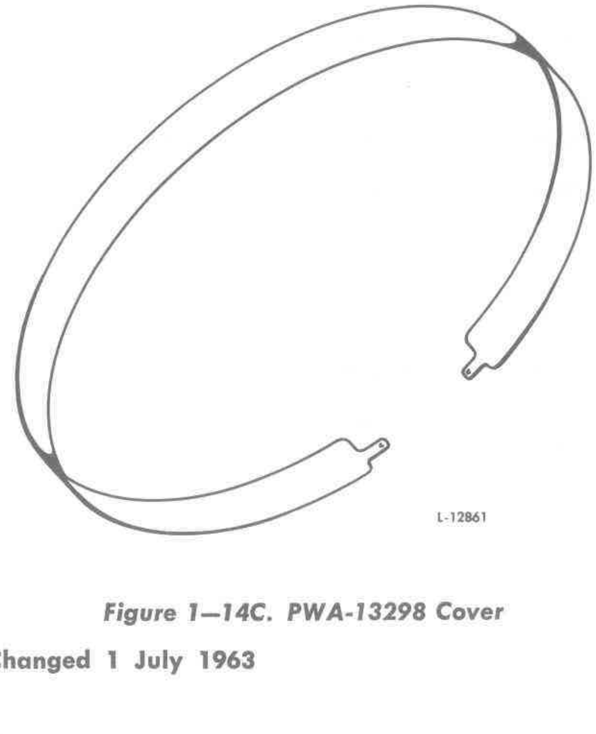


Figure 1–14C. PWA-13298 Cover

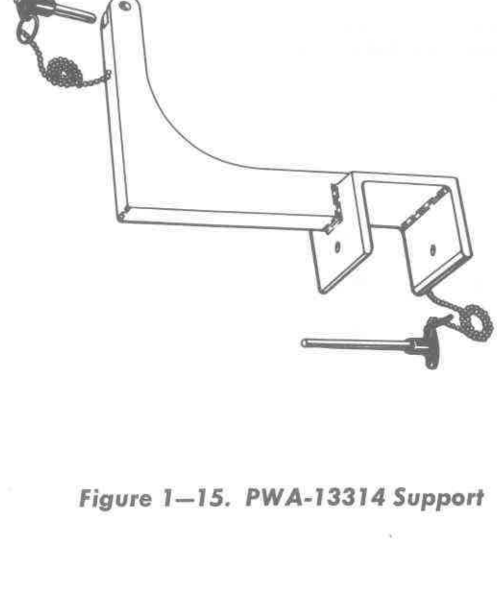


Figure 1–15. PWA-13314 Support

1-3. NUMERICAL TOOL LIST.

Tool No.	Tool Name	Tool Group
AT-1747	Adapter	6-2
AT-1853	Puller	6-1
PWA-7441	Burette	8
PWA-10723	Adapter	9
PWA-13000	Bellmouth	2B
PWA-13001	Screen	2B
PWA 13004	Mount	2B, 4, 7A, 10, 10A, 11
PWA 13005	Mount	2B, 4, 7A, 10, 10A, 11
PWA-13006	Bracket Superseded by PWA-13574	
PWA-13007	Adapter	2B
PWA-13012	Adapter	9
PWA-13013	Adapter	9
PWA-13014	Probe	2B
PWA-13015	Clamp Superseded by PWA-13979	
PWA-13018	Wrench Superseded by PWA-13978	
PWA-13020	Base	18
PWA-13022	Puller	5, 6, 17
PWA-13023	Drift	1
PWA-13024	Puller	1
PWA-13026	Base	5, 17
PWA-13027	Guide	6
PWA-13028	Drift Superseded by PWA-13617	
PWA-13029	Drift Superseded by PWA-13618	
PWA-13030	Guide	5, 17
PWA-13032	Tap	16
PWA-13035	Wrench	14
PWA-13036	Holder	14
PWA-13041	Adapter	1B
PWA-13048	Drift	18
PWA-13049	Base	6
PWA-13051	Puller	18
PWA-13060	Stand	3, 10, 10A, 11
PWA-13061	Plate	4, 5A, 5B, 7A, 10, 10A, 11, 15
PWA-13064	Support	10
PWA-13067	Sling	4, 7A, 10, 10A, 12, 15
PWA-13151	Adapter	9
PWA-13152	Harness Superseded by PWA-14558	
PWA-13159	Holder	7
PWA-13168	Adapter	2B
PWA-13169	Thermocouple	2B
PWA-13181	Adapter	4, 11, 15
PWA-13183	Support	1A, 4, 7A
PWA-13184	Pin	1A, 4
PWA-13251	Puller	13
PWA-13252	Bracket	2B
PWA-13253	Bracket Superseded by PWA-13575	
PWA-13264	Crimper	7
PWA-13268	Mount	2B
PWA-13271	Fixture	6A
PWA-13285	Drift	3
PWA-13298	Cover	11, 15
PWA-13314	Support	10
PWA-13319	Adapter	7A, 8
PWA 13320	Heater	9B
PWA-13330	Stand	4, 7A
PWA-13349	Support	5A, 5B
PWA-13350	Stand Superseded by PWA-13450	
PWA-13351	Gage	19
PWA-13352	Sling	5A, 5B

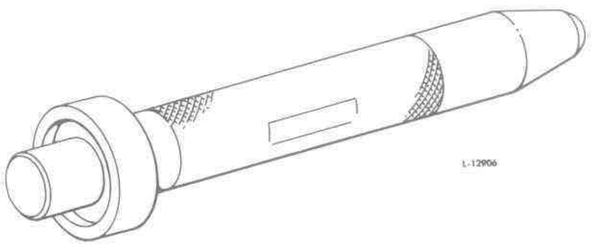


Figure 1—7A. PWA-13023 Drift

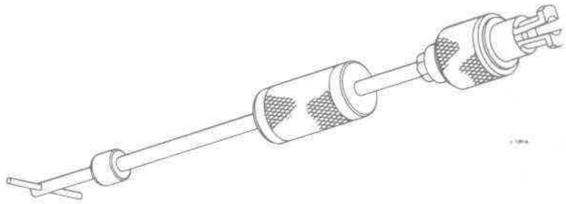


Figure 1—7B. PWA-13024 Puller

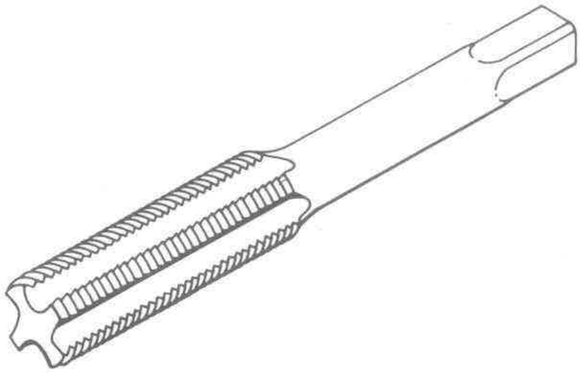


Figure 1—8. PWA-13032 Tap

Tool No.	Tool Name	Tool Group
PWA-13353	Pin	5A
PWA-13362 Superseded by PWA-39025	Gage	
PWA-13376	Adapter	2
PWA-13386	Puller	13A
PWA-13387	Puller	13
PWA-13389	Cover	9A
PWA-13393	Cover	9A
PWA-13416 Superseded by PWA-13574	Bracket	
PWA-13417	Handle	2
PWA-13418 Superseded by PWA-13551	Adapter	
PWA-13441	Cover	7A
PWA-13448	Tube	2A
PWA-13450 Supersedes PWA-13350	Stand	5A, 5B
PWA 13489	Adapter	10A
PWA-13551 Supersedes PWA-13418	Adapter	2
PWA-13574 Supersedes PWA-13006 and PWA-13416	Bracket	2B
PWA-13575 Supersedes PWA-13253	Bracket	2B
PWA-13617 Supersedes PWA-13028	Drift	5, 17
PWA-13618	Drift	6
PWA-13619	Drift	18
PWA-13707	Fixture	14A
PWA-13708	Drift	2C
PWA-13718	Drift	17
PWA-13722	Lock	2A-1
PWA-13943	Clamp	14-1
PWA-13978 Supersedes PWA-13018	Wrench	6
PWA-13979 Supersedes PWA-13015	Clamp	8, 9
PWA-14558 Supersedes PWA-13152	Harness	2B
PWA-16752	Counterbore	14A
PWA-17114	Gage	7A
PWA-17446	Adapter	7A
PWA-39025 Supersedes PWA-13362	Gage	19
PWA-39027	Puller	2C

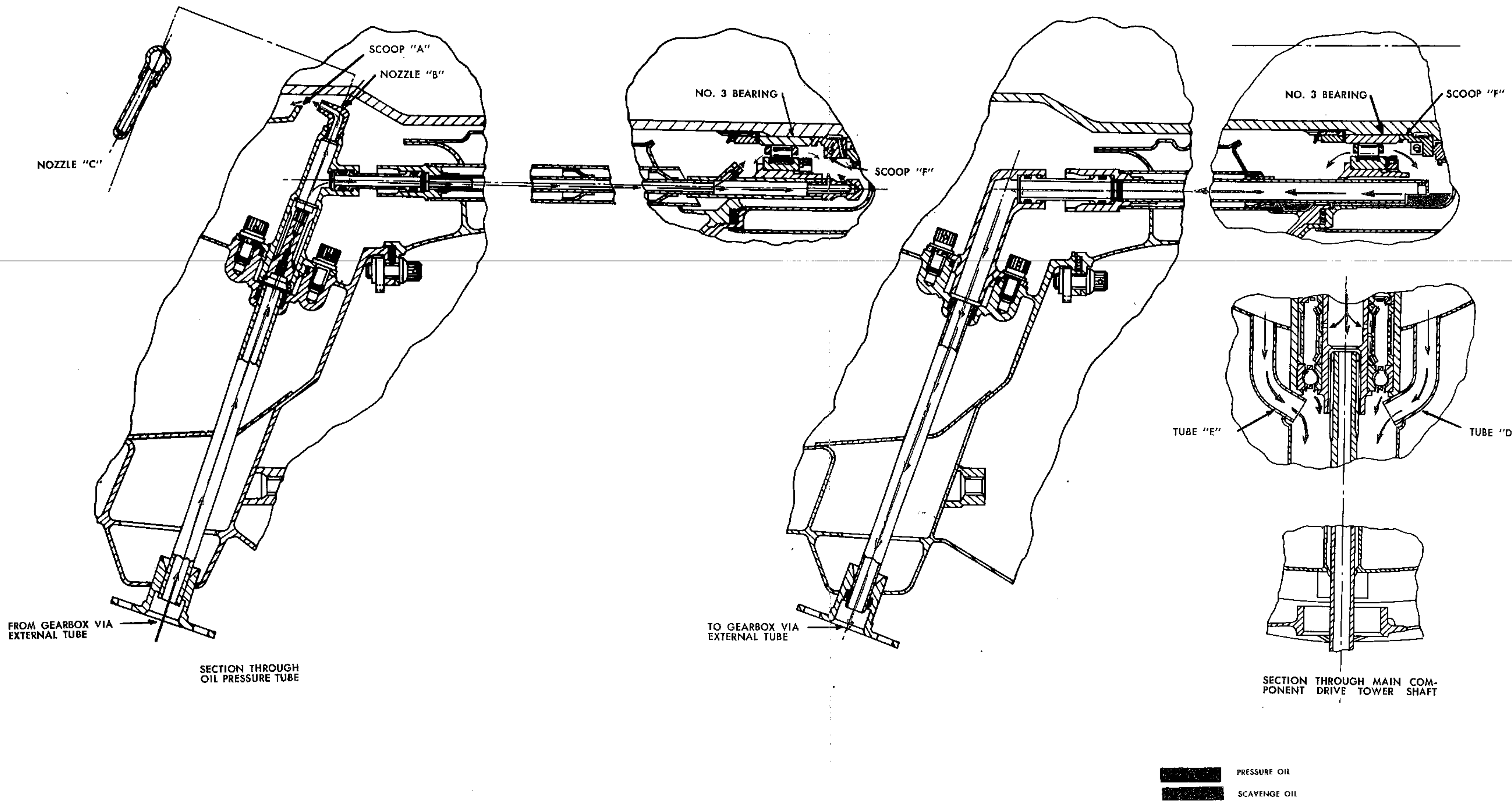


Figure 2-32. Turbojet Engine Lubrication System (Sheet 2 of 3)

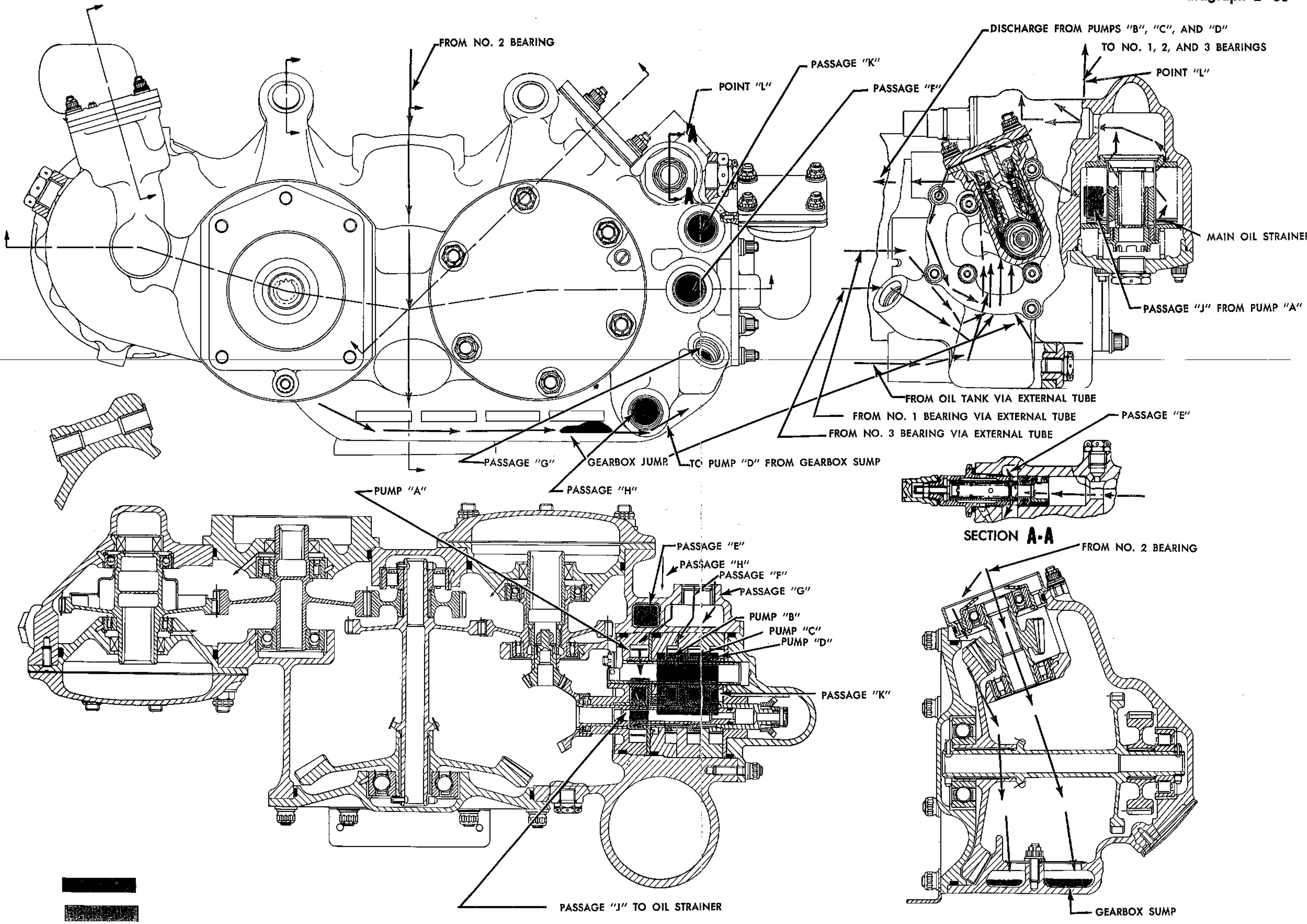


Figure 2—32. Turbojet Engine Lubrication System (Sheet 3 of 3)

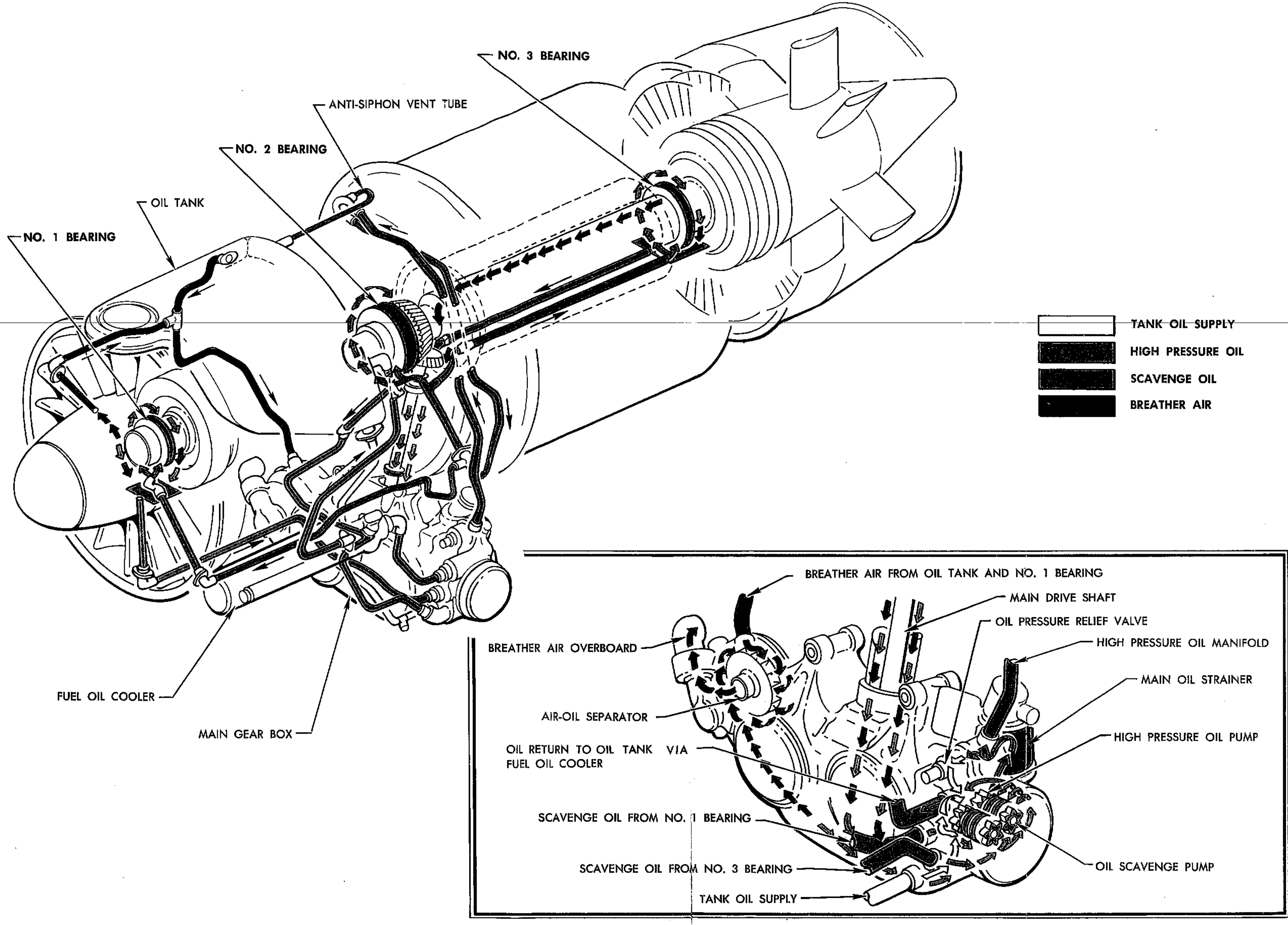


Figure 2-32. Turbojet Engine Lubrication System (Sheet 1 of 3)

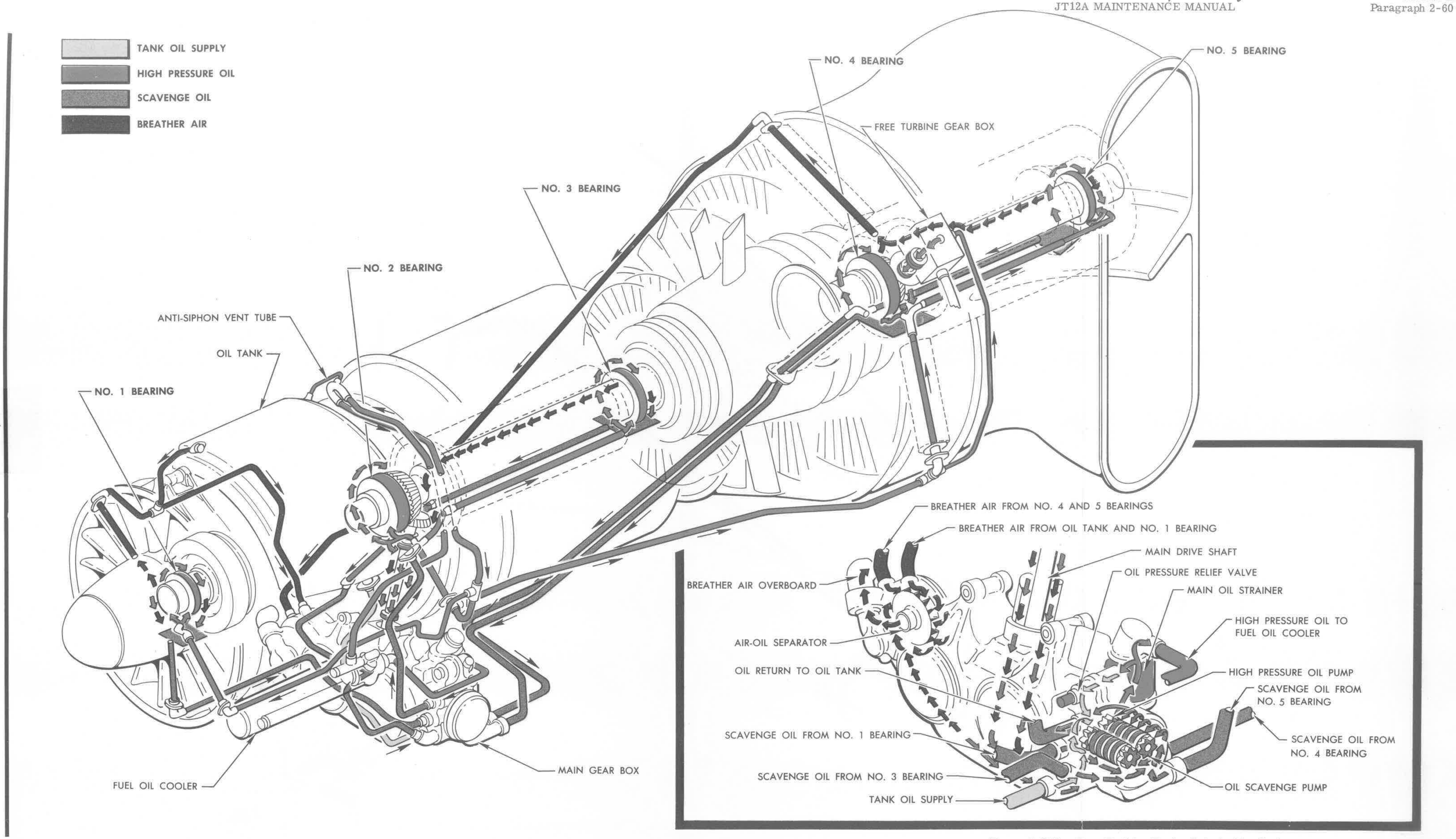
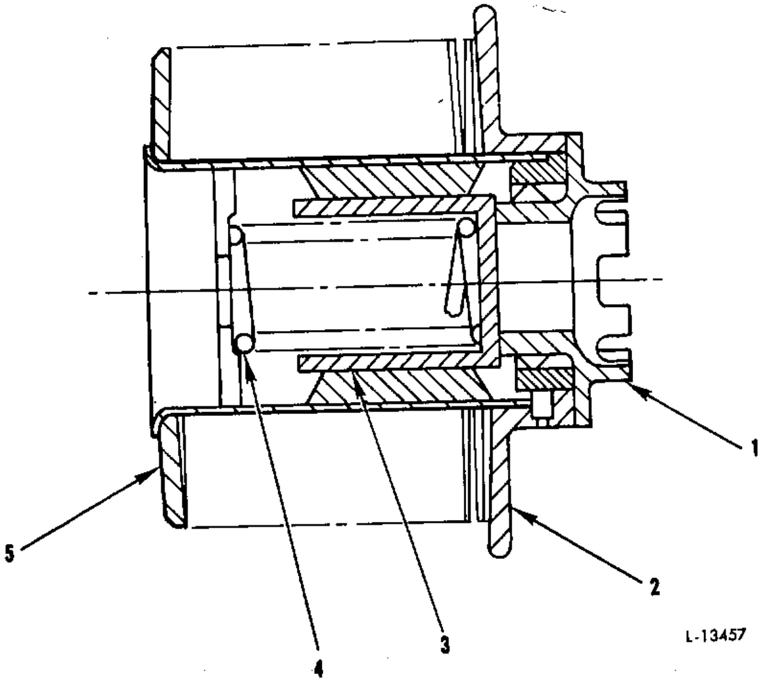


Figure 2-32A. Free Turbine Engine Lubrication System



1. Retaining Nut
2. Oil Screen Support
3. Bypass Valve
4. Bypass Valve Spring
5. Oil Strainer Support

Figure 2-33. Oil Strainer (Cross Section)

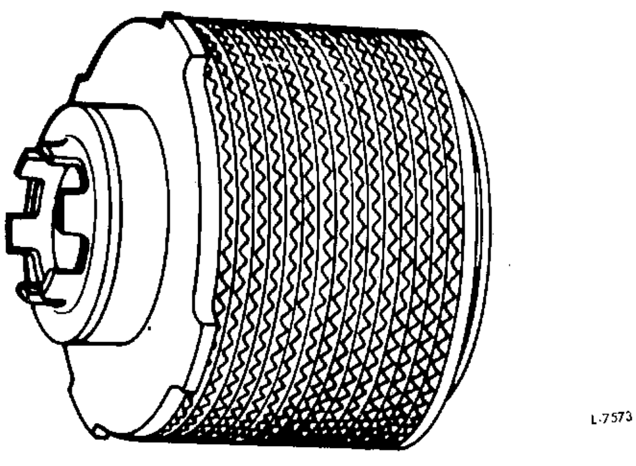


Figure 2-34. Oil Strainer (External View)

2-61. SCAVENGE OIL SYSTEM.

2-62. Scavenge oil from the three main bearings and gearbox is accommodated by three of the four stages in the main oil pump except in the free turbine engine. While the first stage (most remote from the outer pump cover assembly) is a pressure pump, the second and third stages scavenge oil from Nos. 1 and 3 bearings respectively. Oil from the accessory and component drives gearbox and No. 2 bearing is scavenged by the fourth stage. In the free turbine engine an extended pump cover assembly is used to accommodate two additional stages for scavenging oil from Nos. 4 and 5 bearings.

2-63. The output of these three sections empties into a common tube that returns the scavenge oil to the oil tank. A can-type deaerator is an integral part of the oil tank and return oil passes through this deaerator which removes most of the air. The oil tank contains baffles to prevent reaeration of the oil.

2-64. FUEL COOLANT OIL COOLER. (See Figure 2-36.) The temperature of the engine lubricating oil supply is controlled by the fuel coolant oil cooler which is attached to the lower left side of the compressor inlet case. The cooler consists of a housing,

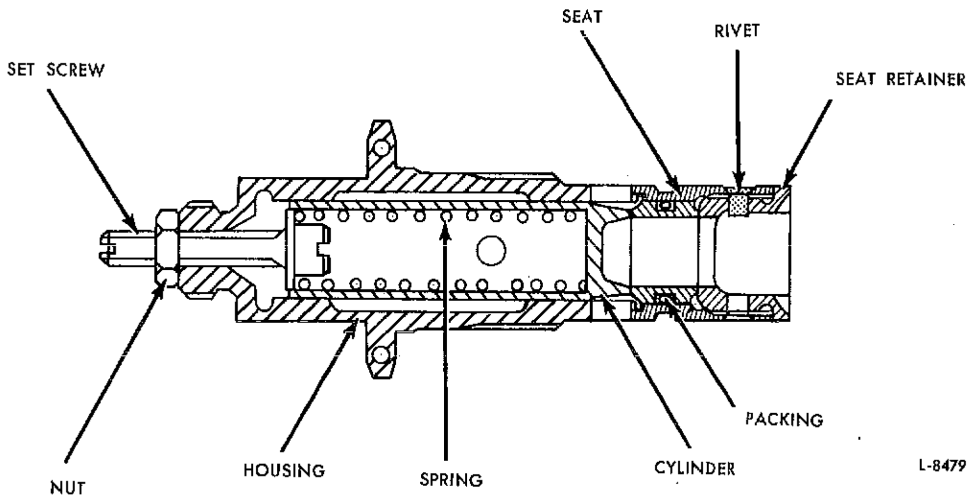


Figure 2-35. Oil Pressure Relief Valve

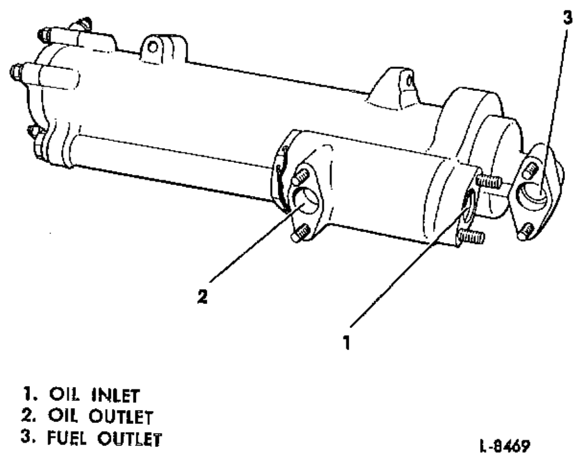


Figure 2-36. Fuel Coolant Oil Cooler

containing a heat exchanger core and a thermostatically compensated pressure valve, located in the return oil system between the scavenge pumps and the oil tank. Oil temperature is reduced by circulating the oil around heat exchanger core tubes through which fuel control discharge flow is routed. Return oil pressure and temperature control the opening and closing the valve. The valve position determines the amount of return oil that circulates through the heat exchanger.

NOTE

On the free turbine engine the oil cooler is mounted on the pressure line rather than on the oil return system. Also the cooler bypass valve is actuated by a 40 psi pressure differential.

2-65. BREATHER SYSTEM. Each of the bearing compartments and the oil tank is vented to the component drive gearbox. The common overboard vent is through a rotary breather (part of the fluid power pump gearshaft assembly) which prevents the majority of oil particles from being carried overboard in the breather airflow.

2-66. AIR SYSTEMS.

2-67. GENERAL. The engine has two separate air bleed systems, a high pressure and an overboard air bleed. The high pressure air system is available for airframe component use and the overboard air bleed is required to preclude engine compressor instability. High pressure air is also used to anti-ice the engine inlet.

2-68. COMPRESSOR BLEED SYSTEM. The engine is provided with a compressor bleed system consisting of the bleed valve assembly and external linkage to the fuel control. Air from the fourth stage passes through holes in the compressor stator spacer and into a cavity formed by the compressor stator spacer, the fourth stage vane outer shroud support ring and the compressor case. Linkage (operated by the fuel control) directs the opening and closing of the bleed valve.

2-69. ANTI-ICING AIR SYSTEM.

2-70. To prevent icing of the compressor inlet surfaces, an anti-icing air system is incorporated in the engine. Compressor discharge air is carried forward to the inlet case by an external tube that is located on the left side of the engine. Air flow through this tube is controlled by a solenoid actuated valve. When icing conditions are encountered, a switch is thrown to energize the solenoid allowing anti-icing air to pass forward.

2-71. Anti-icing air enters the compressor inlet outer case through the anti-icing air boss and into the cavity formed by the compressor inlet outer case and the inlet vane outer shroud. The air then passes through the hollow inlet guide vanes and into the chamber formed by the compressor inlet inner case and the inlet vane inner shroud. Thirty-two equally spaced holes in the compressor inlet vane inner shroud front flange provide openings where the air is ejected into the airstream.

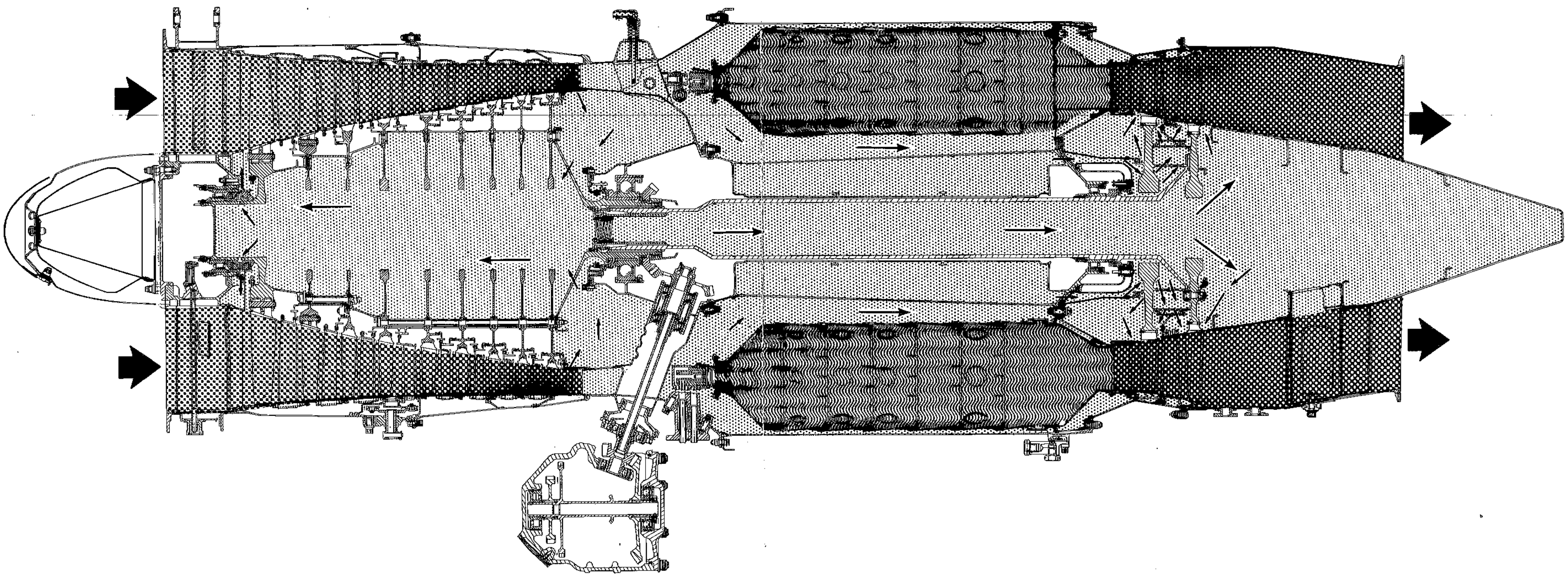


Figure 2–37. Cooling Air System

2–72. COOLING AIR SYSTEM. (See *Figure 2–37.*) Ninth stage air passes through holes in the compressor rotor rear hub, down through the inside of the rotor and out through holes in the front hub. This air is used to pressurize the main bearing seals and to cool hot section parts.

2–73. ELECTRICAL SYSTEM.

2–74. GENERAL. The electrical system is designed to facilitate engine removal by reducing to the absolute minimum the number of fittings that must be disconnected. This is accomplished by connecting the electrical leads from all the engine components (with the exception of the turbine exhaust thermocouples) into a common harness.

2–75. IGNITION SYSTEM (INTERMITTENT). (See *Figure 2–38.*)

2–76. GENERAL. The ignition system consists of two identical, four joule, independent units, one for each sparkigniter. The ignition system will operate satisfactorily with an input voltage of 14 to 30 volts D. C. The spark rate (which depends on the input voltage) is 1.6 to 3.3 per second. An input filter is incorporated in each unit to eliminate radio interference.

2–77. OPERATION. Input voltage supplied to the exciter is first passed through a radio noise filter to prevent high frequency feedback into the aircraft electrical system. From the filter this voltage reaches the vibrator and passes through the primary of the stepper transformer, the vibrator driver coil, and through a pair of contacts (normally closed) to ground. A point capacitor is connected across these contacts to damp excessive arcing.

2–78. With the contacts closed, current flows through the primary of the stepper transformer (producing a magnetic field) and through the driver coil. The driver coil pulls the contacts open, interrupting the current flow, and causing the magnetic field to collapse. Spring action returns the contacts to a closed position and the cycle recommences.

2–79. The collapse of the magnetic field in the stepper transformer induces a high voltage in the secondary. This produces successive pulses flowing into the storage capacitor through the gas charged rectifier tube, which limits the flow to a single direction. With repeated pulses the capacitor stores a greater and greater charge, at a constantly increasing voltage.

2–80. When this voltage reaches the predetermined level for which the spark gap in the seal discharger tube has been set, the gap breaks down. This allows the accumulated energy to flow through the lead to the electrodes of the sparkigniter.

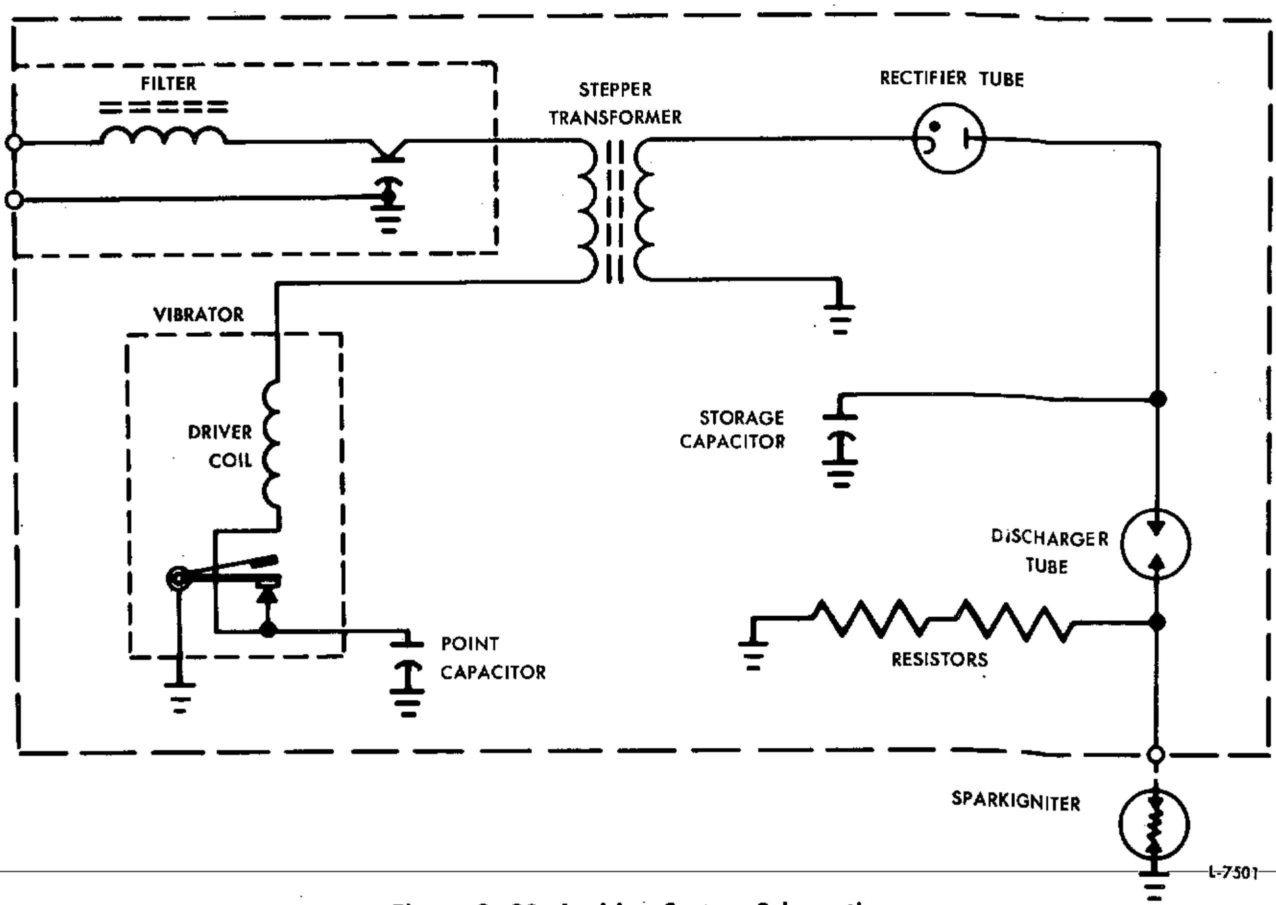


Figure 2–38. Ignition System Schematic

2–81. The bleeder resistors are provided to protect exciter components in the event of inadvertent operation in open circuit condition.

2–82. The spark rate will vary, depending on the value of input voltage. At lower values, more time will be required to raise the voltage on the storage capacitor to the level necessary to break down the spark gap. However, since that level remains constant (being established by the physical properties of the gap) a full normal store of energy will always be accumulated by the storage capacitor before discharge.

2–82A. IGNITION SYSTEM (CONTINUOUS–OPTIONAL).

2–82B. GENERAL. The continuous duty ignition system employs one high tension and intermittent duty exciter and one high tension and continuous duty exciter. Since the system is composed of one intermittent and one continuous exciter, the electrical system must take into account two different duty cycles. For starting purposes, the two exciters are operating and the duty cycle established by the requirements of the intermittent exciter, should be observed. Whenever conditions warrant continuous ignition, only the continuous exciter, which incorporates a removable resonant type vibrator, a removable discharger tube, and a silicon rectifier for longer life, should function.

2–82C. OPERATION. DC power is supplied to the input connector of the high tension exciter and is initially routed through a radio noise filter to prevent high frequency feedback to the aircraft power line from the primary winding of the transformer and the vibrator. This input voltage then operates the driver coil of the vibrator and is furnished to the primary of the stepper transformer. The voltage in the driver coil passes to ground through a set of normally closed contacts across which a point capacitor is connected to damp excessive arcing. When the contacts are in the closed position, the flow of current through the primary of the stepper transformer establishes a magnetic field. The action of the driver coil in the vibrator then opens the contacts, the flow of current stops, and the collapse of the magnetic field induces a high alternating voltage in the secondary of the stepper transformer. This high alternating voltage, in the form of successive pulses, flows into the storage capacitors through the rectifier, which limits flow to a single direction. The storage capacitors assume a greater and greater charge at a constantly increasing voltage and when the voltage level for which the sealed discharger tube has been calibrated is reached, the gap breaks down.

2–82D. A portion of the accumulated charge from the storage capacitors passes through the primary of the trigger transformer and the series trigger capacitor. The surge of current induces a very high voltage in the secondary of the transformer which ionizes the air gap at the sparkigniter and produces a preliminary or trigger spark. When the air gap is thus made conductive, the storage capacitor discharges the remainder of its accumulated energy, together with the charge from the trigger capacitor, resulting in a very high energy capacitive spark. The bleeder resistor in the trigger circuit serves to dissipate any residual charge on the trigger capacitor between the time of the spark and the start of the next cycle. In addition, a resistor is also connected across the discharger tube of the continuous duty exciter in order to bleed off any residual charge from the storage capacitor, thus minimizing shock hazard when the discharger tube is removed from the exciter.

2–83. ENGINE INDICATING SYSTEMS.

2–84. TURBINE PRESSURE SENSING SYSTEM. The turbine pressure sensing system consists of four manifold assemblies that are interconnected to form an averaging pressure sensing system. Pressure taps are provided on the manifolds for airframe connections. Each manifold assembly is made up of a pressure probe and tubing.

2–85. TURBINE TEMPERATURE SENSING SYSTEM. The turbine temperature sensing system consists of a dual junction thermocouple cable ***(Figure 2–39)*** and three dual junction thermocouples ***(Figure 2–40)***. Two connectors are provided in the thermocouple cable, one for connecting to an averaging indicator and the other for individual checking of the thermocouples.

2–86. FUEL SYSTEM.

2–87. FUEL PUMP.

2–88. The engine fuel system uses a single element, centrifugal boost, main fuel pump, mounted on the component drive gearbox. On the rear of the pump is a mounting pad for the engine fuel control, to which fuel is directed through a passage within the mounting pad.

2–89. Fuel enters the centrifugal boost impeller of the pump and the impeller raises this pressure to approximately 40 psi. Fuel leaves the impeller and passes through an externally mounted fuel de-icing heater which maintains the fuel temperature at approximately 30°C (85°F).

2–90. The fuel passes through the fuel de-icing heater and returns to the pump at the inlet of the by-passing type fuel filter. It then passes through the filter and is directed to the main pumping element. The fuel pressure is increased by the main pumping element to 800 psig and passes out of the pump to the engine fuel control. Any fuel not required by the engine is returned to the pump at the main stage inlet area.

2–91. FUEL DE-ICING HEATER.

2–92. The fuel de-icing heater and a cockpit controlled electrically operated shut-off valve are attached to the lower right hand side of the compressor inlet case.

2–93. An external tube ports compressor discharge air from the diffuser case, through the shut-off valve, to the fuel heater. Fuel pump interstage fuel is externally routed to the heater and back to the pump.

2–94. When fuel icing causes the pressure drop across the fuel pump interstage filter to exceed 7 to 8 psi a differential switch (on the pump) operates a warning light indicating that the fuel heater should be used.

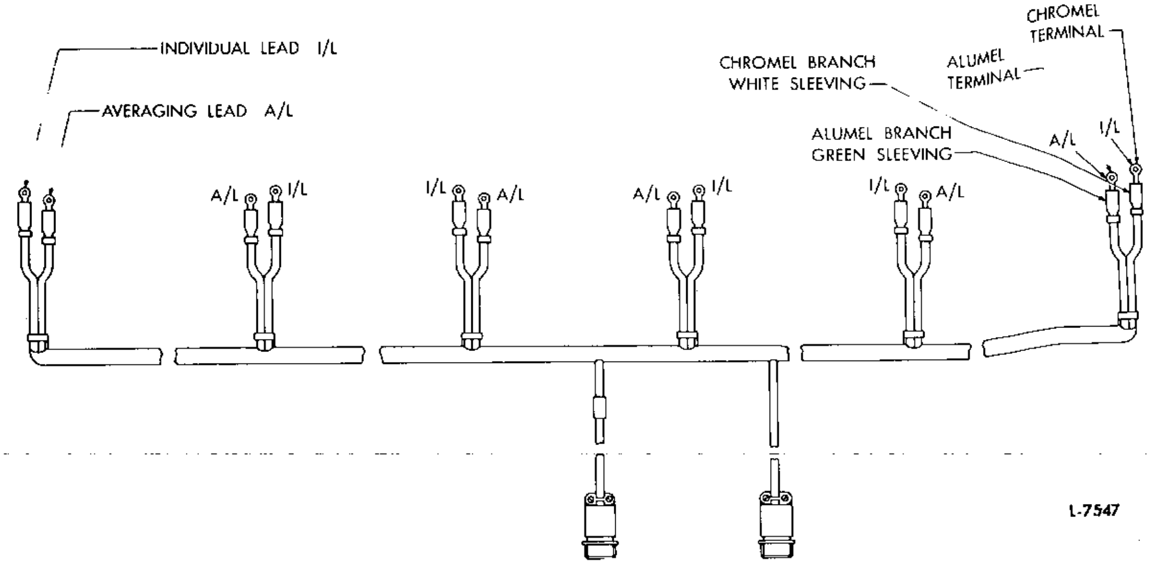


Figure 2–39. Dual Junction Thermocouple Cable

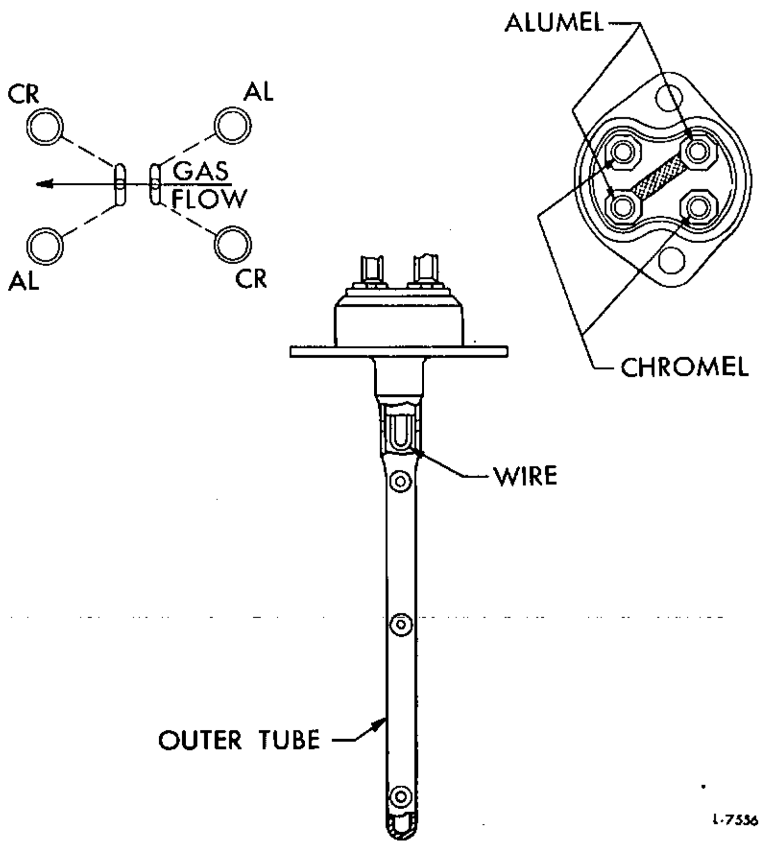


Figure 2-40. Dual Junction Thermocouple

2-95. Opening the shutoff valve allows warm compressor discharge air to flow to the heater. The air flows through tubes in the heater core raising the temperature of pump interstage fuel which is circulating around the tubes.

2-96. FUEL CONTROL (HOLLEY).

2-97. The fuel control is a hydromechanical type. There is no secondary system within the control as an alternate to the primary computing and metering system. All critical factors influencing the metering of fuel flow for efficient engine performance under all variable conditions are sensed and interpreted by the computing section, and signals are sent to the metering section to obtain the correct fuel flow.

2-98. The fuel control senses the pressure of the air entering the engine (P_{t2}), the pressure of the air in the engine diffuser section (P_{t3}), and the speed of the engine (N) to regulate and maintain the required output. When the power lever setting is changed, and while adapting to a new steady-state fuel rate, the fuel control varies the fuel flow between the limiting values established by safe turbine inlet temperatures and lean mixture combustibility. The control permits the fuel flow to reach these limits during acceleration and deceleration but does not permit transgression in either direction, thus preventing excessive turbine inlet temperature at the rich limit and flameout at the lean limit.

2-99. BASIC FUNCTION.

2-100. The fuel control is divided into two major sections, the computing section and the metering section. The computing section contains the sensing devices and the servo systems actuated by these devices to move the fuel metering valve axially and rotationally. The correct metering port area for any combination of conditions is thereby obtained to control the required rate of fuel flow. The basic function of the metering section is the metering of fuel through variable ports in the hydraulically operated fuel metering valve. The bypass valve maintains a constant pressure drop across the metering ports of the fuel metering valve. It also returns excess fuel to the fuel pump.

2—101. The fuel metering valve meters fuel to the engine through three rectangular ports in the fuel valve sleeve. The pressure drop through the ports is maintained constant by means of a bypass valve. This valve returns all fuel flow in excess of engine requirements, through the high return system, to the inter-stage pressure section of the fuel pump. Since the pressure drop across the valve can be kept constant, fuel can be varied proportionally by increasing or decreasing the rectangular port area of the fuel metering valve.

2—102. The total flow area of the metering ports is determined by the computing section. The computing section establishes the various hydraulic pressures which are used to position the fuel metering valve for the correct amount of fuel to the engine combustion chambers at all times. The input signals to the computing section are: compressor discharge pressure (P_{t3}), compressor inlet air pressure (P_{t2}), engine speed (N), and control power lever angle (PLA). Fuel is metered to the engine to maintain the desired engine speed, acceleration and deceleration (minimum ratio), for any combination of varying signals. The axial position of the fuel metering valve is determined by changes in engine speed and power lever angle, and the rotational position of the fuel metering valve is determined by changes in compressor discharge pressure (P_{t3}). Thus the fuel metering valve moves both axially and rotationally to establish the metering orifice required for different conditions of engine operation.

2—103. FUEL CONTROL FUEL SYSTEM.

2—104. GENERAL. Four systems in the fuel control unit position the fuel metering valve, by means of hydraulic pressures, to meter the correct fuel requirements for different engine operation conditions. These systems are governing, acceleration, deceleration or minimum flow, and shut-off.

2—105. GOVERNING SYSTEM. The governing system regulates the metering of fuel to maintain engine steady-state operation as a function of control power lever angle (PLA), compressor inlet air pressure (P_{t2}), compressor discharge pressure (P_{t3}), and engine speed (N). The governor cam is positioned rotationally by power lever angle (PLA) and axially as a function of compress inlet air pressure (P_{t2}). The governor cam lever, acting through the governor servo and the governor set lever, establishes a spring load on the governor piston in opposition to the speed sense piston signal. The centrifugal force speed sense piston driven by engine speed (N) supplies a hydraulic signal which results in positioning the governor piston. The governor piston, through the acceleration lever assembly and the fuel servo valve, moves the fuel metering valve axially between the limits established by the acceleration cam and the minimum ratio stop.

2—106. ACCELERATION SYSTEM. The acceleration system controls the metered fuel flow rate during engine acceleration. Acceleration fuel flow is a function of compressor discharge pressure (P_{t3}), engine speed (N) and compressor inlet air pressure (P_{t2}). As the power lever is advanced for acceleration, the governor cam is repositioned rotationally which in turn repositions the governor servo. The changed governor servo position moves the governor set lever to increase the spring force on the governor piston. At this time the acceleration lever spring moves the acceleration lever assembly to make contact with the acceleration cam, which limits travel of the fuel servo valve in the increasing fuel flow direction. The increase in fuel flow through the metering valve causes a change in engine speed (N), which increases the compressor discharge pressure (P_{t3}) and moves the burner pressure servo valve. The fuel metering valve is rotated accordingly by means of the yankee screw driver principle. As the engine accelerates to the newly selected speed, increased centrifugal speed sense piston differential force causes the acceleration cam to rotate through the action of the speed loop piston and also increases the governor spring force through the governor piston which causes the acceleration lever assembly to move off the acceleration cam and reduces the port area of the fuel metering valve until the correct steady-state fuel flow is established. Axial positioning of the acceleration cam is accomplished by the repositioning of the acceleration and governor cam lever through the operation of the dual bellows system. With a change in compressor inlet air pressure (P_{t2}), the sensing bellows, which is opposed by the evacuated reference bellows translates a force to the servo lever. Movement of the servo lever, repositions the servo, which results in a change in pressure differential across the servo piston. This change in pressure differential moves the servo piston and repositions the governor cam axially. As the governor cam is repositioned, the acceleration cam is also repositioned, due to the acceleration and governor cam lever.

2—107. MINIMUM FLOW SYSTEM. The minimum ratio system, which is part of the minimum flow system, limits the axial closing of the fuel metering valve, thereby scheduling constant minimum ratio (fuel flow per unit of burner pressure) fuel flow. An adjustable minimum flow ratio stop limits axial travel of the fuel metering valve in the closing direction. Thus the ratio of deceleration or minimum fuel flow to compressor discharge pressure (P_{t3}) is maintained constant down to a burner pressure value of 29 PSIA. As the fuel flow is reduced by virtue of the new position assumed by the fuel servo valve determined by the minimum ratio stop, compressor discharge pressure (P_{t3}) drops as a result of reduced speed, causing the servo piston to rotate the fuel metering valve in accordance with changes in compressor discharge pressure (P_{t3}).

2—108. Incorporated within the control is a fixed minimum fuel flow system which maintains an absolute minimum fuel flow level at a predetermined constant fuel flow. As the minimum fuel flow rate is approached, the minimum flow check valve is seated by spring force, and the pressure drop is then a function of fuel flow through the orifice in the minimum flow check valve. The pressure differential across the minimum fuel flow diaphragm and piston decreases, and spring force causes the minimum fuel flow make-up valve to open, which allows control inlet fuel pressure (F_1) to be ported through the orifice in the minimum flow check valve and maintains the absolute fuel flow level at a predetermined constant fuel flow.

2-109. SHUTOFF SYSTEM. To shut down the engine, a two position fuel shutoff valve is incorporated in the fuel control. When the power lever is closed to shut down the engine, a cam moves the recirculation valve to the open position, permitting metered fuel to be returned to the inter-stage of the two-stage fuel pump through the return fuel passage. The metered fuel pressure drops and allows the throttling shutoff valve springs to move the throttling valve (shutoff valve) against its seat below six degrees power lever shaft rotation.

2-110. OPERATION.

2-111. Engine main pump fuel pressure (F_1) is supplied to the control, and a quantity of this fuel is filtered through a servo fuel filter to provide fuel pressure for the computing section. In the event this filter becomes contaminated, a ball check valve will bypass unfiltered fuel to the computing section when the pressure differential exceeds design specifications.

2-112. As fuel enters the control, the bypass valve maintains a constant pressure differential between primary fuel pressure (F_1) and metered fuel pressure (T_v) by bypassing excess fuel to the interstage of the two stage fuel pump. Since this pressure differential has been established as constant, fuel flow is a function of the fuel metering valve port area. The fuel metering valve is designed to open or close rotationally with changes in compressor discharge pressure (P_{t3}) and to open or close axially with changes in speed (N) and compressor inlet air pressure (P_{t2}) on acceleration, and with power lever angle (PLA), speed (N) and compressor inlet air pressure (P_{t2}) on governing.

2-113. BLEED VALVE ACTUATOR. The bleed valve actuator is incorporated to control the position of the engine compressor bleed valve. At a predetermined signal, the three-dimensional acceleration cam sends a signal through the bleed valve cam lever which repositions the bleed valve actuator servo. Filtered fuel pressure (F_2) is then ported through the bleed valve actuator servo to operate a piston which controls either the opening or closing of the engine compressor bleed valve.

2-114. CLUTCH ARRANGEMENT. Incorporated within the control is a clutch arrangement which prevents damage to the fuel control while making allowable adjustments. If the limit of the idle or the maximum adjustments is reached, the clutch plate slips, thus preventing internal damage to the fuel control.

2-114-1. DESCRIPTION OF OPERATION FOR HAMILTON JFC 56-2 AND 56-4 FUEL CONTROLS FOR JFTD 12A-4A ENGINE. The fuel control is a hydromechanical control designed to meter fuel to the JFTD 12 engine. The control has a fuel metering system and a computing system. The metering system selects the rate of fuel flow to be supplied to the engine in accordance with the amount of power requested, but it is subject to engine operating limitations scheduled by the computing system as a result of monitoring various operating parameters. The computing system thus allows the maximum engine performance available without exceeding engine operating limits.

2-114-2. METERING SYSTEM. After entering the fuel control, the fuel flow passes through the fine servo supply filter. This is a 40-micron screen of the wash-through type which is self-cleaning because the fuel velocity through the axis of the cylindrical screen is significantly greater than that of the flow through the mesh supplying the servo control valves. Downstream of this portion of the filter, the fuel proceeds through a full flow screen of the 100-mesh size. Both screens are protected by ball valves that allow flow to bypass the screens if they are clogged sufficiently to cause the pressure drop across them to exceed 15 psi. An annular trap prevents dumping of the clogging contaminants into the control when bypassing the fuel flow screen.

2-114-3. Fuel from the filter goes to the metering, or throttle valve. This is a window type valve positioned by a half-area servo. Piston position is controlled by a rotating pilot valve displaced from its hydraulic null (steady-state) position by compressor discharge pressure, engine speed, rotor load, power lever, or any combination of these parameters. These actuating signals work in conjunction with each other to produce a net torque on the multiplying lever. A balancing torque is created by a spring load varied with throttle valve position. As long as the resultant torque is zero, the throttle valve maintains a constant position. Any change in signal torque, displaces the pilot valve and causes motion of the throttle valve until the unbalanced signal torque is equalized by the new valve position and corresponding spring force.

2-114-4. Fuel from the throttle valve passes through the minimum pressure and shutoff valve on its way to the engine. The valve is referenced to pump interstage pressure and a spring force to ensure that control inlet pressure is a minimum of 120 psi above inter-stage pressure for positive servo actuation during starting and high altitude conditions. This also ensures that the control discharge pressure is 80 psi minimum above interstage pressure when the gas generator power lever is in an operating position. When actuated for the shutoff function, control inlet pressure is directed to the spring side of the valve, closes the valve and allows the spring to keep it in the shutoff position. The valve employs an O-seal for the seat to ensure drop tight closing.

2-114-5. To ensure a predictable flow, the pressure drop across the throttle valve is maintained nominally at 40 psi by a bypass type regulating valve and sensor. The flow forces acting on the regulating valve are compensated for by utilizing the impulse bucket principle to improve the accuracy of the basic valve. This minimizes the work required of the pressure regulating valve sensor and increases the accuracy of pressure regulation. The lower end of the pressure regulating valve is subjected to servo pressure; the upper end is balanced by a modulated pressure nominally 30 psi less than throttle valve supply and a spring force equivalent to 30 psi. The purpose of plumbing the valve in this manner is to limit the authority of the pressure regulating valve sensor. In the event of a failure in the direction of low control discharge pressure, the control will meter at the 30 psi level and prevent bypassing the total flow back to the pump inlet. Variations in fuel temperature are compensated for by the action of a bimetallic disk working on the 40 psi (nominal) equivalent reference spring in the pressure regulating valve sensor. The pressure regulating valve is capable of bypassing 8500 pounds per hour flow with a pressure drop across the bypass ports below 100 psi. This low pressure drop prevents the pump from operating against an excessively high head or causing large increases in fuel temperature in case it is desired for cooling purposes.

2-114-6. The windmill bypass and shutoff control valve is plumbed into the line leading to the spring side of the pressure regulating valve. Movement of the gas generator power lever to the shutoff position, or an overspeed of the free turbine beyond a desired maximum value, displaces this control valve to the left. This changes the pressure on the spring side of the regulating valve to pump interstage pressure. The pressure regulating valve now acts as a 30 psi relief valve with ample capacity to handle the full windmilling fuel flow. Because of the reduced pressure upstream of the throttle valve, a port located in this line downstream of the filter provides a pressure signal 30 psi above interstage pressure to the automatic fuel manifold dump valves, replacing the high pressure signal supplied during normal operation. With the windmill bypass and shutoff valve pilot valve in shutoff position, the control inlet pressure is directed to the spring side of the shutoff valve. This closes the valve and allows the spring to keep it in the shutoff position. The control valve is dimensioned to sequence the shutoff and dump valve signal functions with the gas generator power lever in the zero degrees to ten degrees range of operation.

2-114-7. COMPUTING SYSTEM.

2-114-8. GAS GENERATOR SPEED CONTROL. To set the maximum available engine power with this control, the gas generator power lever actuates the speed set cam to select a gas generator governor droop line. The position of this governor droop line is biased by rotor blade pitch. In the event of a free turbine governor failure, the bias prevents the gas generator from causing an overspeed of the rotor before a pitch correction can be made. This resetting of the gas generator droop line limits the amount of power the gas generator can deliver to the free turbine to correct for the apparent underspeed.

2-114-9. Actual gas generator speed is represented in the control by the position of a double acting piston which is also a three-dimensional cam. A flyweight governor driven by the gas generator control the motion of this piston by displacing a rotating pilot valve from its steady state position. A proportional feedback system provides a unique piston position for every speed. A second three-dimensional cam, located on the gas generator power lever, rotates to provide a "required" speed input and translates to reposition the gas generator droop line with pitch. The inter-related action of these controlling parameters positions the rollers in the multiplying system as a function of speed by rotating the droop cam. Control of the minimum W_f/P_3 ratio for lean blowout protection is provided by a constant radius portion of this cam that limits the travel of the rollers toward decreasing fuel flow.

2-114-10. FREE TURBINE SPEED CONTROL. The free turbine power lever actuates a speed setting cam to select a free turbine governor droop line. The position of this droop line is biased by a rotor pitch signal supplied by an external control shaft. The free turbine flyweight speed governor is mounted on the control and positions a piston in the control to provide a position signal representing actual free turbine speed. The free turbine speed signal is transmitted to the control via a flexible cable.

2-114-11. FREE TURBINE OVERSPEED CUT-OFF. The control provides a means of automatically shutting off all fuel flow to the engine if the free turbine speed exceeds a desired maximum value. In the event of this overspeed, the piston indicating free turbine speed actuates a tripping lever to move the windmill bypass and shutoff control valve to the shutoff position. To prevent premature restarts, the tripping lever becomes locked in position and can only be released by moving the gas generator power lever to the shutoff position. This releases the locking latch and resets the overspeed mechanism.

The JFTD12A-5A engine incorporates two overspeed protective systems. Should the free turbine reach 113 percent of rated speed, the first overspeed system will automatically reduce fuel flow so that free turbine speed will decrease. At approximately 111 percent free turbine speed, fuel flow will be restored to its former value and the free turbine will again accelerate. The free turbine will cycle between these speeds until the power lever is retarded to a position such that the free turbine speed does not reach 113 percent. In the event the free turbine reaches 114.4 percent of rated speed, the second overspeed system will automatically shut off all fuel flow to the engine. The power lever must be retarded to the shutoff position to reset the latter overspeed system.

2-114-12. ACCELERATION LIMITING CONTROL. The acceleration of the engine is controlled by a three- dimensional cam containing a function of W_f/P_3. The W_f/P_3 value is multiplied in the linkage by compressor discharge pressure to produce a resulting value of fuel flow. When the acceleration cam is in operation to control the maximum value of W_f/P_3, it overrides the speed setting linkage.

2-114-13. The acceleration limiting cam has a provision to protect against a broken gas generator speed sensing driveshaft. In the event of such a failure, the speed servo (3-D cam) bottoms in its bore in the low speed direction while the push rod on the speed servo bottoms on an adjustable stop set near the zero speed position to eliminate feedback to the governor pilot valve. The three-dimensional cam then places the limiting linkage at a W_f/P_3 ratio corresponding to the value selected for this failure condition.

2-114-14. COMPRESSOR DISCHARGE PRESSURE SENSING. The compressor discharge pressure sensor assembly consists essentially of a pair of matched bellows, the evacuated and the motor bellows, and a sensor lever. The motor bellows is externally exposed to compressor discharge pressure and the resultant force caused by P_3 pressure on the bellows is opposed by an evacuated bellows of equal size. The net force, which is proportional to absolute compressor discharge pressure, is transmitted through the sensor lever to a set of rollers whose position is proportional to the required Wf/P_3. These rollers ride between the sensor lever and a multiplying lever. A force proportional to compressor discharge pressure is transmitted through the rollers to the multiplying lever. Any change in the roller position or the compressor discharge pressure signal results in an unbalanced torque which will displace the rotating pilot valve from its hydraulic null position, thereby repositioning the throttle valve. The movement of the throttle valve extends or relaxes a spring which will return the multiplying lever to its equilibrium position when the throttle valve reaches the required position. Both the motor and the evacuated bellows are located in a chamber vented to ambient pressure so that in the event of an evacuated bellows failure, the fuel flow error is only the difference between the flow required for the absolute pressure reading and that required for a gage pressure reading. In the event of a motor bellows failure, the compressor discharge pressure will be sensed on the external surfaces of the evacuated bellows and the system will continue to function. The vent line to the bellows chamber contains an orifice which will allow compressor discharge pressure sensing, should a gross motor bellows failure occur.

2-114-15. COMPRESSOR BLEED CONTROL. The control incorporates a control valve and a power piston to provide a mechanical output motion that operates the compressor bleed strap as a function of actual corrected speed. The control valve is actuated by a linkage from the three-dimensional cam that is translated by the gas generator speed piston. A modulated bleed signal is used. Feedback from the output repositions the control valve at null. This allows bleed strap position to be set as a function of N_1 speed.

2-114-16. Collective Pitch Lever. The collective pitch control shaft repositions the free turbine speed setting linkage and translates the three-dimensional speed setting cam in the gas generator speed linkage. This changes the position of the multiplying rollers and resets both governor droop lines as required by changes in rotor blade pitch.

2-114A. FUEL PRESSURIZING AND DUMP VALVE.

2-114B. Metered fuel flows from the fuel control, through the fuel coolant oil cooler and a fuel flowmeter, to the fuel pressurizing and dump valve. The fuel pressurizing and dump valve housing contains two separate valves, the pressurizing valve and the dump valve.

2-114C. The pressurizing valve divides the fuel flow between the fuel nozzle orifices (primary and secondary) to ensure proper atomization of fuel discharges into the combustion chambers. The valve remains closed, sending all fuel to the primary orifices of the nozzles, until a predetermined pressure is reached. As the pressure is increased, the valve opens, allowing a portion of the fuel to flow to the secondary orifices of the nozzles. An adjustment is provided to regulate operation of the valve.

2-114D. The dump valve provides a means of draining fuel from the fuel manifold at engine shutdown. The valve, which is spring loaded to open, is closed by a fuel signal during engine operation. When the engine is shut down, the valve opens and allows fuel to drain.

2-114E. An inlet strainer, incorporating a bypass feature to offset strainer clogging, is located in the pressurizing and dump valve. A poppet type inlet check valve is located downstream from the inlet strainer.

2-114F. Bolts attach the fuel pressurizing and dump valve to an adapter located on the diffuser case. The fuel pressurizing and dump valve attaching boss has four discharge ports. Two of these ports direct primary fuel flow through ferrules to the primary fuel inlets of the fuel manifold. The remaining ports direct secondary fuel flow through ferrules to the secondary fuel inlets of the fuel manifold.

2-115. ENGINE CONTROLS AND INSTRUMENTATION.

2-116. GENERAL.

2-117. In addition to the turbine discharge pressure or engine pressure ratio indicator, the following controls are usually considered necessary for normal control and operation of the engine, for checking the mechanical condition of the engine, and for checking or adjusting the thrust output of the engine.

2-118. These controls and instrumentation are normally used in manned aircraft and should also be available to ground personnel of a pilotless aircraft during ground operation and check-out. The controls and instrumentation may differ in various installations but provision must be made for them in some phase of ground operation.

a. Anti-Icing Heat Light - Indicates when the engine air inlet anti-icing system is in operation.

b. Anti-Icing Heat Switch - Opens and closes the valve which admits the flow of compressor bleed air to the engine inlet for anti-icing.

c. Engine Master Switch - Controls all electrical power to the engine.

d. Engine Starter Switch - Actuates the starter mechanism which turns the compressor rotor.

e. Exhaust Gas Temperature Indicator - Indicates the turbine discharge temperature. The indicator will usually indicate the average of several exhaust gas temperature probes; however, individual probe readings may be provided in some installations.

f. Fuel Boost Pump Switch - Energizes an external fuel boost pump for starting, and during all engine operation.

g. Fuel Flow Indicator - Indicates fuel flow (in pounds per hour) to the inlet of the engine driven fuel pump.

h. Fuel Inlet Pressure Indicator - Indicates fuel boost pump pressure at the inlet of the engine driven fuel pump.

i. Fuel System Shutoff Switch - Opens and closes the emergency shutoff valve which, in turn, isolates the engine fuel system from the external fuel supply.

j. Ignition Switch - Energizes the ignition system for starting.

k. Oil-In Temperature Indicator - Indicates the temperature of the engine oil as it enters the oil pressure pump.

l. Oil Pressure Indicator - Indicates engine oil pressure.

m. Tachometer - Indicates engine rpm during starting, and monitors engine operation to make certain that the compressor is not overspeeding.

n. Power Lever (Turbojet Engines) - Modulates engine thrust from idle to take-off. The detent provided for idle represents the lowest permissible level of thrust for engine operation. Fuel to the engine is automatically shut off at power lever positions below idle.

o. Control Levers (Free Turbine Engines) - The hydromechanical fuel control incorporates the following control levers:

(1) Gas Generator Power Limit Lever - Schedules gas generator speed (N1) in the engine starting and

idle speed range. Also provides topping governor rpm control in the power range and, when moved below the IDLE position, close the fuel control shutoff valve.

(2) Free Turbine Speed Selector Lever (N_2 Lever) - Permits selection of the desired free turbine speed.

(3) Pitch (Load Governing) Lever - This is not a direct control, but a helicopter rotor blade pitch control lever whose position is fed into the engine as a signal.

2-119. ENGINE MOUNTS - TURBOJET ENGINES.

2-120. FRONT MOUNT. Two point vertical suspension is provided by two mount fittings on the compressor case. This front mount takes vertical loads only.

2-121. MAIN MOUNT. A main mount is located on each side of the diffuser case. Side, vertical, axial, torque, and engine thrust loads are taken at one or the other of these mounts, but not at both. Ball and socket-type mounts are used for the main mounts and provision is made for thermal expansion between the two mounts.

2-122. ENGINE SPECIFICATIONS. (See Tables 2-2 and 2-2A.)

2-123. TROUBLESHOOTING.

2-124. Finding and correcting engine troubles can be accomplished by first studying the symptoms carefully and then checking each possible cause, beginning with the most probable, until the exact cause of the trouble is determined.

2-125. Thorough knowledge of the engine will result in a minimum of running defects, but some may occur as a result of inadvertently exceeding operational limitations under adverse conditions.

2-126. Before attempting to ascertain the difficulty, or to work on an engine which has been reported malfunctioning during flight, consult the flight report and all other available sources for any pertinent information which might give a clue in diagnosing the trouble.

2-127. Table 2-3 outlines the common symptoms, causes, and remedies of engine malfunctioning.

2-127A. ENGINE WINDMILLING.

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.

c. If an engine windmills for more than 15 minutes with the oil supply shut off or interrupted (provided engine was operating at windmill speeds when oil was shut off), record conditions of operation and send the engine to overhaul for bearing inspection. Particular attention must be given to the No. 2 bearing.

d. If oil supply was shut off or interrupted for more than ten seconds at speeds in excess of windmilling or before engine decelerated to windmilling speed following engine shutdown, record conditions of operation and send engine to overhaul for bearing inspection. Particular attention must be given to the No. 2 bearing.

CAUTION

Any power ON operation at or above IDLE with zero oil pressure for more than ten seconds shall require that engine be sent to overhual 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 replaced.

2-127B. ENGINE OPERATION AT ZERO OIL PRESSURE.

a. Engines operated at zero oil pressure for a maximum of ten seconds may be continued in service without subsequent disassembly and bearing inspection.

b. Engines operated at zero oil pressure for more than ten seconds must be disassembled and bearings given complete inspection.

TABLE 2-2. SPECIFICATIONS (TURBOJET ENGINES)

Models	JT12A-6 -6A (L) -6A (N), -8 (L), and -8 (N)	
Type	Axial-flow, gas turbine	
Compressor		
Type	Axial, single spool	
Stages	Nine	
Direction of Rotation	Clockwise	
Turbine		
Type	Reaction	
Stages	Two	
Direction of Rotation	Clockwise	
Combustion Chambers		
Type	Can-Annular, Straight Flow	
Number	Eight	
Location	Numbers one to eight clockwise, with number one at top and to right of vertical centerline.	
Engine Dimensions (in inches at room temperature). (See Figures 2-41 and 2-41A.)	JT12A-6, -6A (L) -8 (L)	JT12A-6A (N) and -8 (N)
Length (largest axial length of engine including any local axial projections and placement of any movable or adjustable parts in the position resulting in maximum axial length)	78"	70 1/2"
Diameter (Diameter of largest circle concentric with the engine axis including local radial projections around full circumference of engine)	22"	22"
Fuel System		
Specification	PWA-522	
Lubrication System		
Specification	PWA-521B Lubricating Oil	

Equipment

Standard - Fuel pump, fuel control, air inlet anti-icing system, ignition system, exhaust temperature thermocouples, pressure probes, and associated plumbing.

Additional - Oil tank, fuel oil cooler, fuel anti-icing heater, fuel control cross-shaft, inlet nose cone and associated plumbing.

Engine Dry Weight*

JT12A-6, -6A 448 lbs. (Approximate)

JT12A-8 468 lbs. (Approximate)

*Not including oil tank and associated hardware and plumbing, fuel oil cooler and its plumbing, fuel flowmeter fireseal brackets, ground handling brackets, instrumentation provisions and bosses, fuel anti-icing heater, fuel control cross-shaft, aircraft equipment brackets, shipping covers and enclosures.

TABLE 2-2A. SPECIFICATIONS (FREE TURBINE ENGINES)

Models	JFTD12A-1, -4A, -5A
Type	Axial-flow, gas turbine
Compressor	
Type	Axial, single spool
Stages	Nine
Direction of Rotation	Clockwise
Turbine	
Type	Reaction
Stages	Two
Direction of Rotation	Clockwise
Free Turbine	
Type	Reaction
Stages	Two
Direction of Rotation	Counterclockwise
Combustion Chambers	
Type	Can-annular, Straight Flow
Number	Eight
Location	Numbers one to eight clockwise, with No. 1 at top and to right of vertical centerline.

Engine Dimensions (in inches at room temperature). (See Figure 2-41B.)	
Length (largest axial length of engine including any local axial projections and placement of any movable or adjustable parts in the position resulting in maximum axial length) JFTD12A-1, -4A	108"
JFTD12A-5A	107"
Diameter (diameter of largest circle concentric with the engine axis including local radial projections around full circumference of engine)	30"
Fuel System	
Specifications	PWA-522
Lubrication System	
Specification	PWA-521B, Type II Lubricating Oil

Engine Dry Weight*

JFTD12A-1	882 lbs.	(Approximate)
JFTD12A-4A	920 lbs.	(Approximate)
JFTD12A-5A	935 lbs.	(Approximate)

*Not including oil tank and associated hardware and plumbing, fuel-oil cooler and associated plumbing, flowmeter fireseal brackets, ground handling brackets, inlet nose cone, combustion chamber case rear mount bracket, instrumentation provisions and bosses, fuel heater, aircraft equipment brackets, shipping covers, and enclosures.

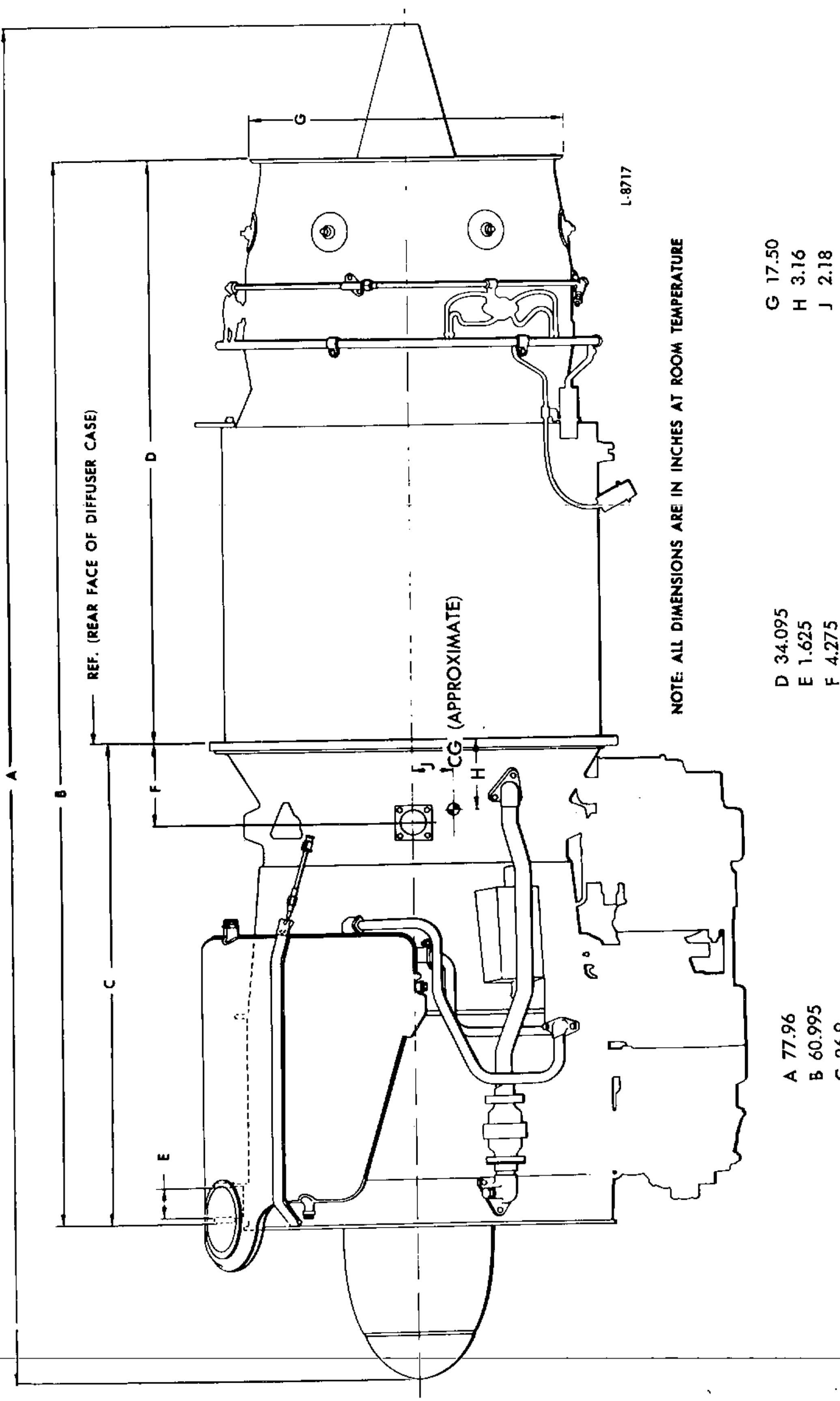


Figure 2-41. Engine Dimensions (JT12A-6, JT12A-6A[L] and JT12A-8[L])

2-127B-1. ENGINE OPERATION WITH FUEL CONTAMINATED OIL SYSTEM.

a. Establish percentage of oil system contamination by laboratory analysis of oil samples and correct cause of contamination. (See Figures 2-41-1 and 2-41-2.)

NOTE

If laboratory facilities are not available and actual degree of contamination cannot be determined accurately, it will be necessary to reject engine and inspect main bearings as outlined in step d. Use JP-5 curve as guide for JP-1 fuel. Due to wide range of specific gravities encountered in PWA-521B (Military Specification MIL-L-23699) Type II lubricating oils, minimum and maximum curves have been presented to illustrate spread. If specific gravity of oil being used is not known, specific gravity at selected temperature 16°, 27°, 38°C (60°, 80°, 100°F), of uncontaminated sample should be taken, then a curve for this oil can be added to figure 2-41-1 by drawing a straight line from new specific gravity reading to temperature point for fuel being used. WSX 6000 and Shell 505, represent minimum and maximum specified gravity for that class of oil.

b. Following limits may be used as guide to inspection of engines operated with oil systems contaminated by fuel:

Percent of Dilution	Engine Operating Time
Up to 25 percent	Up to five hours
25 to 40 percent	Up to one hour

c. If oil system contamination falls within above limits, inspect main oil strainer, drain and service engine oil system. Inspect main oil strainer after first subsequent engine run.

d. If oil system contamination and/or engine operation time exceeds above limits, reject engine and disassemble sufficiently to inspect all main bearings.

NOTE

Engine with fuel contaminated oil shall not be operated until corrective action has been taken.

2-127C. ENGINE FERRYING. (See Tool Group 2A-1.) Failed engine may be ferried in airframe by securing PWA-13722 compressor rotor lock in starter-generator drive pad or in hydraulic pump drive pad.

2-128. REMOVAL AND REPLACEMENT OF ENGINE COMPONENTS.

2-129. GENERAL.

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 misassembly can possibly result in a failure, check each part number to be sure correct part is used.

2-130. TOOLS.

a. Use plastic or rawhide hammer heads (never metal) when driving on engine parts. Never lift heavy parts by hand. Use a chain hoist and special lifting tools.

b. Jackscrews and attaching screws, bolts, and nuts must be tightened in small increments starting with any one and continuing with one diametrically opposite.

2-131. TUBES.

a. During removal of various tube assemblies, remove loose ferrule and nuts from each tube prior to cleaning and inspection.

b. Use suitable plugs and coverings over all openings and take every precaution to prevent dirt, dust, cotterpins, bolts, nuts, lockwire, and other foreign matter from entering engine.

c. Do not bend tubing during removal of parts.

d. Dust caps used to protect open tubes against contamination must always be installed over tube end and not in tube ends. Flow through tubes could be blocked off if tubes are inadvertently installed with dust caps in tube ends.

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

NOTE

To avoid damage to tube it is necessary to use two wrenches to remove or install loose nut. Additional wrench must be used to hold nipple while nut is being loosened or tightened.

f. Tag or note location of all clips and brackets to ensure installation in same position at assembly.

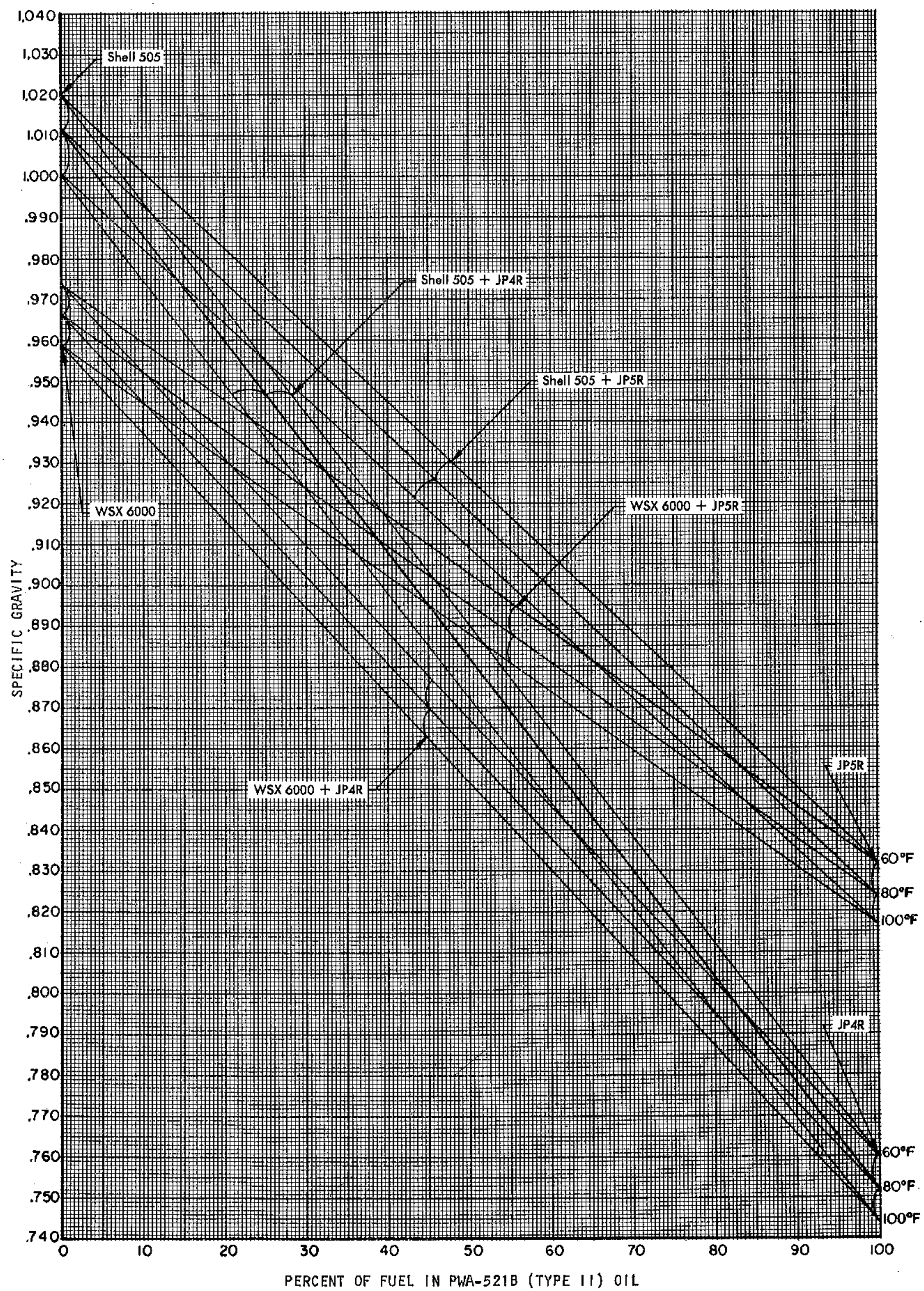


Figure 2-41-1. Fuel Contamination Curve

2—127C. ENGINE FERRYING. (See ***Tool Group 2A-1***.) Failed engine may be ferried in airframe by securing PWA-44530 compressor rotor lock in starter-generator drive pad or in hydraulic pump drive pad.

2—128. REMOVAL AND REPLACEMENT OF ENGINE COMPONENTS.

2—129. GENERAL.

2—130. TOOLS.

a. Use plastic or rawhide hammer heads (never metal) when driving on engine parts. Never lift heavy parts by hand. Use a chain hoist and special lifting tools.

b. Jackscrews and attaching screws, bolts, and nuts must be tightened in small increments starting with any one and continuing with the one diametrically opposite.

2—131. TUBES.

a. During removal of the various tube assemblies, remove the loose ferrule and the nuts from each tube prior to cleaning and inspection.

b. Use suitable plugs and coverings over all openings and take every precaution to prevent dirt, dust, cotter-pins, bolts, nuts, lockwire, and other foreign matter from entering the engine.

c. Do not bend tubing during removal of parts.

d. Dust caps used to protect open tubes against contamination must always be installed over the tube end and not in the tube ends. Flow through the tubes could be blocked off if the tubes are inadvertently installed with dust caps in the tube ends.

e. 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.

Note

To avoid damage to the tube it is necessary to use two wrenches to remove or install the loose nut. The additional wrench must be used to hold the nipple while the nut is being loosened or tightened.

f. Tag or note the location of all clips and brackets to ensure installation in the same position at assembly.

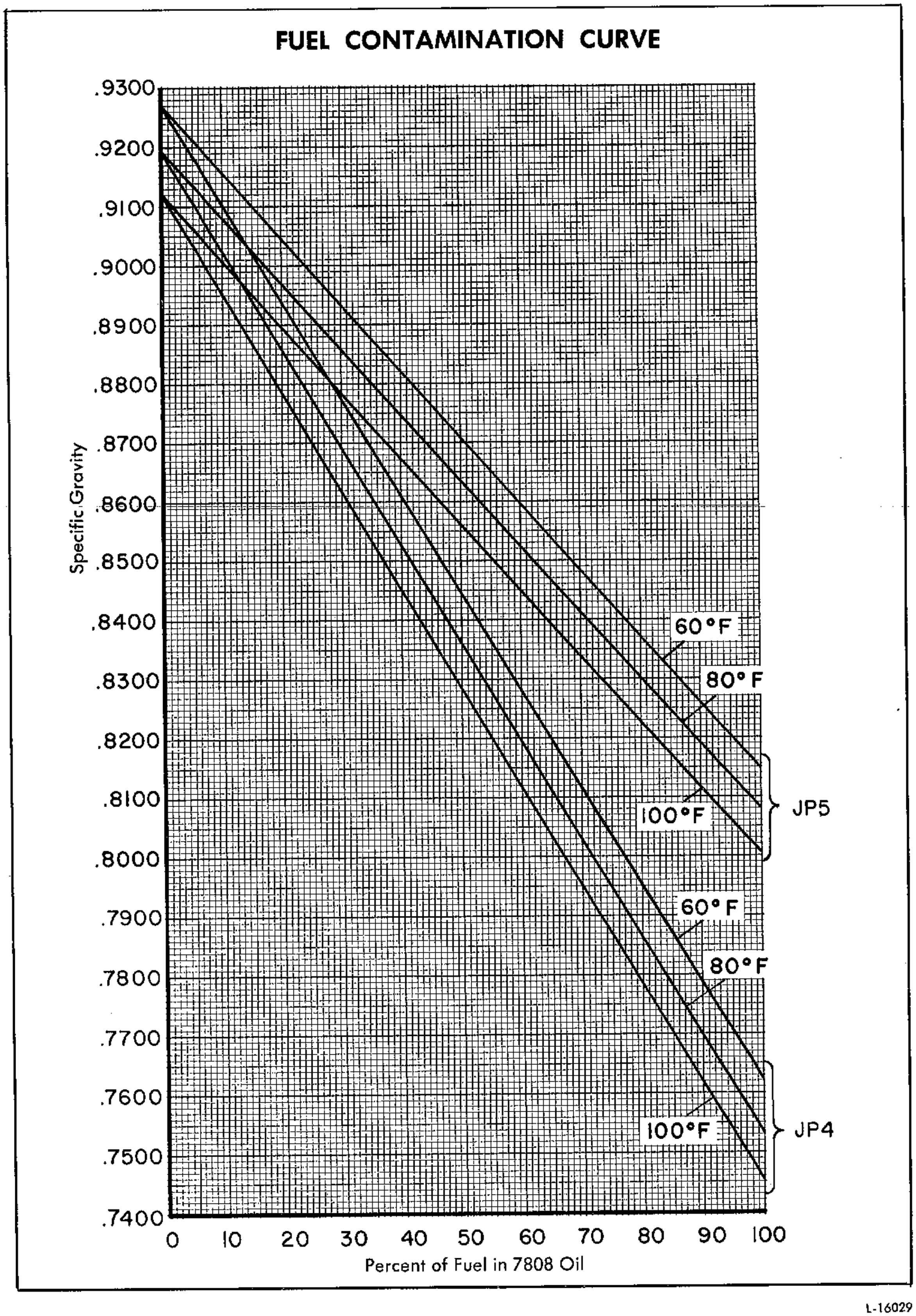
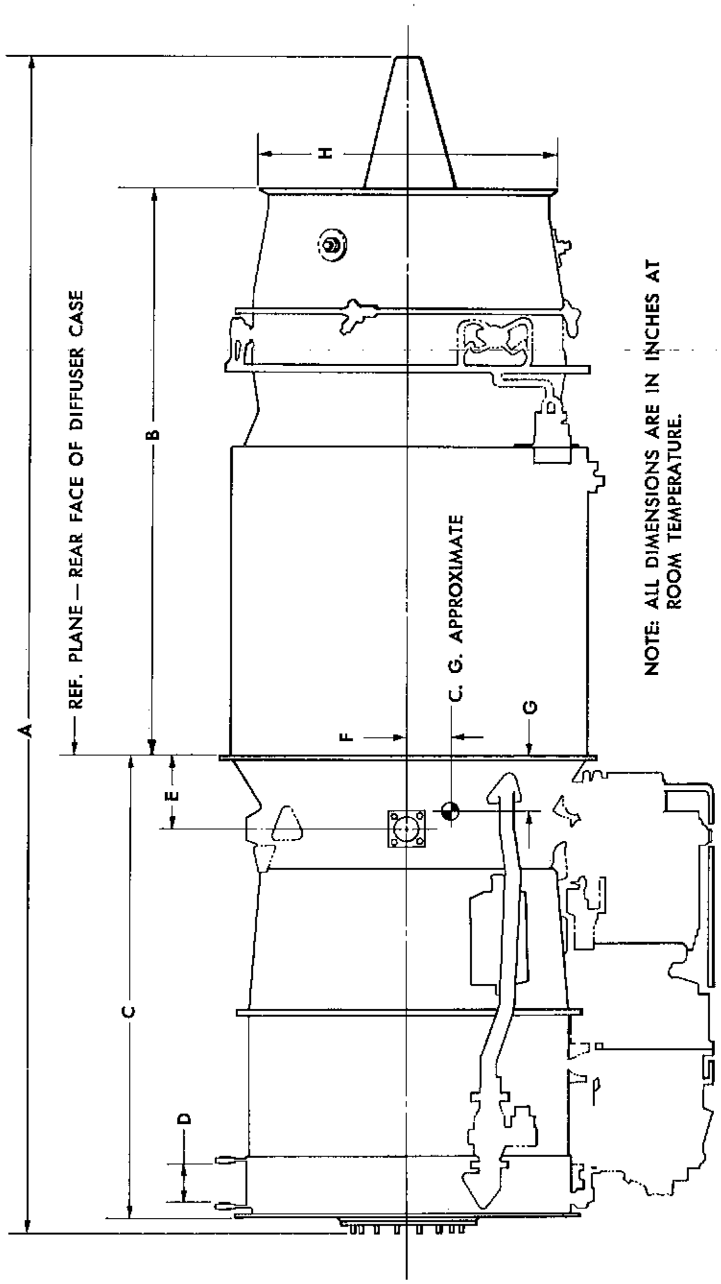


Figure 2-41-2. Fuel Contamination Curve PWA-521B (Type I Oil)



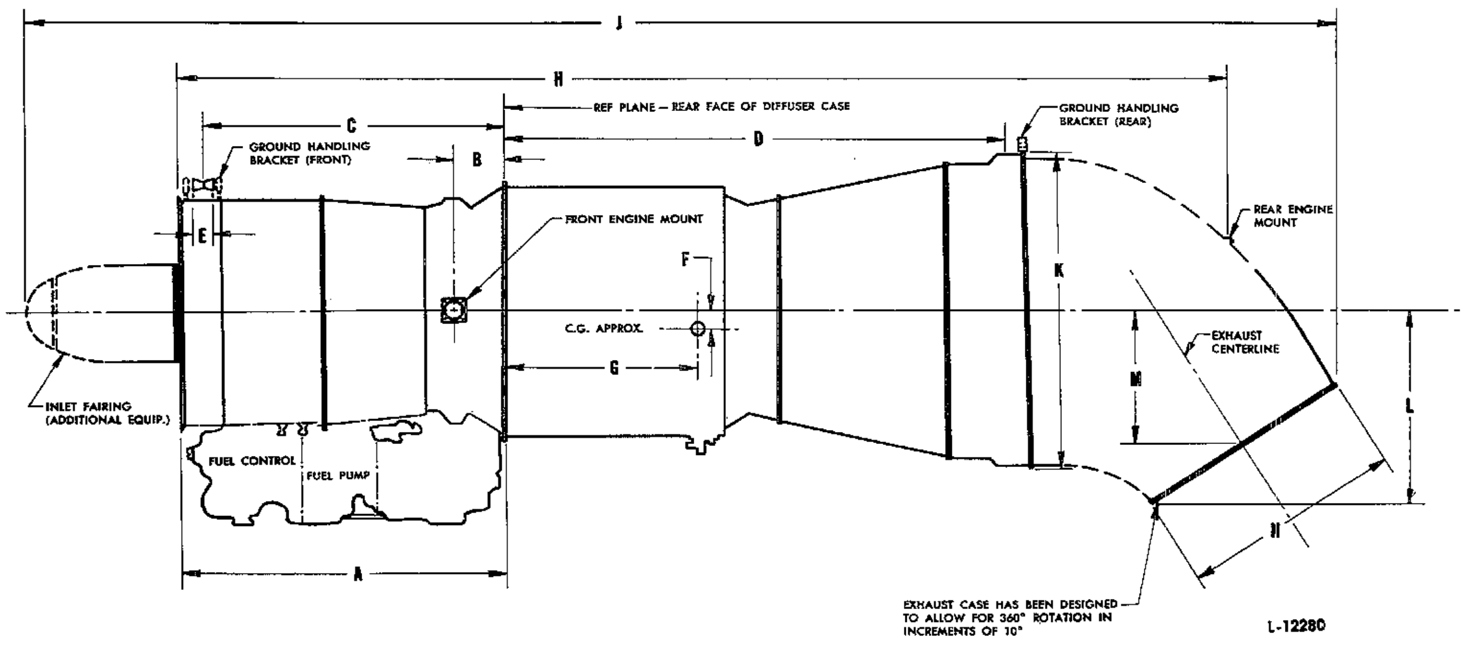
NOTE: ALL DIMENSIONS ARE IN INCHES AT ROOM TEMPERATURE.

SYMBOL	DIMENSION
A	70.45
B	34.095
C	27.567
D	1.625

SYMBOL	DIMENSION
E	4.275
F	2.22
G	3.46
H	17.50

L-8714

Figure 2-41A. Engine Dimensions (JT12A-6A[N] and JT12A-8[N])



Symbol	Dimension	Symbol	Dimension	Symbol	Dimension
A	27.6	F	1.2* (-1) 1.3* (-4A and -5A)	K	29.9 (-1) 29.1 (-4A and -5A)
B	4.3	G	16.7* (-1) 16.3* (-4A) 16.1 (-5A)	L	20.3**
C	25.9			M	13.2
D	41.2 (JFTD12A-1) 43.2 (JFTD12A-4A) 45.6 (JFTD12A-5A)	H	90.0	N	21.0
E	1.6	J	107.0		

NOTE

All dimensions are in inches at room temperature.

*Depends on amount of additional equipment used.
**Radial dimension.

Figure 2-41B. Engine Dimensions (JFTD12A-1, -4A, and -5A) Free Turbine Engines

TABLE 2–3. TROUBLESHOOTING CHART

Trouble	Probable Cause	Investigation	Remedy
ENGINE			
No rpm during attempted start.	No electrical power to starter system.	Check source of electrical power.	
	Engine is "frozen".	Attempt to rotate by hand.	Replace engine.
	Starter drive shaft in component drive gearbox sheared.	If sounds of starter rotation are heard during attempted start, but engine does not rotate, shaft is sheared.	Replace engine.
Insufficient rpm during attempted start.	Excessive turbine and compressor blade rubbing.	Listen for loud scraping noise while engine is rotating.	Replace engine.
Engine fails to light-off when power lever is advanced to idle.	No fuel to engine.	Check fuel supply and position of fuel system switches.	
	Defective ignition system.	Turn on system and listen for sparkigniter operation.	Refer to IGNITION SYSTEM TROUBLE-SHOOTING.
	Defective engine fuel system.	Check fuel flow indicator for minimum starting fuel flow.	Refer to ENGINE FUEL SYSTEM TROUBLE-SHOOTING.
	Defective starter system.	Check tachometer for maximum speed at which starter will rotate engine.	Replace starter.
Engine lights-off but fails to accelerate to idle.	Inadequate voltage for starter.	If engine starts, but fails to accelerate due to lack of help from the starter, auxiliary power unit is inadequate.	Use larger capacity auxiliary power unit.
	Engine is "frozen".	Attempt to rotate compressor by hand.	Replace engine.
	Defective engine fuel system.	Check fuel flow indicator during attempted start.	Refer to TROUBLE-SHOOTING ENGINE FUEL SYSTEM.
Fluctuation of rpm and turbine exhaust temperature.	Defective engine fuel system.		Refer to TROUBLE-SHOOTING ENGINE FUEL SYSTEM.
	Defective instruments and/or instrument circuits.	Use instruments with units of known accuracy and check engine operation.	Replace faulty instruments.

TABLE 2-3. TROUBLESHOOTING CHART (continued)

Trouble	Probable Cause	Investigation	Remedy
Engine roughness.	Internal interference between rotors and stators.	Check for scraping noise as engine slows down or at shut-down. Check oil strainer for metal particles.	Replace engine.
	Defective accessories.	Check for unusual noises emitting from accessories or malfunctioning system.	Replace defective accessories.
Engine surges during acceleration.	Defective compressor bleed system.	Perform operational check of compressor bleed system.	Refer to ENGINE COMPRESSOR BLEED SYSTEM TROUBLESHOOTING.
	Defective fuel control unit.	If bleed system is satisfactory, fuel control unit is faulty.	Replace fuel control.
EPR increase with anti-icing on.	Leaking Pt2 probe.	Check Pt2 Probe. Perform leak test.	Replace any probe that leaks.
FUEL SYSTEM			
Engine fails to light-off when power lever is advanced to idle.	Midadjusted power lever linkage.		Readjust power lever linkage.
	Faulty cut-off valve in fuel control.	If there is fuel from the aircraft fuel system and the power lever linkage is rigged correctly, cut-off valve in fuel control unit is not opening.	Replace fuel control.
	Defective engine-driven fuel pump.	If fuel flowmeter indicates some fuel flow, but not enough for normal start, pump may be defective.	Replace engine fuel pump.
Engine lights-off, but fails to accelerate to idle.	Faulty accelerating system in fuel control unit.		Replace fuel control.
	Clogged fuel control inlet filter screen.	Check fuel flowmeter. Minimum fuel flow during start should be indicated.	Clean filter.
Engine fails to accelerate above IDLE, is slow to accelerate, or hesitates during acceleration.	Air trapped in fuel system.		Disconnect fuel pressurizing and dump valve signal pressure line at control end and pressurize system by energizing boost pump. Crank engine until uninterrupted fuel flow is observed. Fuel system should be bled each time system has been exposed to air.

TABLE 2-3. TROUBLESHOOTING CHART (continued)

Trouble	Probable Cause	Investigation	Remedy
	Inadequate fuel supply.	Check aircraft fuel supply to assure adequate quantity of fuel is available.	
	Defective fuel boost pump.	Check fuel control and fuel pressurizing and dump valve screens for evidence of "gold dust" indicating pump failure. NOTE Torque fuel pressurizing and dump valve inlet strainer plug 125 to 175 pound-inches.	Replace fuel pump.
Hot start.	Minimum flow adjustment too high.	Check fuel flowmeter to determine if a normal start fuel flow is indicated.	Replace fuel control.
Improper fuel flow at altitude.	Defective fuel control.		Replace fuel control.
Low minimum fuel flow and/or low speed instability.	Idle speed too low.	Check idle rpm.	Adjust fuel control.
	Minimum fuel flow adjustment too low.	If idle speed is minimum, fuel flow is too low.	Replace fuel control.

TABLE 2–3. TROUBLESHOOTING CHART (continued)

Trouble	Probable Cause	Investigation	Remedy
Low maximum fuel flow and instability.	Clogged filter screen in fuel control unit.	Clean filter and check engine operation. If condition persists, fuel control is defective.	Replace fuel control.
Ground idle speed incorrect.	Fuel control adjustment not correct.	Check tachometer idle rpm.	Adjust engine idle speed.
Engine surges during acceleration, or fails to accelerate properly.	Defective fuel control.	Perform operational check of compressor bleed system. If satisfactory, fuel control is faulty.	Replace fuel control.
	Clogged filters in engine-driven fuel pump or fuel control.		Clean filters.
Engine fails to decelerate when power lever is retarded.	Misadjusted minimum fuel flow setting.		Replace fuel control.
Engine flames out during deceleration.	Defective fuel control.		Replace fuel control.
Engines continue to run a short time with power lever in closed position.	Defective cut-off valve in fuel control.		Replace fuel control.
Engine overtemperature. (See ENGINE TEST for limits.)	Improperly trimmed fuel control.	Check engine trim.	Trim engine. See ENGINE TEST.
	Defective exhaust gas temperature indicating system.	Check thermocouples and harness.	Repair and/or replace faulty units.
	Defective fuel control.		Replace fuel control.
	Internal engine damage.	Perform visual inspection.	Send engine to overhaul for physical inspection.
Engine overspeed. (See ENGINE TEST for limits.)	Improperly trimmed fuel control.	Check engine trim.	Trim engine. See ENGINE TEST.
	Defective fuel control.		Replace fuel control.
	Internal engine damage.	Perform visual inspection.	Send engine to overhaul for physical inspection.

TABLE 2-3. TROUBLESHOOTING CHART (continued)

Trouble	Probable Cause	Investigation	Remedy
OIL SYSTEM			
Low or fluctuating oil pressure	Insufficient oil supply	Check oil level	Service oil system
	Clogged or dirty strainer	Pull oil strainer	Clean strainer
	Relief valve adjusting screw backed off		Adjust relief valve
	Defective oil pressure transmitter and/or indicator	Replace cockpit instrument with indicator of known accuracy and recheck pressure	Replace instrument
	Pressure pump failure	Check oil pressure transmitter and indicator for proper operation. If pressure indicating system is satisfactory and pressure remains low after cleaning the oil strainer, the pressure pump has failed	Replace engine pump
Excessive oil pressure	Defective oil pressure transmitter and/or indicator	Replace cockpit instrument with indicator of known accuracy and recheck pressure	Replace instrument
	Misadjusted relief valve	If pressure indicating system is satisfactory and engine operational check does not disclose any apparent malfunctioning, the relief valve can be adjusted	Adjust relief valve
Excessive oil consumption	Cracked carbon seals at bearing locations	Check inlet and exhaust areas for collections of oil	Reject engine
	Defective oil pressure and scavenge lines or connections	Visually inspect all oil lines and connections for evidence of leaks	Replace as necessary
	Defective oil pumps	Oil mist spraying from compressor bleed valve. Oil level check shows low oil supply	Reject engine

NOTE

The engine should be rejected in cases where amount of discharge from overboard breather shows definite increase with time, or where oil consumption shows rapid increase. Isolate engine section responsible for breather discharge as aid in determining corrective action required.

TABLE 2-3. TROUBLESHOOTING CHART (continued)

Trouble	Probable Cause	Investigation	Remedy
IGNITION SYSTEM			
WARNING Because voltage to igniter plugs is dangerously high, ignition switch must be in OFF position before removal or checking of any of ignition system components. A sufficient period of time must elapse between operation of ignition system and removal or checking of components to ensure complete dissipation of energy from ignition system.			
No spark at igniter plug	Dirty or defective igniter plugs	Remove inoperative igniter plug	Clean or replace igniter plugs as necessary
	Open ignition circuit	Check circuit continuity	Replace broken leads or connections
	Defective exciter unit		Replace faulty unit
	No external power		Check external power source
COMPRESSOR BLEED SYSTEM			
Engine fails to develop thrust at high power and/or stalls during acceleration or deceleration	Bleed valve does not close	Defective bleed strap	Strap kinked or broken Check linkage from fuel control to bleed valve See paragraph 2-262A
ANTI-ICING SYSTEM			
Shutoff valve fails to operate when system is turned on	No electrical power	Check continuity of electrical circuit	Replace broken leads and connectors
	Solenoid inoperative	Check for power to the solenoid and then check operation	Replace the actuator shutoff valve
	Valve sticking		Replace the actuator shutoff valve

2-132. GASKETS AND PACKINGS. Replace all removed gaskets, packings, and rubber parts with new ones. Make sure that new non metallic parts to be installed (such as an oil seal) show no sign of having deteriorated in storage. Moisten preformed packings or O-ring seals with petrolatum, or jet engine oil, prior to installation of part or parts.

2-132A. GASKET LUBRICANT (Gredag)

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

NOTE

Gasket lubricant is known as Gredag Lubricant No. 55 Graphited, and may be procured from Acheson Industries, Inc., Acheson Colloids Division, 1635 Washington Street, Port Huron, Michigan 48061.

2-133. FASTENERS.

a. 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 head fits into castellation of nut, and unless otherwise specified, bend one end of cotterpin back over stud or bolt, and other end down flat against nut. Only lockwire and cotterpins made of corrosion resistant steel shall be used.

b. Bushing plugs must be lockwired to boss or case. Do not lockwire plug to bushing.

2-134. IDENTIFICATION OF METAL PARTICLES.

2-135. GENERAL.

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

b. The following equipment and chemicals are required to make these tests: (1) source of open flame, (2) permanent magnet, (3) two ounces of aqueous solution of ten percent ammonium nitrate, (4) an electric soldering iron, (5) two ounces each of 50 percent by volume hydrochloric acid and concentrated nitric acid (6 sodium hydroxide pellets).

WARNING

Use extreme care in handling the acids.

2-136. TEST PROCEDURE.

NOTE

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

a. 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.

b. Steel -- The particles can be isolated by using the permanent magnet. Steel or iron is attracted by the magnet.

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

e. Aluminum -- When particles of aluminum are dropped in a solution of sodium hydroxide (one sodium hydroxide pellet to three cc's. of water) they will react by giving off gas bubbles and gas will be visible. Aluminum silicone paint will cause a milder reaction of the same type. Silver particles will not react when placed in the solution.

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

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

2-137. INSTALLATION OF "O" RING AND JAM NUT TYPE CONNECTOR (UNIVERSAL FITTING). (See Figure 2-42.)

2-138. ASSEMBLY OF FLEXIBLE TYPE FITTINGS. (See Figure 2-43 and Table 2-3-1).

2-139. 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 be avoided.

2-140. USE OF ANTI-GALLING AND ANTI-SEIZE COMPOUNDS.

CAUTION

Extreme care must be exercised to see that anti-galling and anti-seize 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.

a. General

(1) Extreme pressure lubricants may be applied to certain areas such as splined drives, various case snaps, bearing journals, etc., at assembly to prevent galling of highly stressed surfaces.

(2) Antiseizure compounds may be applied at assembly to facilitate disassembly of certain hot section and turbine threaded fittings.

(3) Penetrating oil may be used at disassembly to further facilitate disassembly of engines.

b. Materials

(1) Wet Fel-Pro C-200 or C-300 antigalling compounds are approved for threaded parts and mating faces of threaded and other parts in hot section and turbine areas. Optimum results are obtained with Fel-Pro C-200 baked on (SPOP 146), but the use of wet Fel-Pro C-200 or C-300 brushed on without prior surface preparation or baking is permissible. In this latter use, less long-term durability is obtained.

(2) dgf-123 (PMC 9934) colloidal graphite dry film lubricant in a volatile carrier has been found satisfactory for use on ball sockets and in the assembly of snugly fitting parts such as bearing races, spacers and seals on hubs and shafts.

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

CAUTION

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).

(4) Molybdenum disulfide, in either its powder form (PMC 9523) or suspended in some vehicle such as alcohol or engine oil, has been found satisfactory for use in assembling combustion chamber cases, turbine nozzle cases, exhaust cases, turbine shaft splines and threads.

(a) PWA 541 Antiseizing Compound Lubricant.

1 Thoroughly mix molybdenum disulfide powder and grade 1010 oil in the following proportions.

PMC 9523 Powder	80% ±3% by weight
PMC 9852 Oil	20% ±3% by weight

2 Continue mixing until lubricant is smooth, and free from lumps, cakes, skins, and grit.

3 Store lubricant in closed containers to ensure freedom from undue contamination.

(5) Parker Thread Lube (PMC 9936) antigalling and antiseize compound is approved for spark igniter plug threads, studs, and steel threaded case assembly plugs.

(6) Marvel Mystery Oil (PMC 9534) gage lubricant is approved for use at engine teardown to facilitate disassembly of engines.

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

c. Restrictions

(1) Unless otherwise specified, antiseize or antigalling compounds must not be used at following locations:

(a) All face splines.

(b) All main rotor disk, hub, and spacer snaps.

(c) Conical seats.

(d) Fuel fittings.

2-141. INSTALLATION AND HANDLING OF BALL AND ROLLER BEARINGS

a. Procedure

(1) Wear a clean pair of gloves, made of an approved lint free material, when handling bearings.

(2) When assembling inner races of bearings on their mating shafts, it will be necessary to expand inner race by using controlled heating. The inner race of demountable bearings and complete bearing assembly of nondemountable bearings may be raised to required temperature by immersion in a controlled hot oil bath. Shafts and bearing races must be checked for size and trueness before heating in order to avoid abnormal fits. Hot oil tanks used for expansion heating must be kept closed when not in use to minimize contamination of the oil by airborne dirt and abrasives.

(3) Never allow bearings to rest on bottom of a hot oil tank since they may become contaminated from settlings and their temperature will be much higher than indicated oil temperature. A heavy screen or series of rods extending three or more inches above tank bottom will keep bearings surrounded by oil at a uniform temperature and will allow any dirt to settle at bottom of tank. Use engine oil thermostatically controlled at temperatures not exceeding 250°F(121°C). Change oil and clean tank periodically as necessitated by amount of use.

2-141A. INSTALLATION OF CUP TYPE KEY WASHERS

a. Procedure
(See Figure 2-43A.)

(1) General. After nut has been correctly seated and tightened to required torque, cup type key washer shall be indented as specified. Where number of rounded slots in nut or bolt is less than required indentations listed, crimping must be accomplished at each available location. Portion of tool that forms indentations shall be spherically shaped and have spherical radius of not less than 0.050 inch.

(2) Position Control. To preclude shearing of tabs, position of cup washer shall be indicated by marking cup washer and adjacent surface so that any rotation of cup washer can be detected when torquing nut.

(3) Acceptance Standards

(a) New cup type key washer was used.

CAUTION

Cup type key washers that are loose enough to shake or rattle are not acceptable.

(b) Identations were formed as shown. A properly secured cup washer will normally be tight, but in instances where there is no axial pinch on the diaphragm portion of washer, washer may be moved by hand through limits of tab clearance.

(c) Indentations in any one washer shall be approximately same shape and size, shall not be broken, cracked or torn.

(d) Indentations in cup washer shall have been formed into rounded slots in nut when nut is provided with such slots.

(e) Cup washer has not moved during assembly.

2-141B. INSTALLATION OF TAB AND ELLIPITICAL TYPE KEY WASHERS

a. Installation Of Tab Type Key Washers (See Figure 2-43B.)

(1) Key washers must be used only one time.

(2) Key washer shall be positioned such that unbent keys are as far as possible from axis of part to be locked. Prebent key, Key B, shall be tight to overhanging surface or braced against side of hole as shown to prevent possible movement of part being locked.

(3) All unbent keys on key washer are to be bent as safeguard against reuse.

(4) To preclude shearing of internal tabs, position of key washer shall be indicated by marking key washer and adjacent nonrotating surface so that any rotation of key washer can be detected when tightening nut.

b. Installation Of Elliptical Key Washers (See Figure 2-43C.)

(1) Install elliptical type key washers as shown in referenced figure.

2-141C. COTTERPINNING

a. General. Cotter pins are not reusable. New cotter pins must be used for each application.

b. Locking Nuts With Cotter Pins (See Figure 2-43D.)

(1) Before installing cotter pin tighten nut to low side of required torque range, unless otherwise specified, then continue tightening until slot aligns with hole in bolt. If slot in nut does not line up with hole before maximum allowable torque is reached, back off nut, then retighten. If slot still does not line up, select new nut and repeat assembly procedure.

(2) While preferred installation would locate centerline of hole in bolt midway into nut slot, any installation wherein more than 50 percent of cotter pin diameter is located below nut castellation is acceptable. In event 50 percent or more of cotter pin diameter is located above nut castellation, new nut must be selected and installed.

(3) Install each cotter pin with head seated firmly in slot of nut with axis of eye at right angles to bolt. Bend prongs so that head and upper prong are firmly seated against bolt, and lower prong is firmly seated against corresponding nut flat. Upper prong may be cut off even with top of bolt to provide necessary clearance. Lower prong may also be cut off to provide necessary clearance and/or a snug fit against corresponding nut flat.

c. Retaining Pins And Rod Ends With Cotter Pins (See Figure 2-43E.)

(1) Install cotter pin with axis of eye parallel to shank of clevis pin or rod end. Bend prongs around shank of pin or rod end. Prongs may be cut to obtain normal end position.

2-141D. INSTALLATION OF RETAINING RINGS

a. General

(1) Retaining rings must be installed using approved retaining ring pliers. Internal type rings must not be compressed beyond the point where ends of rings meet. External type rings must be expanded only enough to allow installation without becoming bent. After installation, ensure that each retaining ring is completely seated, without looseness or distortion, in its groove. Distorted or loose retaining rings must be replaced.

b. Plain Retaining Rings

(1) Plain retaining rings may contain slightly rounded edges on one side and sharp edges on the opposite side. Slight rounding, caused by stamping die, is not a bevel and ring must not be classified as a beveled ring.

(2) Plain retaining rings must be installed only in square sided grooves. When one side of a plain ring has visibly sharper corners, this side must be installed away from detail part(s) being retained, so that sharp-edged side thrusts against the groove.

2-142. ANTI-SEIZE COMPOUNDS. In order to facilitate subsequent disassembly, apply antiseize compound to all threaded parts attached to the hot section, except silver plated parts, fuel fittings, and location where other compounds or materials are specifically recommended.

2-143. TABLE OF LIMITS.

2-144. Refer to the Table of Limits in all assembly operations involving fits, clearances, and backlashes.

2-145. TORQUE VALUES.

2-146. Refer to the Table of Limits for Torque Values.

Tube Dia.	Thread Size	Part Number for 75 Durometer A Packings: AMS 7260, 7267, or 7273	Torque lb-in	Part Number for 77 Durometer C (100 Durometer A) Packings: PWA 401	Torque lb-in
0.250	0.625-18	227407	25-30	399615	55-60
0.3125	0.6875-16	227413	30-35	451083	65-70
0.375	0.750-16	226366, 626155	30-35	410629	65-70
0.4375	0.8125-16	227419	45-50		
0.500	0.875-14	227401, 598643, 669480	55-60	391009	100-120
0.5625	1.000-12	227425	60-65		
0.625	1.0625-12	226195	65-70	443330	130-140
0.750	1.1875-12	227427	70-80	389114	140-160
0.875	1.375-12	227431	75-85	452427	150-170
1.000	1.500-12	227433	100-110	389847	200-220
1.125	1.625-12	227451	100-110	409309	200-220
1.250	1.750-12	227439, 598678	100-110	414121	200-220
1.500	2.125-12	227445	100-110	409179	200-220

PWA Flexible Fittings
Table 2-3-1

2-146A. OIL TUBES.

2-146B. CLEANING.

a. Soak tubes in tank of PMC 9047 for two hours at room temperature.

NOTE

PMC 9047 "Super Carb" solution is made by Turco Products, Inc., 55 percent methane chloride, 15 percent Cresyllic Acid, ten percent potassium base soap, and 20 percent inhibitor. An equivalent solution may be used.

b. Pull suitable size swab (rag) through tube ID.

c. Rinse tubes with kerosene at room temperature.

d. Air dry.

2-146C. ENGINE GASPATH CLEANING.

a. Remove burner pressure (P_b), exhaust pressure (P_{t5}), and compressor inlet pressure (P_{t2}) probes; blank off bosses and cap tube ends.

NOTE

If aircraft installation prevents probe removal, sense lines to fuel control may be disconnected at either probe or control end. Control side of these lines must be capped off to prevent foreign material from entering control. Probes or sense lines must be blown out toward engine gaspath from disconnected end prior to reconnection to fuel control.

b. Ensure anti-icing valve, fuel heater valve, and all airframe air valves, if any, are closed.

c. Equipment Required.

(1) Tank of ten gallon capacity minimum.

(2) Pump suitable for pumping cleaning solution.

(3) Nozzle to vaporize cleaning solution, sized and fabricated so that it can be located to provide uniform distribution of cleaning solution across engine inlet.

NOTE

For nozzle, use water applicator (P/N 21C2373 G001, General Electric or equivalent).

(4) Hoses, valves, and connections as required to transfer cleaning solution from tank to nozzle.

(5) Compressed air source maintained at 50 to 100 psi.

d. Prepare cleaning solution by volume of nine gallons of water to one gallon of Harco 141 cleaner to yield ten gallon mixture of water to Harco 141 at 9:1 ratio.

NOTE

If inlet temperature is below freezing, five gallons of ethyl alcohol and four gallons of water shall be used in place of nine gallons of water for solution with one gallon of Harco 141 cleaner. Band B 20- 20+ may be used in place of Harco 141.

e. Following cleaning procedure is applicable to engine installed in test stands and shall be modified by blocking off airframe connections as necessary to adapt it for use on installed engines:

(1) Assemble equipment and adjust nozzle to provide even distribution of cleaning solution across engine inlet. To ensure adequate cleaning of stators, adjust spray pattern to one-half size of engine inlet and slowly rotate nozzle through circumference of engine inlet.

(2) Pour ten gallons of cleaning solution into tank.

(3) Using starter, motor engine (ignition off) to approximately ten percent N_1 speed (approximately 1600 rpm).

CAUTION

If engine has been run, allow to cool for one hour prior to performing cleaning operation.

(4) With engine motoring at approximately 1600 rpm inject three gallons of cleaning solution across engine inlet. Use compressed air to adjust for fine mist of cleaning solution, and regulate pressure to obtain flow rate of three gallons per minute.

(5) When step (4) is completed discontinue starter operation and allow engine to run down to stop.

(6) Repeat steps (3), (4), and (5) until ten gallons of cleaning solution have been injected.

(7) At conclusion of last wash, motor engine on starter to minimize presence of cleaning solution in engine. Prior to start, ensure that cleaning solution does not remain in P_b, P_{t5}, or P_{t2} sense probes or lines by blowing air toward engine gaspath from disconnected ends. Reconnect pressure sense lines. Start engine and run at idle for approximately five minutes.

(8) After running engine at idle for approximately five minutes, increase speed to approximately 75 percent then open anti-icing, fuel heater, and aircraft cabin air bleed valves if any. Maintain this power to ensure air lines are purged of cleaning solution. Aircraft cockpit should be left open during this run if engine is installed.

(9) It is recommended that corrosion protection per paragraph 2-146D be accomplished after engine is cleaned.

(10) Retrim engine, if necessary.

2-146D. ENGINE GASPATH CORROSION PROTECTION.

a. The corrosion protection should be applied to a cold engine. If engine has been run above 75 percent rpm, allow to cool for 30 minutes.

b. Using starter, motor engine (do not use ignition). Inject approximately five ounces of corrosion preventive oil (Rust-Lick 606) into engine intake. This is best accomplished by using jet engine corrosion control cart (Model 65A102J1, P/N 1390-100, Liquidonics, Westbury, New York) and nozzle (P/N 21C2374G001) that will produce fine spray.

NOTE

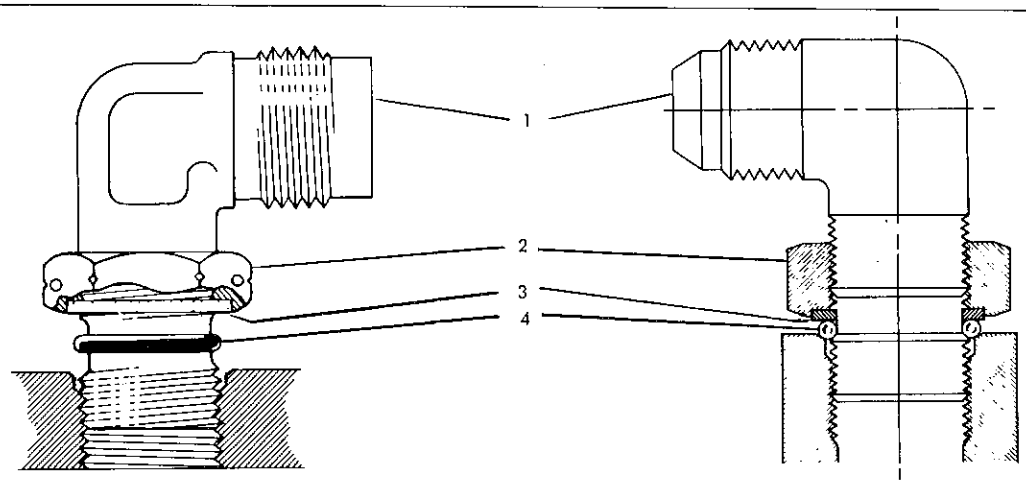
It is necessary for operator to watch compressor and immediately initiate flow of corrosion preventive oil as compressor starts to turn. This is to ensure that maximum amount of corrosion preventive oil passes to latter compressor stages prior to opening of bleed valve.

WARNING

Do not allow corrosion preventive oil to remain on bare skin for prolonged periods as it may have an irritating effect.

c. Any corrosion preventive oil ejected from bleeds should be washed from engine and/or cowling with water.

d. After next engine start, run engine at idle with anti-icing, fuel heater, and aircraft cabin air bleed valves in open position until systems have been purged of oil vapors. During this run aircraft cockpit should be open if engine is installed.



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

Figure 2—42. Jamnut Installation (Sheet 1 of 3)

2—147. MAIN OIL STRAINERS

2—148. REMOVAL.

a. Remove the hex head plug in the oil strainer cover.

b. Drain any oil in the strainer into a suitable container.

c. Remove the nuts and washers securing the oil strainer cover to the gearbox and remove the cover and spring.

d. Remove the strainer assembly from the gearbox.

2—149. DISASSEMBLY.

(See *Tool Group 14.*)

a. Place the base of the oil screen holder in a vise or on a bench.

b. Position the flange of the strainer in the locating recess of the holder.

c. Install the top plate so that the cutouts fit the lugs on the screen support and the upright bolts pass through the holes in the top plate.

d. Install the wing nuts on the bolts and compress the spacers.

e. Remove the oil screen spacer retaining nut with the retaining nut wrench.

f. Remove the bypass valve and spring.

g. Remove the strainer cover from the fixture and keeping the screens and spacers in the proper order,

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
1.3125-12	500-700	183649, 198420, 214163, 253424	0-1
		226110, 323462	1/2 — 2-1/2
		183653	3-4
		170987 (with thread undercut)	1/2 — 1-1/2
		170987 (without thread undercut)	2-3
1.0625-12	300-500	235157, 307450, 314431, 317408	0-1
0.875-14	200-350	224913	0-1
0.750-16	150-250	223923, 278121	0.100" Max from undercut
		232179	0-1
		341231	1/2 — 1-1/2
		155974	1-2
		150697, 361593	2-3
0.500-20	60-80	222172, 265050	1/2 — 1-1/2
		303035, 315335, 363010	1-2
		282715	2-1/2 — 3-1/2
0.4375-20	40-65	210247, 233548, 234097, 268652	0.080" Max from undercut
		240875, 360691	1/2 thread max
		168974, 170493, 183630, 228640, 243308, 252790, 331097	0-1
		164433, 224877, 249600, 252785, 260962, 266284, 307064, 361589	1/2 — 1-1/2
		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.

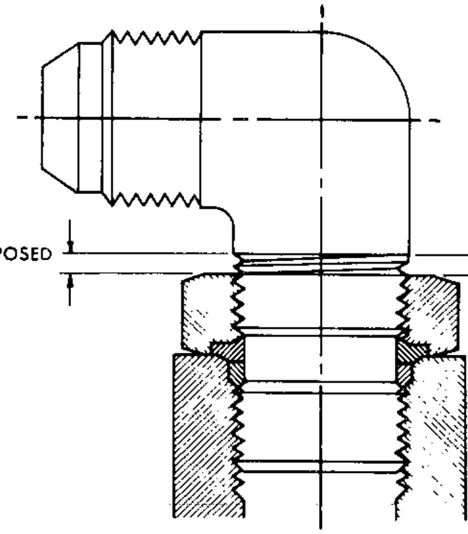
The high limit on thread protrusion is set up to make certain that at least three full lower threads of the fitting are engaged under all tolerance conditions. Thread protrusions below the low limit indicate possible connection faults associated with fittings installed too deep (Seal or packing omission or extrusion, very loose nut, or inadequate seal annulus). If a fitting is found to have too many threads exposed upon periodic service check, the fitting must be removed and reinstalled. If there are still too many threads exposed, the fitting must have extreme tolerances and if the 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 relaxation 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

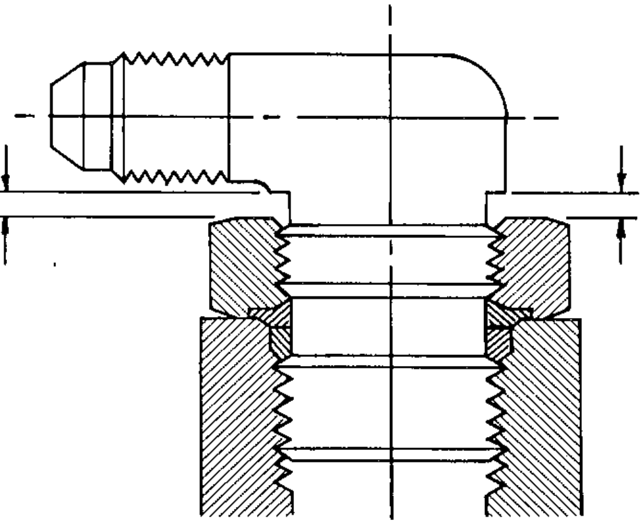
L-7522

Figure 2—42. Jamnut Installation (Sheet 2 of 3)



(b)
TYPICAL POSITION AFTER
INSTALLATION (STANDARD FITTING)

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

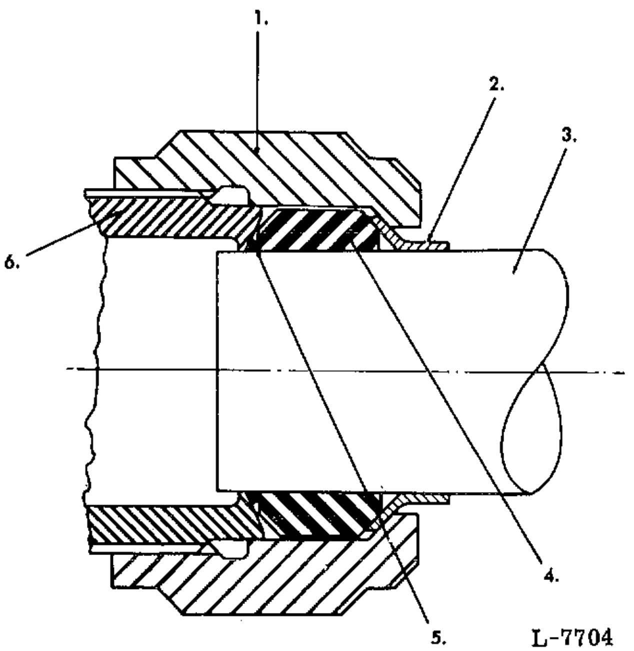


(c)
TYPICAL POSITION AFTER
INSTALLATION (UNDERCUT FITTING)

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).

L-7523

Figure 2–42. Jamnut Installation (Sheet 3 of 3)



NOTE

Moisten rubber seal with engine oil and install it on tube end against ferrule.

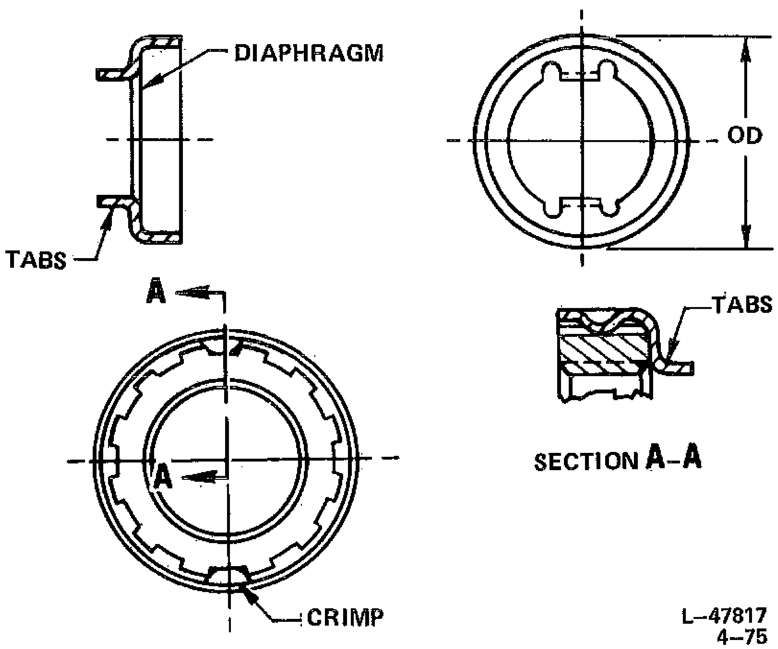
Install retainer on tube positioning it against seal. Minimize stretching of retainer to ensure tight fit.

Install tube to properly aligned connector and tighten nut to recommended torque.

If retainer is not used, seal may protrude between tube and connector and pieces of rubber may enter system.

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

Figure 2-43. Flexible Fitting Installation



Thread Size (Inches)	Indentations Required Number	Spacing
0.000 – 1.500	2	180° ±30° Apart
1.500 – 2.500	4	90° ±30° Apart
2.500 – 4.000	6	60° ±15° Apart
Over 4.000	8	45° ±15° Apart

Figure 2-43A. Typical Crimping of Internal and External Cup Type Key Washers

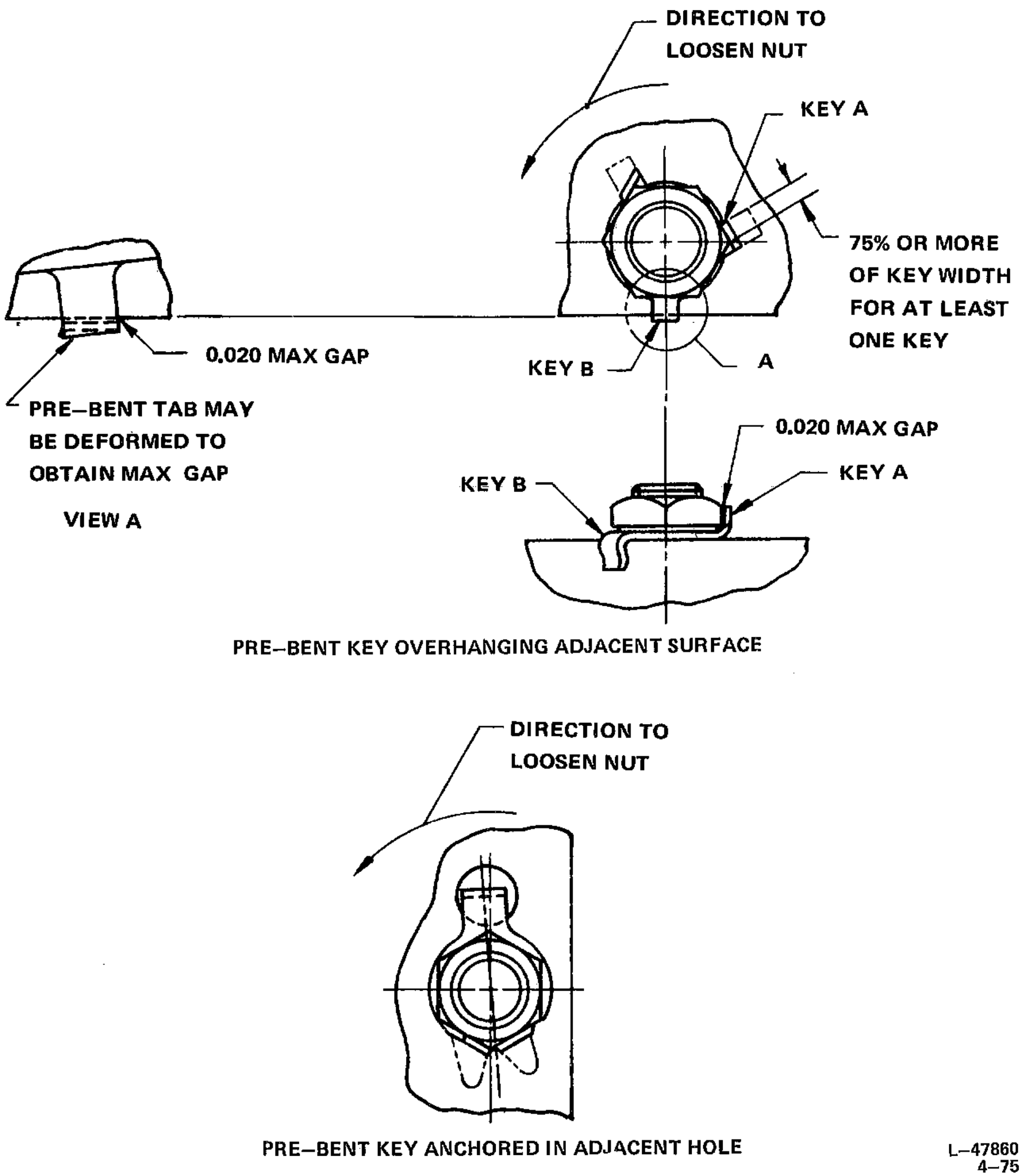
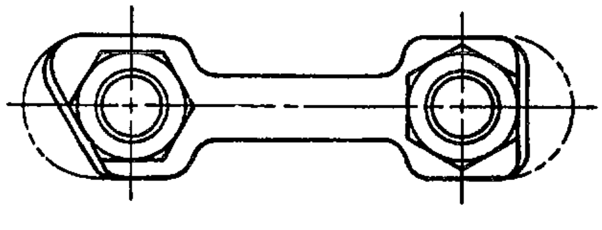


Figure 2-43B. Installation of Tab Type Key Washer



NOTE

Key washer must be used only one time. Installation of this type of key washer shall be accomplished by bending washer up across one whole face of hexagon as shown with a 0.020 inch maximum gap between flat of nut and washer.

Figure 2-43C. Installation of Elliptical Type Key Washer

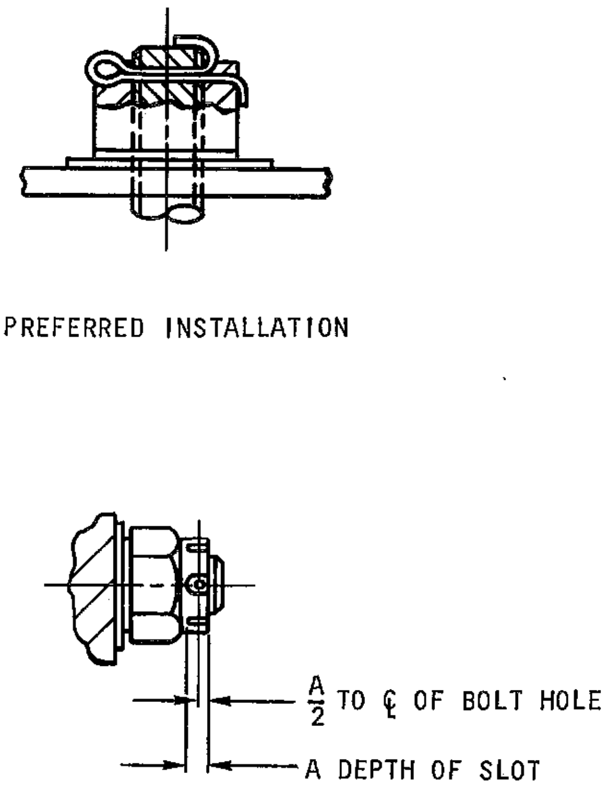


Figure 2-43D. Locking Nuts With Cotter Pins

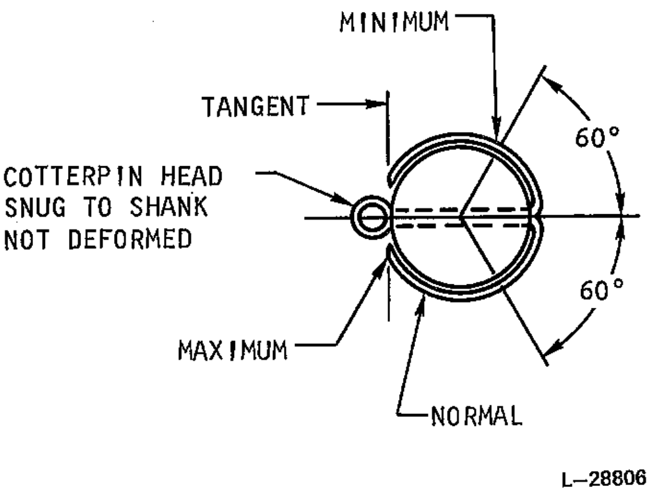


Figure 2-43E. Installing Cotter Pin on End of Retaining Pin/Rod

d. Install wing nuts on bolts and compress spacers.

e. Remove oil screen spacer retaining nut with retaining nut wrench.

f. Remove bypass valve and spring.

g. Remove strainer cover from fixture and keeping screens and spacers in proper order, slide screens and spacers onto a suitable rod (Figure 2-44). Remove strainer support from fixture.

NOTE

Care should be taken to prevent screens and spacers from sliding off of rod during cleaning.

2-149A. MAIN OIL SCREEN CONTAMINATION.

2-149B. It is difficult to provide specific limits regarding size, wieght, composition, and number of particles accumulating on the main oil screen for continued engine operation. The foreign particles might be metal particles, dirt, rubber, and lint.

2-149C. In certain instances, when a quantity of foreign particles is found on the oil screen, disassembly of engine may be justified. The extent of disassembly shall be determined by amount and nature of material found. A strong magnifying glass is helpful in examining metal particles to determine shape, possible discoloration for indication of mechanical shearing, burning, fatigue failure, etc. If small amounts of dust, and particles of aluminum or silver are found on the oil screen, this, in itself, should not be of a major concern.

2-149D. If a small quantity of particles is found on the oil screen, it is permissible to flush the entire oil system, fill with new oil, and operate engine for at least 30 minutes using a gradual increase in thrust up to take-off power. Following this test run, inspect oil screen for cleanliness.

NOTE

If the oil screen is essentially clean, the engine could be expected to be satisfactory for continued flight operation under close surveillance, consisting of oil screen inspection after first flight, five hours of operation, 15 hours of operation and then during normal periodic maintenance. Or, if the screen assembly continues to be contaminated, engine should be disassembled to determine a possible source of failure causing the release of particles.

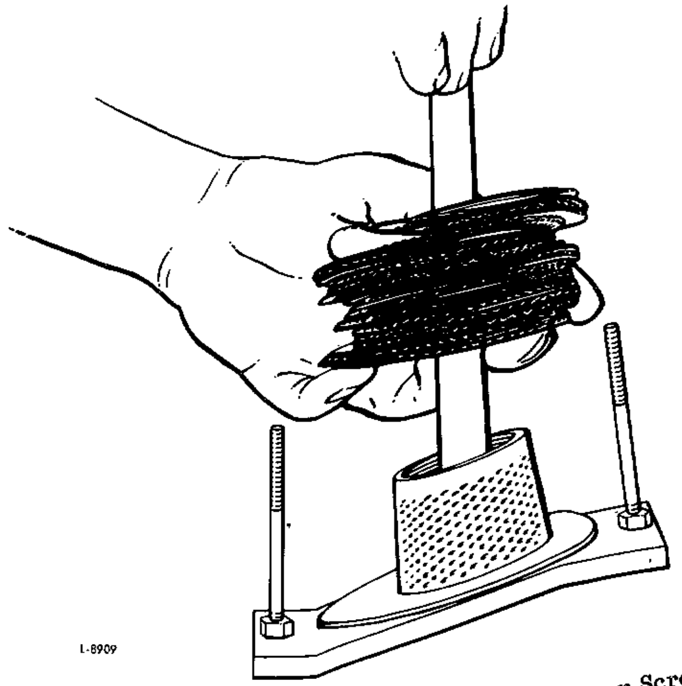


Figure 2-44. Removing Oil Strainer Scree and Spacers

2-149E. Extreme amounts of sludge or carbon particles in the oil screen can be detrimental as this could indicate breakdown of the oil and reduction of oil flow due to clogging of bearing jets. Other than minute fuzz-like pieces, steel particles in main oil screen are cause for concern and engine should be rejected.

2-149F. Particles of metal found in an engine may be granular and/or flake form. Granular particles are defined as grain-like particles which have the appearance of having been removed by a grinding process. It is possible that some granular particles will appear in flake form as a result of having passed through gears. However, it is not likely that all granules generated will be subjected to a rolling process, therefore, they can be readily identified by a close visual inspection. Metal flakes are defined as small flat pieces of metal appearing as flimsy masses or scale-like particles.

2-149G. Identify metal particles per paragraph Identification of Metal Particles.

2-150. CLEANING.

a. Separate screens and spacers by sliding parts along the rod.

b. Loosen screens from spacers and immerse them for a few minutes in cold type carbon remover.

c. Clean parts in trichlorethylene or petroleum solvent and dry them with air jet.

d. Examine parts for cleanliness and repeat cleaning operation if necessary.

2-151. ASSEMBLY.
(See Tool Group 14 and Figure 2-45.)

a. Place base of oil screen holder in vise or on bench.

b. Position flange of strainer in locating recess of holder.

c. Stack spacers and screens on baffle with outlet strainer at both ends and with each screen between outlet and inlet spacer.

d. Place oil screen support over assembled screens and spacers with pin in support aligned with slot in bushing.

e. Install top plate so that cutouts fit lugs on support and upright bolts pass through holes in top plate.

f. Install spring and bypass valve.

g. Install spacer retaining nut in baffle bushing and tighten nut with retaining nut wrench so that screens and spacers cannot be rotated by hand. Nut must be seated solidly against bushing.

NOTE

Complete sets of parts consisting of two screens and one each of outlet and inlet spacers must be added or removed to meet tightening requirement.

h. Remove the strainer assembly from holding fixture.

2-152. INSTALLATION.

a. Install strainer in oil strainer bore of gearbox.

b. Place new seal on OD of strainer cover and install spring and cover over oil strainer.

c. Secure cover to gearbox with washers and locknuts. Torque locknuts as recommended. (See Reference 834.)

d. Install plug and new seal in cover. Tighten plug to recommended torque and lockwire, as shown in Figures 2-54, 2-55B, and 2-57.

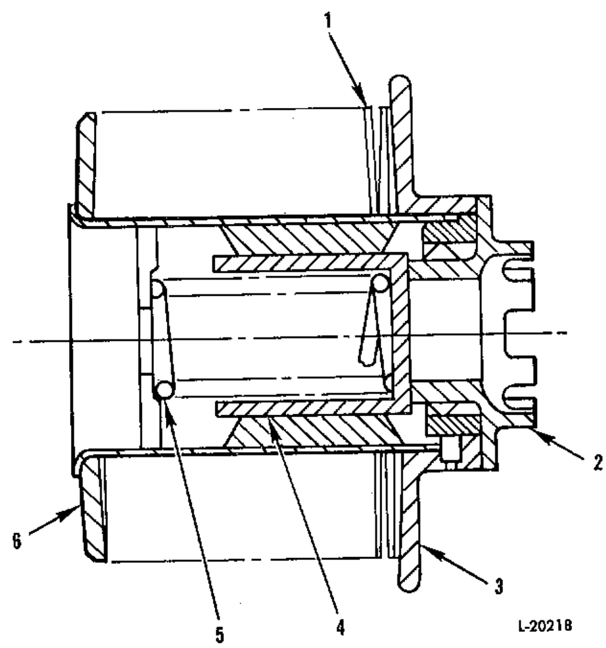
2-152A. FUEL PUMP FILTER.

2-152B. REMOVAL.

a. Shut off all fuel.

b. Remove drain plug from strainer cover and drain fuel into suitable clean container.

c. Remove bolts securing strainer cover to fuel pump.



1. Assemble spacers and screens so that outlet spacers will be at both ends and each screen will be between an outlet spacer and an inlet spacer.
2. Retaining nut
3. Oil screen support
4. Bypass valve
5. Bypass valve spring
6. Oil strainer support

Figure 2-45. Oil Strainer

CAUTION

Do not remove one bolt at a time. Bolts must be loosened and removed evenly to prevent damage to housing.

d. Rotate cover 1/6 of turn in clockwise direction and remove.

e. Inspect and then discard filter element.

2-152C. INSTALLATION.

a. Install new filter element and packings in housing.

NOTE

Replaced packings shall be coated with petrolatum (Federal Specification VV-P-236).

b. Position strainer cover on fuel pump. Rotate cover 1/6 of turn counterclockwise.

c. Secure with bolts. Tighten bolts to recommended torque and lockwire.

CAUTION

Hold cover in position while installing bolts. Bolts must be tightened evenly around circle to avoid damage to housing.

d. Install drain plug in cover. Tighten to recommended torque and lockwire.

2-152D. FUEL CONTROL (HOLLEY) INLET FILTER.

2-152E. REMOVAL.
(See Tool Group 6-1 and Figure 2-45A.)

a. Remove filter screen cover, filter screen, and support assembly. Remove packing from cover.

b. Install AT-1853 puller into filter element as shown in Figure 2-45A.

c. Hold T-handle of puller, and tighten smaller hexnut to expand nylon against filter ID. Tighten securely.

d. Position spacer detail of tool against casting face.

e. Tighten larger hexnut until filter is free, and pull filter group from housing.

f. Unscrew filter retainer, attached spring, and seat assembly from filter body assembly. Remove filter screen assembly and packings from filter body assembly.

NOTE

Spring and seat assembly is attached to filter retainer by spinning; these two parts should not be separated.

g. Remove pin from filter body assembly to free check valve guide, spring, and check valve.

2-152F. CLEANING.

a. Rinse all parts thoroughly in bath of clean test fluid conforming to Military Specification MIL-F-7024, Type II.

b. Blow off any visible contamination, especially lint, with filtered, dry compressed air.

2-152G. INSTALLATION.
(See Figure 2-45A.)

a. Place spring in end of check valve guide, and place filter check valve over protruding end of spring.

b. Insert assembled parts in filter body assembly. Align hole in guide with hole in body, and install pin.

c. Place new packing over body assembly so it is seated in groove at end of body, and slide filter screen assembly over body until packing is covered.

NOTE

New packing shall be coated with petrolatum (Federal Specification VV-P-236). Install filter screen assembly with care to prevent cutting packing.

d. Place new packing in groove between screen assembly and body assembly. Install filter retainer along with attached filter spring and seat assembly.

NOTE

If filter spring and seal assembly was removed from filter retainer, spin spring and seat assembly to retainer. Seat assembly must not be free to rotate after spinning.

e. Place assembled filter body assembly in fuel control main body.

f. Place filter screen and support assembly on filter spring and seat assembly. Install new packing on cover and secure filter group in place by installing cover.

2-153. COMPRESSOR INLET CONE.

2-154. REMOVAL.

a. Remove bolts securing compressor inlet outer front cone to the outer rear cone.

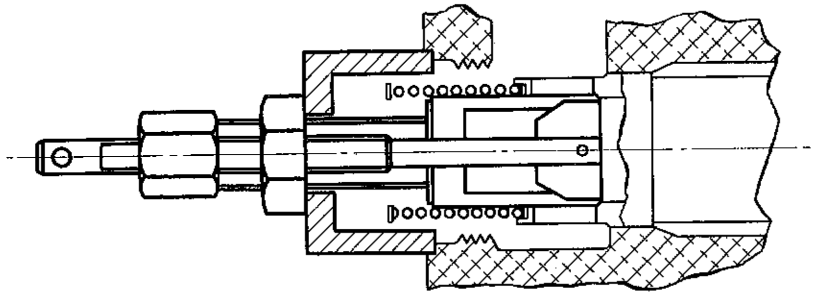
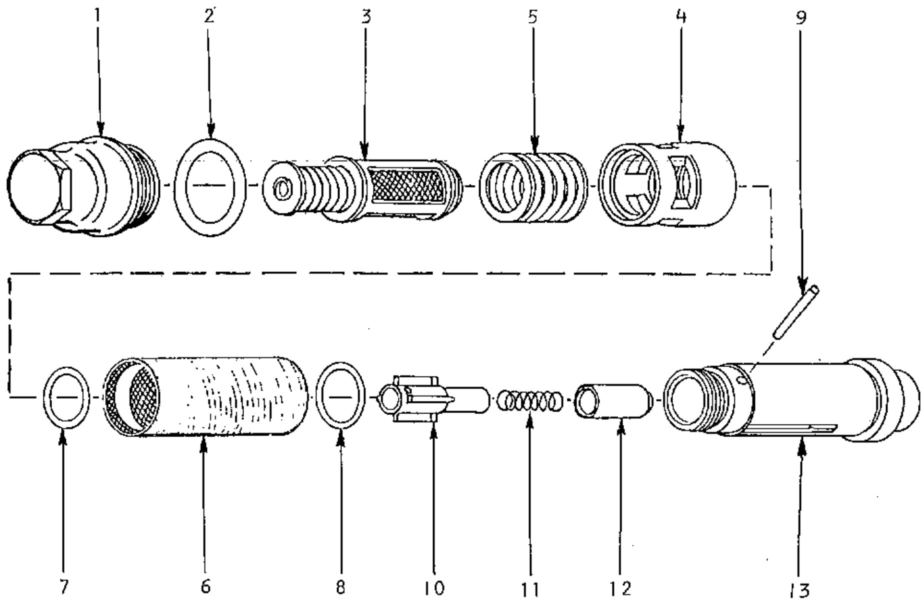


Figure 2-45A. Fuel Control Fuel Filter Puller



1. Filter screen cover
2. Packing
3. Filter screen and support assembly
4. Filter retainer
5. Filter spring and seat assembly
6. Filter screen assembly
7. Packing
8. Packing
9. Pin
10. Check valve guide
11. Spring
12. Check valve

Figure 2-45B. Fuel Filter Group (Holley Fuel Control)

b. Remove bolt securing outer rear cone to inner cone. Unfasten nuts securing inner cone to compressor inlet case.

2-155. INSTALLATION.

a. Secure inner cone to compressor inlet case with nuts. Tighten nuts to recommended torque.

b. Attach outer rear cone to inner cone with bolt and tabwasher. Tighten bolt to recommended torque and secure with tabwasher.

c. Secure compressor inlet outer front cone to outer rear cone with bolts. Tighten bolts to recommended torque and lockwire.

2-156. IGNITER PLUG LEADS.

WARNING

Because voltage to plug is dangerously high, ignition switch must be in OFF position before removal or checking of any of ignition system components. A sufficient period of time must elapse between operation of ignition system and removal or checking of components to ensure complete dissipation of energy from ignition system.

2-157. REMOVAL.

a. Disconnect right plug lead at plug and at ignition exciter.

b. Unfasten any clips securing lead to diffuser case and remove lead.

c. Remove left plug lead in same manner.

2-158. INSTALLATION.

a. Apply molybdenum powder (Molykote Type Z or equivalent) on lead nut threads.

b. Install right lead on plug and ignition exciter.

c. Torque nuts to 140 to 160 pound-inches.

CAUTION

Do not twist lead when tightening nuts. Insufficient torque on high tension lead nut at igniter plug end can cause ignition radiated noise to be picked up by the aircraft radio equipment.

d. Secure lead to diffuser case with clip.

e. Install left lead in same manner.

2-159. ELECTRICAL SYSTEM WIRING HARNESS. (See Figure 2-46.)

2-160. REMOVAL.

a. Disconnect wiring harness at right and left ignition exciters, anti-icing solenoid, fuel pump, and fuel de-icing heater.

b. Remove harness receptacle from inlet case rear flange.

c. Unfasten any clips securing harness to engine and mark location of input receptacle. Remove harness.

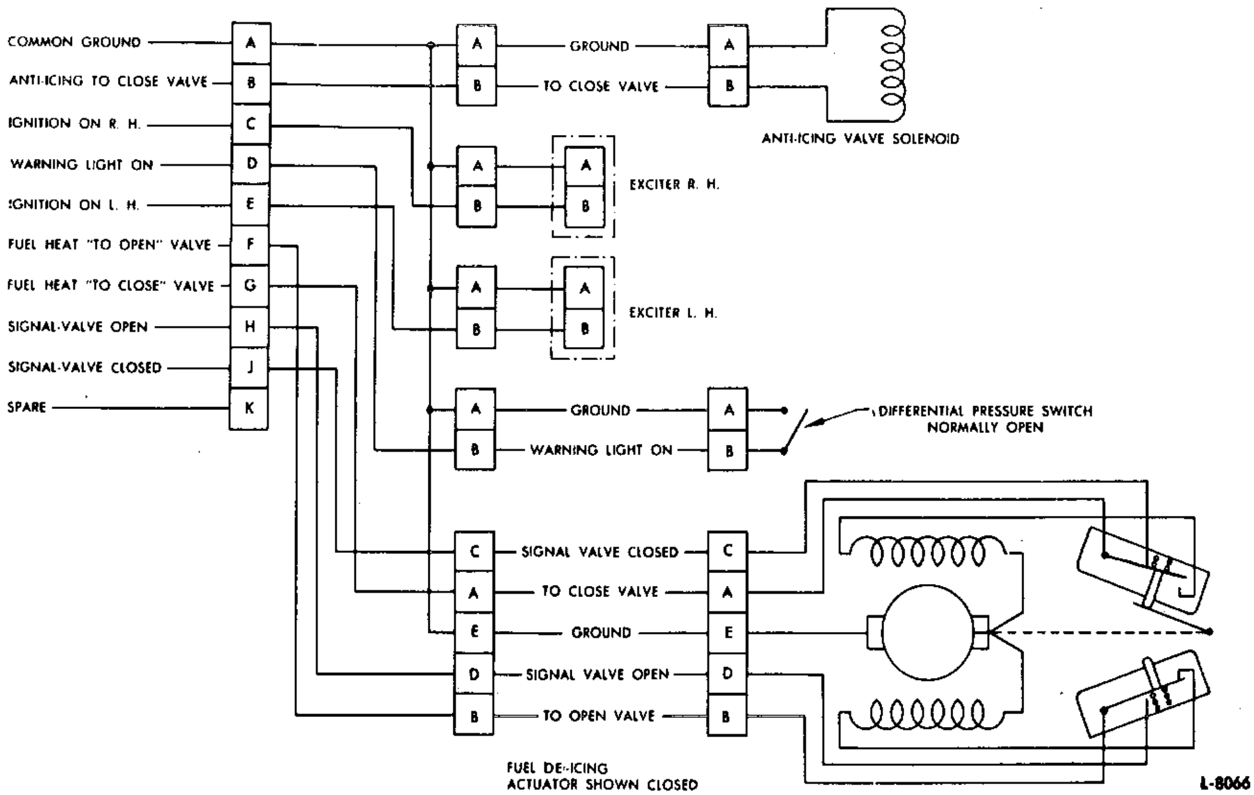


Figure 2-46. Electrical System Schematic

2-161. INSTALLATION.

a. Install wiring harness on engine by passing harness underneath compressor section at inlet case rear flange.

b. Secure wiring harness receptacle to inlet case rear flange with screws and locknuts. Tighten locknuts to recommended torque.

c. Connect ignition input leads to ignition exciters, anti-icing input lead to anti-icing solenoid, fuel pump lead to fuel pump differential switch, and remaining lead to fuel de-icing heater.

d. Tighten lead nuts fingertight, turn 45 degrees maximum, and lockwire.

2-162. IGNITER PLUGS.

2-163. REMOVAL.

a. Disconnect plug lead at right plug.

b. Remove plug from diffuser case.

NOTE

For engines which incorporate one continuous and one intermittent duty ignition system, replace continuous ignition plug (right side) after maximum of 150 hours of continuous igniter operation.

c. Remove left plug in same manner.

2-164. CLEANING.

a. Degrease plug in hot trichlorethylene solvent.

CAUTION

Do not use abrasive cleaner on plug.

b. Clean outer shell of plug with wire brush.

c. Remove deposits from external surface of firing end of plug with hot trichlorethylene solvent and nonmetallic brush. It is not necessary to restore ceramic to state of cleanliness of new plug.

2-165. INSPECTION OF IGNITER PLUG BOSSES. (See Tool Group 16.)

2-166. If inspection of the plug boss threads indicates thread damage, dress threads with igniter plug boss tap.

2-167. INSTALLATION.

a. Coat threads of right plug with BG Mica Lube A-768 antiseize compound.

NOTE

To prevent contamination of plug electrode, do not apply compound to first thread.

b. Install plug and new gasket in boss in diffuser case.

NOTE

For engines which incorporate one continuous and one intermittent duty ignition exciter, continuous duty exciter is installed on right side of engine when viewed from rear.

c. Tighten plug to recommended torque.

d. Apply molybdenum disulfide powder (Molykote Type Z or equivalent) on plug lead nut threads.

e. Install lead on plug. Tighten nut to recommended torque.

CAUTION

Do not twist lead when tightening nut. Insufficient torque on high tension lead nut at igniter plug end can cause ignition radiated noise to be picked up by the aircraft radio equipment.

f. Install left plug in same manner.

2-167A. DIFFUSER CASE IGNITION EXCITER SUPPORTS.

a. Ignition exciter must contact four supports evenly.

b. Check for flatness by placing piece of flat stock on four supports.

c. Using feeler gage ensure that all support surfaces are level within 0.020 inch.

d. Braze washer onto support per AMS 2665, if required.

2-168. IGNITION EXCITERS.

2-168A. IGNITION EXCITERS - INTERMITTENT DUTY.

2-169. REMOVAL.

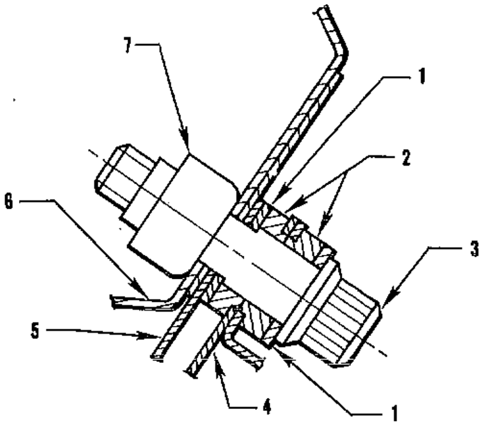
a. Disconnect electrical harness and igniter leads to right ignition exciter.

b. Unfasten bolts securing exciter to mount bracket and remove exciter.

c. Remove left exciter in same manner.

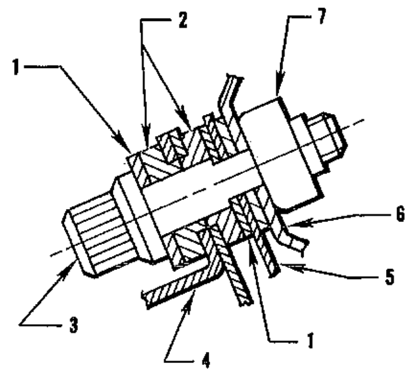
2-170. INSTALLATION. (See Figure 2-46A.)

a. Fasten right and left ignition exciters to supports on diffuser case as shown.



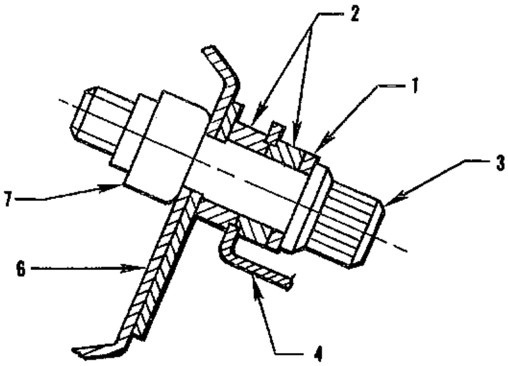
LEFT SIDE
(FOUR PLACES)

INTERMITTENTLY OPERATING
IGNITION SYSTEM



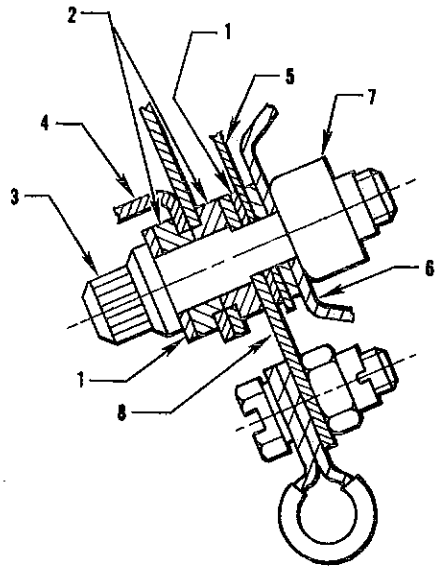
RIGHT SIDE
(THREE PLACES)

INTERMITTENTLY OPERATING
IGNITION SYSTEM



LEFT SIDE
(FOUR PLACES)

CONTINUOUSLY OPERATING
IGNITION SYSTEM



RIGHT SIDE
(LOWER FORWARD BRACKET)

INTERMITTENTLY OPERATING
IGNITION SYSTEM

L-22426

1. Washer
2. Resilient mount
3. Bolt
4. Bracket
5. Heatshield
6. Support
7. Locknut
8. Fuel control pressure sensing tube assembly bracket

Figure 2-46A. Mounting of Ignition Exciters

b. Tighten mounting bolts to recommended torque. (See References 1033 and 1034.)

CAUTION

Ensure that tang on locknuts does not contact sides of ignition exciter support when torquing bolts.

c. Apply molybdenum disulfide (Molykote Type Z or equivalent) on igniter lead nut threads.

d. Install lead on ignition exciter. Tighten nut to recommended torque.

CAUTION

Do not twist lead when tightening nut. Insufficient torque on high tension lead nut at exciter end can cause ignition radiated noise to be picked up by the aircraft radio equipment.

NOTE

Use of resilient mounts does not eliminate requirement that ignition exciter contact four supports evenly.

2-170A. IGNITION EXCITERS - CONTINUOUS DUTY.

2-170A-1. REMOVAL.

a. Disconnect electrical harness and igniter leads.

b. Unfasten bolts securing exciters and remove exciters.

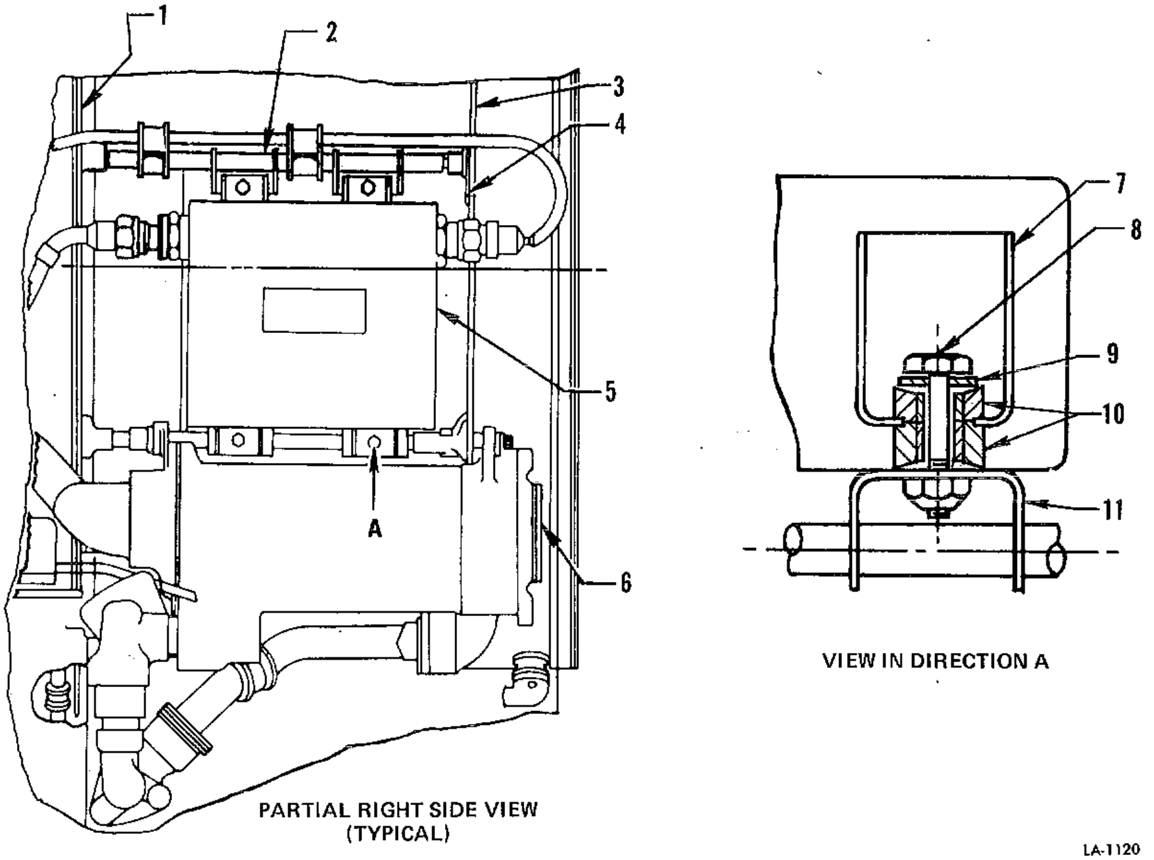
2-170A-2. INSTALLATION.

a. Left side. Fasten ignition exciter to supports on diffuser case as shown in figure 2-46A. Tighten mounting bolts to recommended torque. (See References 1033 and 1034.)

CAUTION

For engines incorporating locknuts, ensure that tangs on locknuts do not contact sides of ignition exciter supports when torquing bolts.

b. Right side. Fasten exciter to rod assembly and compressor inlet case or to rod assemblies as shown in Figure 2-46B.



1. Flange C
2. Rod assembly
3. Flange B
4. Bracket assembly
5. Exciter
6. Heater assembly
7. Exciter mounting bracket
8. Bolt
9. Washer
10. Resilient mount
11. Support

Figure 2-46B. Mounting of Ignition Exciters

c. Apply molybdenum disulfide (Molykote Type Z or equivalent) on igniter lead nut threads.

d. Install leads on ignition exciters. Tighten nuts to recommended torque.

CAUTION

Do not twist lead when tightening nut. Insufficient torque on high tension lead nut at exciter end can cause ignition radiated noise to be picked up by the aircraft radio equipment.

2-170B. VIBRATOR.

a. Replace continuous ignition exciter vibrator assembly after maximum of 150 hours continuous ignition operation.

b. To remove vibrator, remove screw from vibrator holding bracket at output end of exciter. Insert point of screwdriver under bracket and pry up until bracket can be grasped with pliers. Exerting steady pressure, pull vibrator from case. To install new vibrator, position new preformed packing on vibrator approximately one inch toward inner end from aluminum retaining collar. Wrap grounding braid around groove at inner end of vibrator. Insert vibrator into case so that bracket mates with bracket on case and install screw. Torque screw to eight to 12 pound-inches.

2-170C. DISCHARGER TUBE.

a. Replace continuous ignition exciter discharger tube after minimum of 300 hours of continuous ignition operation.

b. To replace discharger tube, cut lockwire and remove two screws at outlet end of exciter. Remove discharge tube cover, holder, and preformed packin Slip anode cap from discharger tube anode, and pull tube from case. Push new tube into case, cathode end first.

NOTE

Distinguish between cathode and anode of any discharger tube by holding the tube vertically so that lettering GLA and part number are right side up; cathode is at bottom.

c. Install discharger tube anode cap. Position preformed packing and grounding braid on discha tube cover and install cover, securing with two and installing new lockwire on screws.

NOTE

Exciter is reparable only at overhaul.

2-171. ANTI-ICING SYSTEM.
(See Figure 2-47.)

2-172. REMOVAL.

a. Remove electrical lead from anti-icing valve solenoid.

b. Remove bolts and locknuts securing anti-icing system to inlet and diffuser cases. Remove anti-icing tube valve, and elbow from engine.

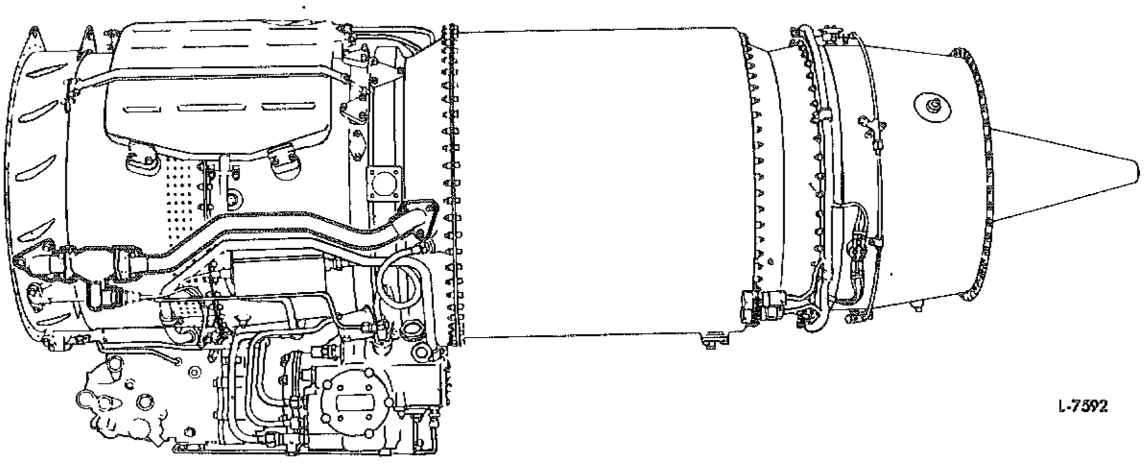


Figure 2-47. Anti-Icing System

·173. DISASSEMBLY.

a. Unfasten bolts securing anti-icing valve to el-
ıw and tube.

b. Separate elbow and tube from valve.

·174. ASSEMBLY.

a. Place gasket, spacer, and gasket on rear
ınge of anti-icing valve and secure valve to the anti-
ing tube with bolts. Tighten bolts to recommended
rque and lockwire.

b. Insert guide into valve and secure guide and
bow to valve. Tighten bolts to recommended torque
d lockwire.

. INSTALLATION.

Place gasket on rear flange of anti-icing tube
ition anti-icing assembly on pads at inlet and
cases.

ecure anti-icing assembly to pads with bolts
nuts. Tighten locknuts to recommended

6. MAIN OIL PUMP (TURBOJET ENGINES).

177. REMOVAL.
(See Tool Group 13.)

a. Remove nuts securing main oil pump to com-
nent drive gearbox.

b. Remove tachometer drive housing cover and
ıtall oil pump puller on tachometer drive housing
ıds. Secure puller with nuts.

c. Using puller, remove main oil pump from
arbox.

NOTE

For engines with main oil pumps incorporating internally threaded bolt heads use PWA-13387 puller to pull pump from gearbox.

178. INSTALLATION.

a. Place new preformed packings in grooves of
pump.

b. Install pump in gearbox, meshing drive gears.

c. Secure pump to gearbox with nuts. Tighten nuts
recommended torque.

d. Secure tachometer drive housing cover to
ısing with nuts.

2-178A. MAIN OIL PUMP
(FREE TURBINE ENGINES).

2-178B. REMOVAL.
(See Tool Group 13A.)

a. Remove Nos. 4 and 5 Bearing oil scavenge external tubes.

b. Remove nuts securing main oil pump to component drive gearbox.

c. Secure jaws of oil pump puller under puller lugs of pump housing.

d. Using puller, remove pump from gearbox.

2-178C. INSTALLATION.

a. Place new preformed packings in grooves in oil pump.

b. Install pump in gearbox aligning hole in pump cover with locating pin in gearbox and meshing pump drive gears.

c. Secure pump to gearbox with nuts.

d. Install new packings on scavenge tube connectors and install Nos. 4 and 5 Bearing oil scavenge external tubes.

2-179. PRESSURE OIL TUBES.

2-180. REMOVAL.

a. Remove bolts securing No. 1 Bearing pressure oil tube to compressor inlet case.

b. Loosen nut securing other end of tube to oil pressure manifold and remove tube.

c. Remove nuts and bolts securing oil manifold to diffuser case.

d. Loosen tube nut securing oil manifold to gearbox connector.

e. Remove manifold, carefully disengaging ferrule at top of manifold from oil tank.

f. On free turbine engines, also perform the following:

(1) Loosen tube nut securing No. 4 Bearing oil pressure tube to connector on free turbine case.

(2) Remove nuts and bolts securing No. 4 Bearing oil pressure tube to connector at component drive gearbox.

(3) Remove No. 4 Bearing oil pressure tube.

(4) Remove tube nuts at each end of free turbine gearbox oil pressure external tube. Remove tube.

2-181. INSTALLATION.

CAUTION

When fastening oil tubes to connector on gearbox, hold gearbox connector with wrench while torquing coupling nut to ensure that torque on connector is not increased inadvertently, thereby stripping gearbox housing threads.

a. Install new preformed packing on ferrule at top of oil pressure manifold and on diffuser case connector.

b. Position manifold on engine engaging ferrule into oil tank and positioning manifold connectors on diffuser case flange and gearbox connector.

c. Secure manifold to gearbox connector with tube nut and to diffuser case with locknuts and bolts. Tighten nuts to recommended torque and lockwire tube nut.

d. Place packing in groove of ID of front connector of No. 1 bearing pressure oil tube and secure tube to inlet case with bolts and locknuts. Tighten nuts to required torque.

WARNING

Ensure packing is installed properly in front connector and not on tube. Leak at this packing allows oil to enter anti-ice air passages, exiting through nose cone anti-ice air holes and wetting compressor gaspath and engine exterior at 4th stage bleed. Severe leak can cause contamination of cabin bleed air.

e. Pressure check front connector for leaks.

(1) Remove compressor inlet case cover.

(2) Install rubber cap on No. 1 bearing jet to restrict degrees of air.

(3) Connect free end of tube to supply of dry air at 50 psi.

(4) Apply soap solution around mating surfaces of front connector and check for leak bubbles.

(5) Remove air supply line from oil tube.

(6) Remove rubber cap from oil jet.

(7) Re-install inlet case cover.

f. Position No. 1 bearing oil pressure tube with forward end on inlet case flange and rear end on connector on oil pressure manifold.

g. Secure tube to inlet case with bolts and locknuts.

h. Secure tube to oil manifold with tube nut. Tighten tube to recommended torque and lockwire.

i. On free turbine engines, also perform following:

(1) Position free turbine gearbox oil pressure external tube with one end on gearbox connector and other end of connector on free turbine case.

(2) Secure tube to connectors with tube nuts. Tighten nuts to recommended torque and lockwire.

(3) Install new packing on forward end of No. 4 bearing oil pressure tube.

(4) Position No. 4 bearing oil pressure tube with forward end on flange of gearbox connector and other end on connector at free turbine case.

(5) Secure forward end to gearbox connector with bolts and nuts. Tighten nuts to recommended torque.

(6) Secure other end of tube to connector on free turbine case with tube nut. Tighten tube to recommended torque and lockwire.

2-182. SCAVENGE OIL TUBES.
(See Figure 2-49.)

2-183. REMOVAL.

a. Remove drain plug from oil tank and drain oil from oil tank.

b. Install new packing and replace plug. Tighten to recommended torque and lockwire.

c. Loosen nut on oil cooler inlet manifold at gearbox.

d. Remove nuts securing manifold to oil cooler and remove manifold.

e. Loosen nut on No. 1 bearing oil return oil tube at gearbox.

f. Remove bolts securing tube to pad on inlet case and remove tube.

g. Loosen nut on Nos. 2 and 3 bearing oil return tube at gearbox.

h. Remove bolts securing tube to right side of diffuser case and remove tube.

i. Loosen nut on oil supply tube at gearbox.

j. Remove bolts securing tube to oil tank outlet boss and remove tube.

k. Remove four connectors from gearbox.

l. Remove bolts securing oil cooler-to-oil tank return tube at oil tank and cooler and remove tube.

m. On free turbine engines, also perform following:

(1) Remove bolts securing No. 4 and No. 5 bearings external oil return tubes to connector on free turbine case.

(2) Remove nut securing No. 4 and No. 5 bearings external oil return tubes to main oil pump.

(3) Remove tubes.

(4) Remove sleeve from pump.

2-184. INSTALLATION.

CAUTION

When fastening oil tubes to connector on gearbox, hold gearbox connector with wrench while torquing coupling nut to ensure that torque on connector is not increased inadvertently, thereby striping gearbox housing threads.

a. Place packing on each of four connectors and install connectors in openings on left side of gearbox. Tighten connectors to recommended torque.

b. Position oil supply tube on left side of engine so that upper fitting is at oil tank outlet boss.

c. Place new packings on fittings and secure tube to boss with bolts and locknuts. Tighten nuts to recommended torque. Tighten tube nut at gearbox connector to recommended torque and lockwire.

d. Position No. 2 and No. 3 bearings oil return tube between gearbox and diffuser case so that fitting on tube is positioned against boss and right side of diffuser case and remaining end is against connector at gearbox.

e. Place packing on fitting end of tube and secure tube to boss with bolts and locknuts. Tighten locknuts to recommended torque.

f. Secure other end of tube to connector with tube nut. Tighten nut to recommended torque and lockwire.

g. Place packing on fitting end of No. 1 bearing scavenge tube and install tube to boss on inlet case with bolts and locknuts. Tighten locknuts to recommended torque.

h. Secure other end of tube to connector with tube nut. Tighten nut to recommended torque and lockwire.

i. Install packing on fitting of oil cooler oil inlet manifold and secure manifold to cooler with bolts and locknuts. Tighten locknuts to recommended torque.

j. Secure other end of manifold to connector with tube nut. Tighten tube to recommended torque and lockwire.

k. Place packings in oil cooler to oil tank tube and secure tube to oil tank and cooler with bolts and locknuts. Tighten locknuts to recommended torque.

l. On free turbine engines, also perform following:

(1) Position two packings on connector at rear end of No. 4 and No. 5 bearings external oil return tubes.

(2) Install new packings on sleeve and position sleeve on forward end of No. 4 and No. 5 bearings external oil return tubes.

2-185. OIL TANK.

2-186. REMOVAL.

a. Remove breather manifold tubes from oil tank.

b. Remove oil return tube from bottom of the oil tank.

Figure 2-48. Deleted.

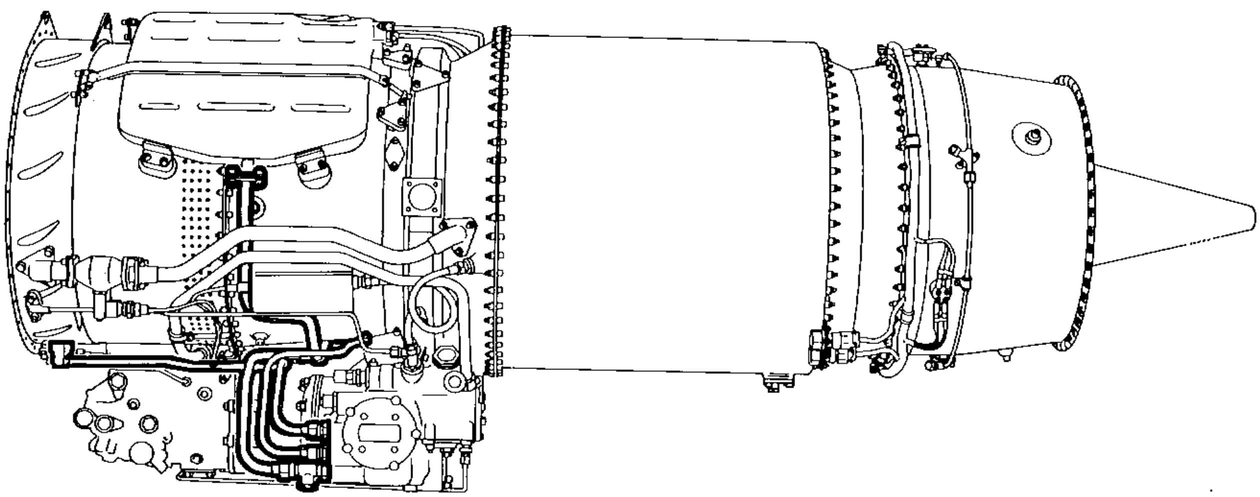


Figure 2-49. Scavenge Oil System

c. Remove the oil supply tubes from the bottom of the oil tank.

d. Remove the bolts securing the oil tank to the engine.

e. Unfasten the straps securing the oil tank to the engine and remove the oil tank.

f. Remove the four mounts from the underside of the oil tank.

g. Remove the straps from the brackets on the inlet case, and the turnbuckle and clevises from the brackets on the diffuser case.

2-186A. CLEANING.

a. Immerse tank in degreasing fluid then bathe in trichlorethylene for two hours to three hours.

b. Using steam cabinet flow steam through tank in direction opposite to normal flow of oil for two hours.

c. Power flush tank with AMS 3065 oil at pressure of four to five psi. Flush tank both in direction of oil flow and in opposite direction.

d. Rinse tank in degreaser fluid and dry.

2-187. INSTALLATION.

a. Insert the two small mounts into the rear holes in the underside of the oil tank.

b. Insert the two large mounts into the front holes in the underside of the oil tank.

c. Position the oil tank on the engine so that the oil tank brackets are aligned with the bosses on the engine.

d. Secure the oil tank to the bosses with bolts and locknuts. Tighten the locknuts and bolts to the recommended torque and lockwire.

e. Secure the straps to the brackets on the inlet case, and the turnbuckle and clevises to the brackets on the diffuser case with bolts and locknuts. Tighten the nuts to the recommended torque.

f. Position the straps over the oil tank and insert the adjusting bolts into the turnbuckles. Tighten the turnbuckles to the recommended torque and lockwire.

2-188. BREATHER OIL TUBES.

2-189. REMOVAL.

a. Remove the bolts securing the No. 1 Bearing breather manifold to the compressor inlet case.

b. Loosen the nuts and bolts securing the other end of the manifold to the breather manifold and remove the manifold and packing.

c. Remove the bolts securing the breather manifold to the oil tank.

d. Loosen the nut securing the manifold to the connector on the gearbox and remove the manifold.

e. Remove the connector from the gearbox.

f. On free turbine engines, also perform the following:

(1) Remove the bolts securing the No. 4 Bearing rear external breather tube to the boss on the free turbine case.

(2) Remove the tube.

(3) Loosen the tube nut securing the No. 4 Bearing front external breather tube to the gearbox connector.

(4) Remove the tube.

2-190. INSTALLATION.

a. Position a new packing on the gearbox breather manifold connector and install the connector in the right side of the gearbox. Tighten the connector to the recommended torque and lockwire.

b. Install a new packing on the oil tank end of the rear breather manifold.

c. Position the rear breather manifold on the engine with the flanged end at the oil tank and the bottom end at the gearbox connector.

d. Secure the manifold to the gearbox connector with the tube nut. Tighten to the recommended torque and lockwire.

e. Secure the manifold to the oil tank with the bolts and nuts. Tighten the nuts to the recommended torque.

f. Place new packings on each end of the front breather manifold tube and position the tube on the engine.

g. Secure the tube to the rear manifold and to the compressor inlet case connector with the bolts and nuts. Tighten the nuts to the recommended torque.

h. On free turbine engines, also perform the following:

(1) Position the No. 4 Bearing front external breather tube on the gearbox connector and secure with the tube nut.

NOTE

Do not tighten the tube nut.

(2) Position two new packings on the forward end of the No. 4 Bearing rear external breather tube.

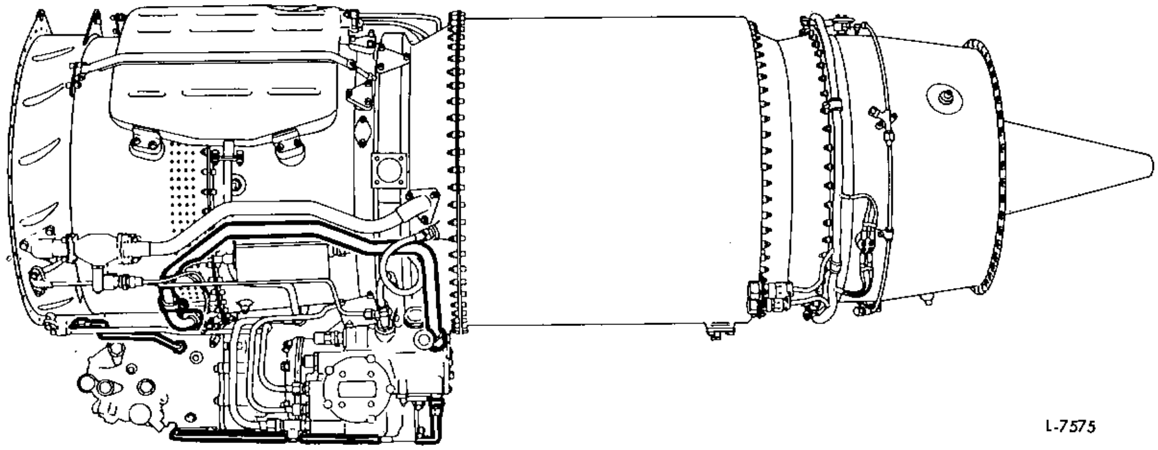


Figure 2-50. Fuel System Tubes

(3) Position a new packing on the rear of the No. 4 Bearing rear external breather tube.

(4) Position the rear external tube, engaging the forward end into the front external tube, with the rear connector flange on the flange of the boss of the free turbine case.

(5) Secure the rear tube to the free turbine case boss with the bolts and locknuts. Tighten the locknuts to the recommended torque.

(6) Tighten the tube nut on the gearbox connector to the recommended torque and lockwire.

2-191. FUEL SYSTEM TUBES.
(See Figure 2-50.)

2-192. REMOVAL.

a. Disconnect the inlet air pressure sensing tube from the inlet air probe at the bottom front of the compressor inlet case. Disconnect the other end of the tube from the fuel control. Remove the tube.

b. Disconnect the oil cooler-to-pressurizing and dump valve tube from the oil cooler and from the pressurizing and dump valve. Remove the tube.

c. Disconnect the fuel control-to-fuel pressurizing and dump valve signal tube from the fuel control and from the pressurizing and dump valve. Remove the tube.

NOTE

Engines incorporating intent of SB 4178 do not have a fuel pressure signal tube. A plug is installed in the pressurizing and dump valve and another plug is installed in the fuel control.

d. Disconnect the fuel control-to-flowmeter lower tube from the fuel control-to-flowmeter upper tube.

e. Disconnect the fuel control-to-flowmeter lower tube from the fuel control. Remove the tube.

f. Disconnect fuel control-to-flowmeter upper tube from flowmeter. Remove tube.

g. Disconnect flowmeter-to-oil cooler tube from cooler and from flowmeter. Remove tube.

h. Disconnect tube nuts securing P_{t3} pressure sensing tube to diffuser case and to fuel control. Remove tube.

2-193. INSTALLATION.

a. Install a new seal on elbow at oil cooler end of oil cooler-to-pressurizing and dump valve fuel tube.

b. Position tube with tube nut on pressurizing and dump valve inlet connector and other end at oil cooler fuel outlet. Secure tubes to oil cooler with nuts. Tighten nuts to recommended torque.

c. Secure tube to pressurizing and dump valve connector with tube nut. Tighten nut to recommended torque and lockwire.

d. Position fuel control-to-pressurizing and dump valve fuel signal tube with one end on valve signal connector and other on connector on fuel control. Secure with tube nuts. Tighten nuts to recommended torque and lockwire.

NOTE

Engines incorporating intent of SB 4178 do not have a fuel pressure signal tube. Install a plug in the pressurizing and dump valve connector and another plug in the fuel control connector.

e. Position flowmeter-to-fuel control upper tube on flowmeter. Tighten tube nut to recommended torque and lockwire.

f. Install a new seal at fuel control end of fuel control-to-flowmeter lower tube.

g. Position flowmeter-to-fuel control lower tube between fuel control and upper tube. Secure lower tube to fuel control with nuts. Secure lower and upper tubes together with tube nut. Tighten nuts and tube nut to recommended torque. Lockwire tube nut.

h. Install a new seal on oil cooler end of flowmeter-to-oil cooler tube.

i. Position flowmeter-to-oil cooler tube on flowmeter outlet and oil cooler fuel inlet. Secure to oil cooler with nuts. Tighten nuts to recommended torque. Secure tube to flowmeter with torque and lockwire.

j. Position inlet air pressure sensing tube on air inlet probe (at bottom front of compressor inlet case) and on fuel control connector. Secure with tube nuts. Tighten nuts to recommended torque and lockwire.

k. Position P_{t3} pressure and sensing tube with one end of diffuser case and other end on fuel control. Secure with tube nuts. Tighten nuts to recommended torque and lockwire.

2-194. FUEL CONTROL.

2-195. REMOVAL.

CAUTION

Do not allow the fuel control to hang by driveshaft during removal as damage to shaft splines may result. Support control whenever it is not secured to fuel pump with locknuts. Flexible driveshaft assembly shall not be used as a step. Distortion and stretching of cable could induce ultimate failure.

a. Remove fuel system tubes connected to fuel control.

b. Disconnect compressor bleed actuating rod.

c. Disconnect power lever linkage from fuel control.

CAUTION

Do not wrench Holley fuel control bleed strap signal valve screw, at any time to actuate bleed strap mechanism as shearing of serration will occur in bleed actuator housing when lever and shafts are disengaged.

NOTE

Do not remove fuel control power lever position indicating quadrant from fuel control. Removal of quadrant may result in mis-indexing of mating parts and improper bleed valve operation. Proper reinstallation of these parts can be assured only through a bench calibration of control.

d. Remove locknuts securing fuel control to fuel pump and remove control.

CAUTION

Do not remove or reindex Holley fuel control dial pointer assembly. Relationship of pointer to shaft is established during bench calibration and cannot be altered in course of control rigging.

2-196. INSTALLATION.

CAUTION

Do not allow fuel control to hang by driveshaft during installation as damage to shaft splines may result. Support control whenever it is not secured to fuel pump with locknuts.

a. Place new seals on fuel inlet tube, and driveshaft end of fuel control.

b. Install control on mounting pad of pump and secure with washers and locknuts. Tighten locknuts to recommended torque.

NOTE

Do not apply lubricant to fuel control driveshaft spline.

c. Engage face-splined power-lever link with face-splined fuel control drive. Install securing nut. Apply torque of 35-45 pound-inches and lockwire nut. As required, adjust power lever linkage. See Figure 2-50A. If linkage appears excessively stiff, actuate at least 50 times to facilitate run-in of bearings.

CAUTION

When rigging power lever linkage on engines equipped with Hamilton Standard fuel controls and before tightening shaft nut, bottom index pin with head or pointer end flush against power lever shaft to ensure proper contact of index pin with power lever stop.

Do not wrench Holley fuel control bleed strap signal valve screw at any time to actuate bleed strap mechanism as shearing of serration will occur in bleed actuator housing when lever and shafts are disengaged.

d. Install fuel system tubes to fuel control.

e. Adjust and install compressor bleed valve linkage.

NOTE

Air bleed valve linkage adjustment shall be performed after each fuel control replacement.

2-196A. COMPRESSOR BLEED VALVE STRAP.

2-196B. REMOVAL (NONCRISSCROSS).

a. Disconnect electrical leads at following locations:

(1) Fuel de-icing heater actuator.

(2) Fuel pump differential pressure switch.

(3) Right-hand ignition exciter box.

b. Remove four bolts that secure fuel de-icing heater actuator to diffuser case-to-fuel de-icing heater air supply line.

c. Remove valve and actuator by slipping it out of heater.

d. Remove fuel de-icing heater attaching bolts.

NOTE

Fuel tubes should remain attached to heater.

e. Remove following (if installed):

(1) Starter-generator:

(2) Fuel control linkage.

f. Disconnect all fuel and air tubes at fuel control.

g. Disconnect bleed valve linkage at fuel control.

CAUTION

Do not wrench Holley fuel control bleed strap signal valve screw, at any time to actuate bleed strap mechanism as shearing of serration will occur in bleed actuator housing when lever and shafts are disengaged.

h. Remove locknuts securing fuel pump to gearbox and remove fuel control, fuel pump, low pressure fuel filter, and fuel de-icing heater as one unit.

CAUTION

Use care during removal to prevent disturbing fuel tubes connecting the units. Do not allow fuel control and pump to hang by pump shaft during removal as damage to shaft splines may result. Support control and pump whenever pump is not secured to gearbox with locknut.

i. Remove bleed valve linkage from bleed valve bellcrank.

j. Remove bleed valve clevis nuts, washers, and bearings.

k. Remove bolts securing bleed valve roller guide. Remove roller guide.

l. Using marking ink, or other suitable marking methods, index bellcrank with compressor case.

m. Remove bellcrank.

n. Remove pin and clevis from one end of bleed valve strap. Grasp the opposite end of strap and pull strap from engine.

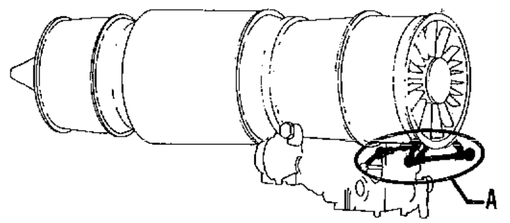
o. Remove pin from remaining clevis and remove clevis from strap.

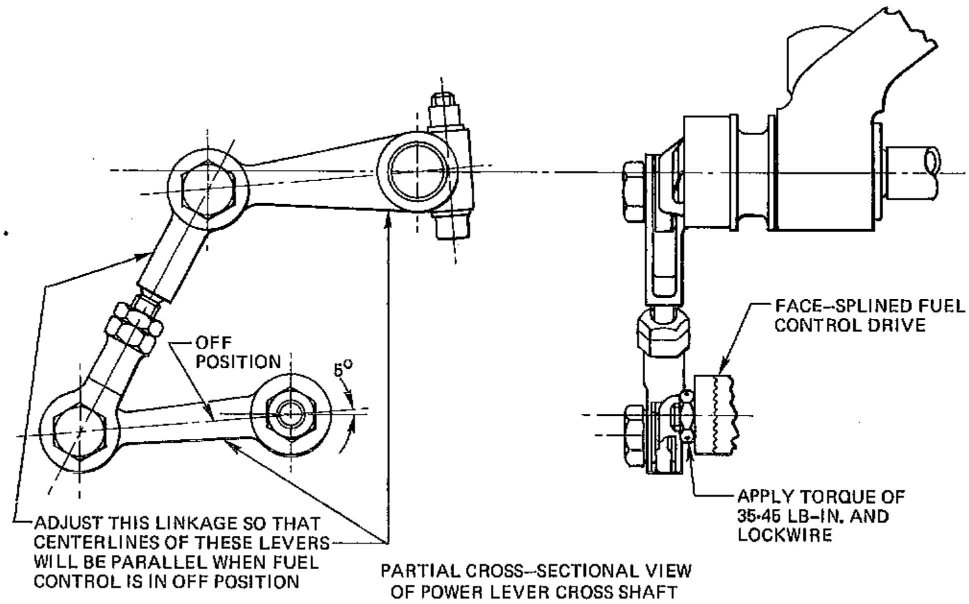
2-196C. INSTALLATION (NONCRISSCROSS). (See Tool Group 2A.)

a. Secure a clevis on one end of bleed valve strap with pin. Secure pin to clevis with lockwire. Pass opposite end of strap through bleed valve opening and around engine, engaging strap in guides located around compressor stator spacer.

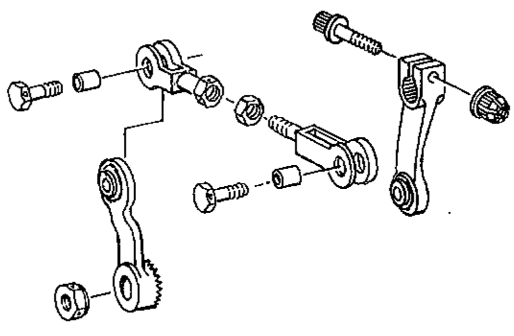
NOTE

When securing pin to clevis with lockwire, insert wire through clevis first and then through pin. Twist lockwire straight out and parallel to bleed strap.





PARTIAL CROSS-SECTIONAL VIEW
OF POWER LEVER CROSS SHAFT
VIEW A



EXPLODED VIEW OF CONTROL LINKAGES
VIEW A

L-61009

Figure 2-50A. Attaching Face-Splined Link to Fuel Control

e. Holding torque on arm, move housing assembly attached to fuel control bleed valve lever forward as far as it will go. Adjust linkage length by turning rod end clevis until holes are aligned with hole in bleed valve arm.

f. Release torque on arm and shorten linkage by turning clevis end of rod three complete revolutions. Tighten rod jamnut against housing. Torque jamnut 20 to 30 pound-inches and lockwire.

g. Secure clevis to bleed valve arm with pin and cotterpin.

2-198A. INSTALLATION (CRISSCROSS STRAP). (See Tool Group 2.)

a. Install spring and linkage assembly by threading onto rod end connector. Do not tighten jamnut.

CAUTION

Do not bend linkage during installation and adjustment.

b. Using required torque adapter and standard torque wrench, apply 200 pound-inches torque in clockwise direction to bleed valve arm.

NOTE

For engines incorporating Holley fuel control, use PWA-13376 adapter. Use PWA-13417 handle and PWA-13551 adapter for engines incorporating Hamilton Standard fuel control.

CAUTION

Care must be exercised when installing and using tools to avoid damage to adjacent tubes. Following bleed strap malfunction or replacement, inspect linkage system for wear, and check fuel control arm to ensure that rotation does not appreciably exceed normal play of about three degrees before piston movement is evidenced by feeling piston seal drag.

c. Holding torque on arm, move fuel control bleed valve lever forward as far as it will go and adjust linkage length by turning linkage assembly until holes on spring housing are aligned with hole in fuel control bleed valve lever.

NOTE

Check alignment of hole by inserting and removing applicable pin.

d. Release torque on bleed valve arm and shorten linkage by turning spring and linkage assembly two complete revolutions. Tighten rod end connector jamnut against housing to 20 to 30 pound-inches and lockwire.

NOTE

For JFTD12A-4A and -5A engines, shorten linkage by turning linkage assembly three and one-half revolutions.

e. Secure spring housing to fuel control bleed valve lever with pin and cotterpin.

2-199. POWER LEVER CROSS SHAFT.

2-199A. REMOVAL.

a. Disconnect linkage from arms at each end of power lever cross shaft.

b. Remove bolts, nuts, and washers securing cross shaft brackets to compressor inlet case and remove power lever cross shaft assembly.

c. Loosen bolts securing lever arms at each end of cross shaft and remove lever arms.

d. Remove spacer from end of cross shaft.

e. Remove brackets from cross shaft.

2-199B. INSTALLATION.

a. Position right side power lever cross shaft attaching bracket on double splined end of power lever cross shaft.

b. Position spacer on inner spline on cross shaft.

c. Position lever arm on outer spline of shaft engaging master spline of arm with master spline of shaft.

d. Tighten bolt to secure arm on shaft.

e. Position left side bracket on cross shaft.

f. Position the lever arm on the end of the shaft engaging the master spline of the arm with the master spline of the shaft.

g. Tighten the bolt to secure the bracket on the shaft.

h. Position the shaft assembly on the engine and secure to the compressor inlet case with the bolts, washers, and nuts. Tighten the nuts to the recommended torque.

2-200. FUEL DE-ICING HEATER.

2-201. REMOVAL.

a. Disconnect the electrical lead from the anti-icing valve actuator.

b. Remove the diffuser case-to-anti-icing valve air supply tube.

c. Disconnect the fuel pump-to-heater fuel pressure tube at the heater.

d. Remove the nut, washer, and bolt securing the lower front mounting lug of the heater to the compressor inlet case.

e. Remove the nut securing the rear mounting stud of the heater support.

f. Remove the bolt securing the top front lug to the compressor inlet case.

g. Pull the heater forward, disengaging the fuel outlet tube, and remove the heater.

h. Remove the fuel outlet transfer tube.

i. Remove the anti-icing valve and actuator from the heater.

2-202. INSTALLATION.

a. Insert the end of the anti-icing valve air manifold into the air inlet port in the fuel de-icing heater cover.

b. Install new seals on the fuel outlet transfer tube and insert one end of the tube into the fuel pump elbow.

c. Secure the fuel de-icing heater support to the compressor inlet case rear flange with the bolts and nuts. Tighten the nuts to the recommended torque and lockwire.

d. Position the heater support expansion-joint sleeve on the front of the support.

e. Install the sleeve spacer (ring groove forward) in the top front mounting lug of the heater. Secure with the retaining ring.

f. Install the sleeve spacer (ring groove forward) in the lower front mounting lug. Secure with the retaining ring.

g. Position the heater on the support engaging the following:

(1) The sleeve spacer (passed through the case flange) into the expansion sleeve.

(2) The top rear mounting stud of the heater, into the hole in the support flange.

(3) The fuel outlet port on the fuel outlet transfer tube.

h. Secure the top front mounting lug to the case with the bolt.

i. Install the nut on the rear mounting stud.

j. Secure the lower front mounting lug to the compressor inlet case flange with the bolt (head forward), washer, and nut.

k. Tighten the nuts and bolts to the recommended torque.

l. Secure the fuel pump-to-fuel de-icing heater fuel supply tube to the fuel inlet port of the heater with the nuts and bolts. Tighten the nuts to the recommended torque.

m. Install a new gasket on the front flange of the diffuser case-to-anti-icing valve air supply tube. Secure the rear of the air supply tube to the diffuser case boss and secure the front flange of the tube to the anti-icing valve. Tighten the bolts to the recommended torque and lockwire.

n. Connect the electrical lead to the anti-icing valve and lockwire.

2-203. FUEL PUMP.

2-204. REMOVAL.

CAUTION

Do not allow the fuel pump to hang by the drive shaft during removal as damage to the shaft splines may result. Support the pump whenever it is not secured to the gearbox.

a. Remove the fuel de-icing heater.

b. Remove the fuel control from the fuel pump.

c. Disconnect the fluid pressure differential switch lead at the switch.

d. Remove the fuel supply line from the fuel pump inlet pad.

e. Remove the locknuts securing the fuel pump to the gearbox and remove the pump.

f. Remove the fluid pressure differential switch from the pump.

2-205. INSTALLATION.

CAUTION

Do not allow the fuel pump to hang by the drive shaft during installation as damage to the shaft splines may result. Support the pump whenever it is not secured to the gearbox.

a. Place two new seals on fluid pressure differential switch and install switch on fuel pump with electrical connector facing rearward.

b. Secure switch to pump with washers and bolts. Tighten bolts to recommended torque and lockwire.

c. Apply a coating of extreme pressure lubricating grease, Plastilube Moly No. 3 or equivalent, to pump drive spline.

NOTE

Avoid using excessive amount of lubricant. Apply an even coat on spline surface with a small, clean paste brush.

CAUTION

Do not apply lubricant to fuel pump drive splines of P/N 524383 (Ceco parts list 9489), P/N 524386 (Ceco parts list 9488), and P/N 500349 (Ceco parts list 9490) fuel pumps. Splines of these controls are lubricated internally by circulation of engine oil.

d. Place new packing in ring groove in periphery of fuel pump driveshaft and install pump on mounting pad of gearbox and secure with washers and locknuts. Tighten locknuts to recommended torque.

CAUTION

Holley P/N 19A31029A fuel control burner pressure fitting shall not be removed to facilitate tightening fuel pump-to-fuel control attaching locknuts.

e. Install fuel control on mounting pad of fuel pump.

f. Connect fluid pressure differential switch lead to switch. Tighten to recommended torque and lockwire.

g. Install fuel supply line to fuel pump inlet pad.

h. Install fuel de-icing heater.

2-205A. FUEL PUMP DRIVESHAFT SEALS REPLACEMENT. (See Figure 2-50D.)

a. Remove screws, locking cups, cover, spring, washer, seal plate, universal washer, ring diaphragm assembly, and driveshaft.

b. Discard locking cups, ring, and diaphragm assembly.

c. Check sealing surface of driveshaft for scratches and/or nicks. Imperfections on this surface are cause for rejection of shaft and consequent rejection of pump.

d. Reinstall driveshaft, making sure it passes through ID of spring.

e. Install new diaphragm assembly.

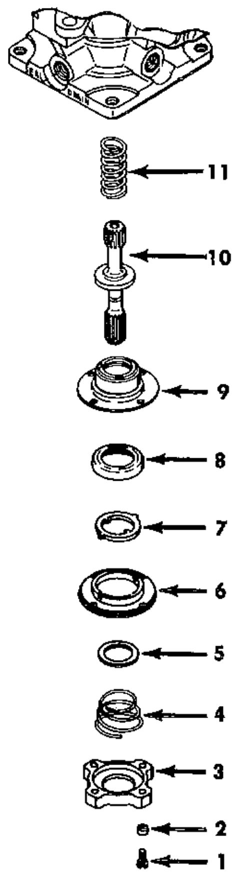
CAUTION

Protect carbon seal sealing surface at all times. Scratches, nicks, or cracks will cause leaks in this area.

f. Install new ring, universal washer, seal plate, washer, spring, cover, new locking cups and screws. Torque screws to 30 pound-inches. Wait 45 minutes and retorque screws to 30 pound-inches. Stake locking cups by bending one edge into screw slot and another edge into slot in cover.

g. Coat external splines of driveshaft with extreme pressure lubricating grease, Plastilube Moly No. 3 or equivalent.

h. Protect shaft against shock or side loads which can cause shaft seal damage prior to engine installation.



1. Screw - four required
2. Locking cup - four required
3. Driveshaft seal cover
4. Spring
5. Washer
6. Seal plate
7. Universal washer
8. Diaphragm ring
9. Diaphragm assembly
10. Main driveshaft
11. Spring

Figure 2-50D. Fuel Pump Driveshaft Seals Replacement

b. Secure remaining clevis on strap with pin. Secure pin to clevis with lockwire.

c. Using the index marks (made at disassembly) as a guide, position bellcrank with connecting links over threaded ends of strap clevises.

d. Attach extension tube to a can of dgf-123 (PWA PMC 9934-1) dry film lubricant. Spray lubricant on both sides of roller guide giving special attention to adequate coverage of bearing tracks.

e. Position roller guide on compressor inlet case, engaging threaded ends of strap clevises in roller guide slots, and with bellcrank protruding through center hole of roller guide.

f. Position a bearing, with a washer on each side, on each clevis.

g. Secure clevises to roller guide with washers and bearings in position with locknuts. Torque locknuts.

h. Secure roller guide to inlet case with bolts. Torque and lockwire bolts.

i. Attach bleed valve linkage and arm to bellcrank with stepped pin and cotterpin.

j. Install fuel control, fuel pump, low pressure fuel filter, and fuel de-icing heater as a unit by attaching fuel pump to gearbox with locknuts. Torque locknuts.

CAUTION

Use care during installation to prevent disturbing fuel tubes connecting the units. Do not allow fuel control and pump to hang by pump shaft during installation as damage to shaft splines may result. Support control and pump whenever pump is not secured to gearbox with locknuts.

k. Install bleed valve linkage on fuel control. (See paragraph 2-198 for system torquing procedure.)

CAUTION

Do not wrench Holley fuel control bleed strap signal valve screw, at any time to actuate bleed strap mechanism as shearing of serration will occur in bleed actuator housing when lever and shafts are disengaged.

l. Connect all fuel and air lines to fuel control.

m. Install starter-generator and fuel control linkage.

n. Secure fuel de-icing heater to inlet case. Torque and lockwire bolts.

o. Install fuel de-icing heater valve and actuator on fuel heater. Position a new gasket on valve flange.

p. Position diffuser case-to-de-icing heater air supply tube flange on valve flange. Secure with bolts. Torque and lockwire bolts.

q. Connect electrical leads to de-icing heater valve actuator, fuel pump differential pressure switch, and to right-hand ignition exciter. Torque and lockwire nuts.

2-196D. REMOVAL (CRISSCROSS STRAP).

a. Disconnect electrical leads at following locations:

(1) Fuel de-icing heater actuator.

(2) Fuel pump differential pressure switch.

(3) Right-hand ignition exciter box.

b. Remove four bolts that secure fuel de-icing heater actuator to diffuser case-to-fuel de-icing heater air supply line.

c. Remove valve and actuator by slipping it out of heater.

d. Remove fuel de-icing heater attaching bolts.

NOTE

Fuel tubes should remain attached to heater.

e. Remove following (if installed):

(1) Starter-generator.

(2) Fuel control linkage.

f. Disconnect all fuel and air tubes at fuel control.

g. Disconnect bleed valve linkage at fuel control.

CAUTION

Do not wrench Holley fuel control bleed strap signal valve screw, at any time to actuate bleed strap mechanism as shearing of serration will occur in bleed actuator housing when lever and shafts are disengaged.

h. Remove locknuts securing fuel pump to gearbox and remove fuel control, fuel pump, low pressure fuel filter, and fuel de-icing heater as one unit.

CAUTION

Use care during removal to prevent disturbing fuel tubes connecting the units. Do not allow fuel control and pump to hang by pump shaft during removal as damage to shaft splines may result. Support control and pump whenever pump is not secured to gearbox with locknuts.

i. Remove locknuts securing compressor bleed valve linkage arm to bleed valve arm. Remove bleed valve linkage and arm together.

j. Remove locknuts securing bearings on compressor bleed valve rigid connecting links.

k. Remove bearings and spacers.

l. Remove bolts securing bleed valve bearing guide to compressor inlet case and remove bearing guide.

m. Remove pins and cotterpins securing ends of bleed valve strap to bleed valve carriages.

n. Grasp female end of strap and pull strap free of guides.

2-196E. INSTALLATION (CRISSCROSS STRAP). (See Figures 2-50B and 2-50C.)

NOTE

If difficulty is encountered when inserting bleed strap, a metal band (obsolete non-crisscross strap, if available) placed against strap cushions will facilitate installation. After strap is in place, pull out band.

a. Thread bleed strap through rectangular opening of compressor inlet case into bleed strap compartment so that wide slotted end of strap emerges from left side of opening.

b. Cross strap ends by inserting narrow end of strap through opening in slot in wide end.

c. For free turbine engines, incorporating non-cushioned bleed strap and left and right bleed strap springs, install springs as follows:

(1) With bleed strap held taut, insert right and left springs through rectangular opening into bleed strap compartment so that springs press on outside of bleed strap.

(2) Position right and left strap supports inside sharp bends of their respective springs.

(3) Secure right spring and support to inlet case with washers and bolts. Torque and lockwire.

NOTE

Left support and spring cannot be secured until bleed valve bearing guide is installed.

d. Place clevis on each end of strap. Ensure that clevis yoke is outward and towards center of bleed valve assembly.

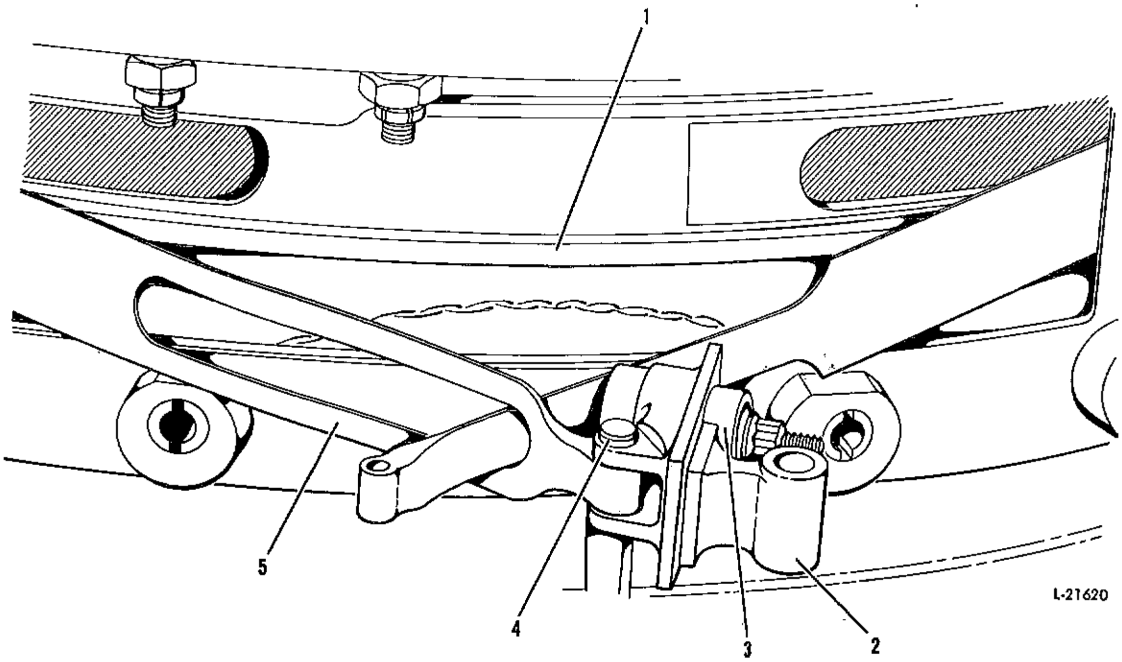
e. Insert pins through clevis and strap (head of pin at right rearward and head of pin at left forward). Secure pins with cotterpins.

f. Attach bleed valve strap lever assembly to both clevises. Ensure that lever right connecting link offset is rearward and that wide spline of bellcrank stem is rearward and to right of center. Secure left and right connecting links to clevises with spacers, bearings, and nuts. Handtighten nuts.

g. Insert lever assembly into rectangular opening in inlet case, positioning links to seat assembly properly.

h. Place compressor bleed valve bearing guide on bench with outboard side up. Install bearing into center boss and secure with retaining ring.

i. Position guide on lever assembly, inserting lever assembly bellcrank stem through guide bearing and link bearings through guide slots. Secure guide to inlet case with bolts. Fingertighten.



1. Inlet case
2. Clevis yoke
3. Connecting link bearing
4. Clevis pinhead
5. Strap

Figure 2-50B. Installing Bleed Strap into Clevis

2-206. FUEL PRESSURIZING AND DUMP VALVE.

2-207. REMOVAL.

a. Remove fuel signal tube from fuel pressurizing and dump valve.

NOTE

Engines incorporating intent of SB 4178 do not have a fuel pressure signal tube. Pressurizing and dump valve port is plugged.

b. Remove cooler-to-pressurizing and dump valve fuel tube.

c. Remove bolts securing pressurizing and dump valve to bottom of diffuser case and remove valve.

d. Remove connectors from valve.

2-208. INSTALLATION.

a. Place a new seal on each connector and install connectors in fuel pressurizing and dump valve. Tighten connectors to recommended torque.

b. Place new seals on ferrules in fuel transfer valve connector at bottom of diffuser case.

c. Position fuel pressurizing and dump valve on fuel transfer connector engaging ferrules in holes on pressurizing and dump valve.

d. Secure valve to connector with washers and bolts. Tighten bolts to recommended torque and lockwire.

e. Pressure check fuel pressurizing and dump valve parting surfaces.

f. Install fuel control-to-fuel pressurizing and dump valve fuel signal tube to connector at lower right side of valve. Tighten tube nut to recommended torque and lockwire.

NOTE

Engines incorporating intent of SB 4178 do not have a fuel pressure signal tube. Pressurizing and dump valve port is plugged.

g. Install a cap on connector on right side of valve and lockwire to plug just above.

h. Install oil-cooler-to-fuel pressurizing and dump valve fuel tube to connector on left side of valve. Tighten tube nut to recommended torque and lockwire.

2-209. PRESSURE CHECK OF PARTING SURFACES. (See Tool Group 9.)

NOTE

Combustion chambers must be removed from engine to perform this pressure check.

a. Attach fuel pressurizing and dump valve signal adapter to fuel signal connection on valve.

b. Attach fuel pressurizing and dump valve drain adapter to dump valve drain.

c. Connect fuel pressurizing and dump valve inlet adapter to inlet connector of valve.

d. Remove plug from secondary pressure tap and install adapter.

e. Install fuel nozzle sealing clamp on each fuel nozzle.

f. Connect test stand outlet ports to inlet adapter and signal adapter. Connect return port to secondary pressure tap adapter and close return port shutoff valve.

g. Supply test fluid at pressure of at least 200 psig to signal adapter to close dump valve.

h. Pressurize system through pressurizing and dump valve inlet and bleed trapped air from fuel manifolds by lifting one nozzle seal on nozzle in each manifold furthest away from pressurizing and dump valve.

i. Increase pressure at test stand to 600 psig and maintain for five minutes.

j. Inspect for leakage at following locations.

(1) Joints between fuel manifolds.

(2) Between fuel manifold and fuel transfer valve adapter.

(3) Between fuel transfer valve adapter and fuel pressurizing and dump valve.

k. After completion of inspection, connect remaining fuel return hose to dump valve adapter and shut off stand to relieve pressure.

l. Shut off inlet and signal lines and start stand.

m. Open valve on secondary pressure tap line.

n. Drain manifold of fluid using ejector in the test stand.

o. Disconnect test stand and adapters.

p. Replace secondary pressure tap plug and lockwire.

CAUTION

Do not disturb any connections that have been pressure checked.

CAUTION

Do not disturb any connections that have been pressure checked.

2-210. THERMOCOUPLE CABLE. (See Figure 2-51.)

2-111. REMOVAL.

CAUTION

In all handling and storage, thermocouple cable should be hung on racks or laid on clean table free of oil and material with which it may become entangled. Severe repeated flexing and hard bending or twisting will break or fray exposed insulation. When cable is hung on racks, care must be taken not to place any small radius bends in any part of the assemblies. Racks should be similar to a segment of a two foot diameter circle.

a. Disconnect thermocouple cable from thermocouples in turbine exhaust case.

b. Remove brackets and clips securing cable to turbine exhaust case.

c. Remove nuts and bolts securing thermocouple cable connectors to bracket on turbine case.

d. Remove thermocouple cable from turbine exhaust case.

2-212. CLEANING.

a. Clean external surfaces of cable by wiping with cloth slightly dampened with trichlorethylene solvent.

b. Clean all terminal contact surfaces (if necessary) using 400 grit emery cloth.

CAUTION

Do not leave any foreign material on terminals.

2-213. INSTALLATION.

a. Place thermocouple cable in position around turbine exhaust case and secure in position with clips.

NOTE

Always work from center of cable toward the ends.

b. Connect each branch lead to indicating thermocouple. Arrange leads in large radius bends. Tighten nuts on larger diameter thermocouple studs (alumel) to ten to 15 pound-inches; tighten nuts on smaller diameter thermocouple studs (chromel) to eight to 12 pound-inches.

CAUTION

Care must be taken not to let lead terminals turn so as to take all slack out of branch leads.

c. Install cable connectors to bracket on turbine case and secure with nuts and bolts. Tighten nuts to recommended torque.

2-214. THERMOCOUPLES.

2-215. REMOVAL.

a. Remove branch leads from thermocouples.

b. Remove bolts and nuts securing thermocouples to exhaust case and remove thermocouples. Internal cleaning of thermocouple may be accomplished by directing air blast of approximately 100 psi through small nozzle. Insert nozzle into probe exhaust holes

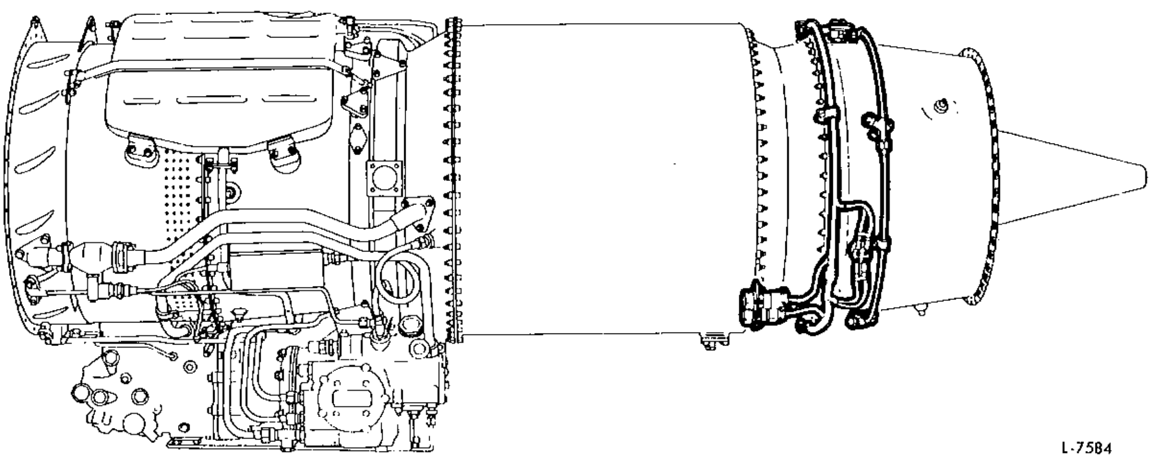


Figure 2-51. Engine Indicating Systems

b. Secure remaining clevis on strap with pin. Secure pin to clevis with lockwire.

c. Using the index marks (made at disassembly) as a guide, position bellcrank with connecting links over threaded ends of strap clevises.

d. Attach extension tube to a can of dgf-123 (PWA PMC 9934-1) dry film lubricant. Spray lubricant on both sides of roller guide giving special attention to adequate coverage of bearing tracks.

e. Position roller guide on compressor inlet case, engaging threaded ends of strap clevises in roller guide slots, and with bellcrank protruding through center hole of roller guide.

f. Position a bearing, with a washer on each side, on each clevis.

g. Secure clevises to roller guide with washers and bearings in position with locknuts. Torque locknuts.

h. Secure roller guide to inlet case with bolts. Torque and lockwire bolts.

i. Attach bleed valve linkage and arm to bellcrank with stepped pin and cotterpin.

j. Install fuel control, fuel pump, low pressure fuel filter, and fuel de-icing heater as a unit by attaching fuel pump to gearbox with locknuts. Torque locknuts.

CAUTION

Use care during installation to prevent disturbing fuel tubes connecting the units. Do not allow fuel control and pump to hang by pump shaft during installation as damage to shaft splines may result. Support control and pump whenever pump is not secured to gearbox with locknuts.

k. Install bleed valve linkage on fuel control. (See paragraph 2-198 for system torquing procedure.)

CAUTION

Do not wrench Holley fuel control bleed strap signal valve screw, at any time to actuate bleed strap mechanism as shearing of serration will occur in bleed actuator housing when lever and shafts are disengaged.

l. Connect all fuel and air lines to fuel control.

m. Install starter-generator and fuel control linkage.

n. Secure fuel de-icing heater inlet case. Torque and lockwire bolts.

o. Install fuel de-icing heater valve and actuator on fuel heater. Position a new gasket on valve flange.

p. Position diffuser case-to-de-icing heater air supply tube flange on valve flange. Secure with bolts. Torque and lockwire bolts.

q. Connect electrical leads to de-icing heater valve actuator, fuel pump differential pressure switch, and to right-hand ignition exciter. Torque and lockwire nuts.

2-196D. REMOVAL (CRISSCROSS STRAP).

a. Disconnect electrical leads at following locations:

(1) Fuel de-icing heater actuator.

(2) Fuel pump differential pressure switch.

(3) Right-hand ignition exciter box.

b. Remove four bolts that secure fuel de-icing heater actuator to diffuser case-to-fuel de-icing heater air supply line.

c. Remove valve and actuator by slipping it out of heater.

d. Remove fuel de-icing heater attaching bolts.

NOTE

Fuel tubes should remain attached to heater.

e. Remove following (if installed):

(1) Starter-generator.

(2) Fuel control linkage.

f. Disconnect all fuel and air tubes at fuel control.

g. Disconnect bleed valve linkage at fuel control.

CAUTION

Do not wrench Holley fuel control bleed strap signal valve screw, at any time to actuate bleed strap mechanism as shearing of serration will occur in bleed actuator housing when lever and shafts are disengaged.

h. Remove locknuts securing fuel pump to gearbox and remove fuel control, fuel pump, low pressure fuel filter, and fuel de-icing heater as one unit.

CAUTION

Use care during removal to prevent disturbing fuel tubes connecting the units. Do not allow fuel control and pump to hang by pump shaft during removal as damage to shaft splines may result. Support control and pump whenever pump is not secured to gearbox with locknuts.

i. Remove locknuts securing compressor bleed valve linkage arm to bleed valve arm. Remove bleed valve linkage and arm together.

j. Remove locknuts securing bearings on compressor bleed valve rigid connecting links.

k. Remove bearings and spacers.

l. Remove bolts securing bleed valve bearing guide to compressor inlet case and remove bearing guide.

m. Remove pins and cotterpins securing ends of bleed valve strap to bleed valve carriages.

n. Grasp female end of strap and pull strap free of guides.

2-196E. INSTALLATION (CRISSCROSS STRAP). (See Figures 2-50A and 2-50C.)

NOTE

If difficulty is encountered when inserting bleed strap, a metal band (obsolete non-crisscross strap, if available) placed against strap cushions will facilitate installation. After strap is in place, pull out band.

a. Thread bleed strap through rectangular opening of compressor inlet case into bleed strap compartment so that wide slotted end of strap emerges from left side of opening.

b. Cross strap ends by inserting narrow end of strap through opening in slot in wide end.

c. For free turbine engines, incorporating non-cushioned bleed strap and left and right bleed strap springs, install springs as follows:

(1) With bleed strap held taut, insert right and left springs through rectangular opening into bleed strap compartment so that springs press on outside of bleed strap.

(2) Position right and left strap supports inside sharp bends of their respective springs.

(3) Secure right spring and support to inlet case with washers and bolts. Torque and lockwire.

NOTE

Left support and spring cannot be secured until bleed valve bearing guide is installed.

d. Place clevis on each end of strap. Ensure that clevis yoke is outward and towards center of bleed valve assembly.

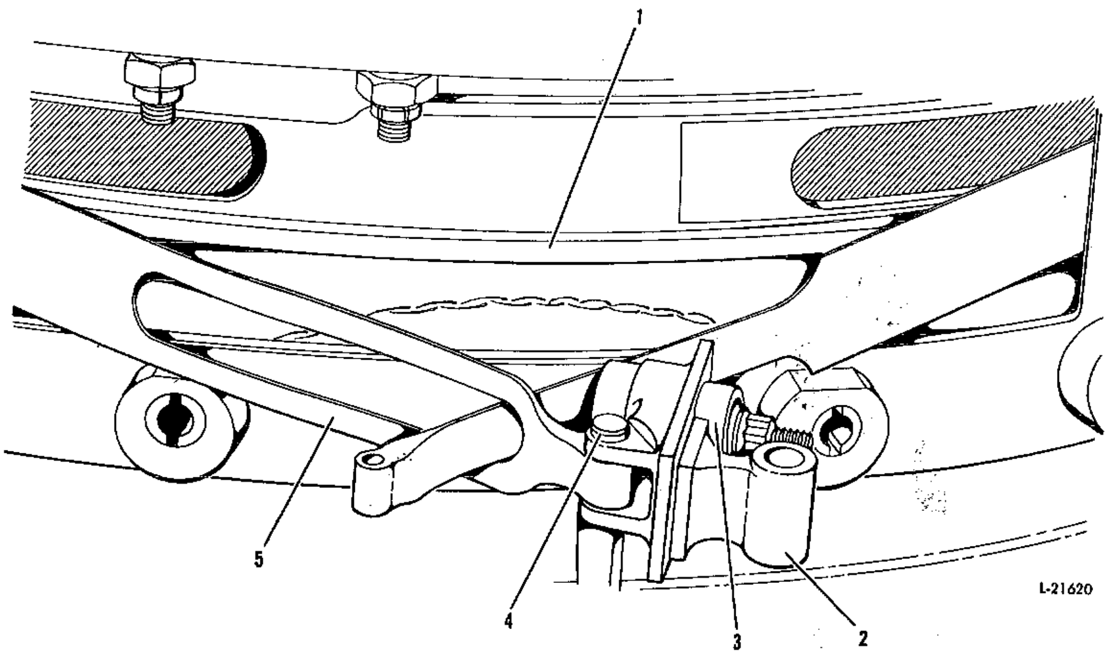
e. Insert pins through clevis and strap (head of pin at right rearward and head of pin at left forward). Secure pins with cotterpins.

f. Attach bleed valve strap lever assembly to both clevises. Ensure that lever right connecting link offset is rearward and that wide spline of bellcrank stem is rearward and to right of center. Secure left and right connecting links to clevises with spacers, bearings, and nuts. Handtighten nuts.

g. Insert lever assembly into rectangular opening in inlet case, positioning links to seat assembly properly.

h. Place compressor bleed valve bearing guide on bench with outboard side up. Install bearing into center boss and secure with retaining ring.

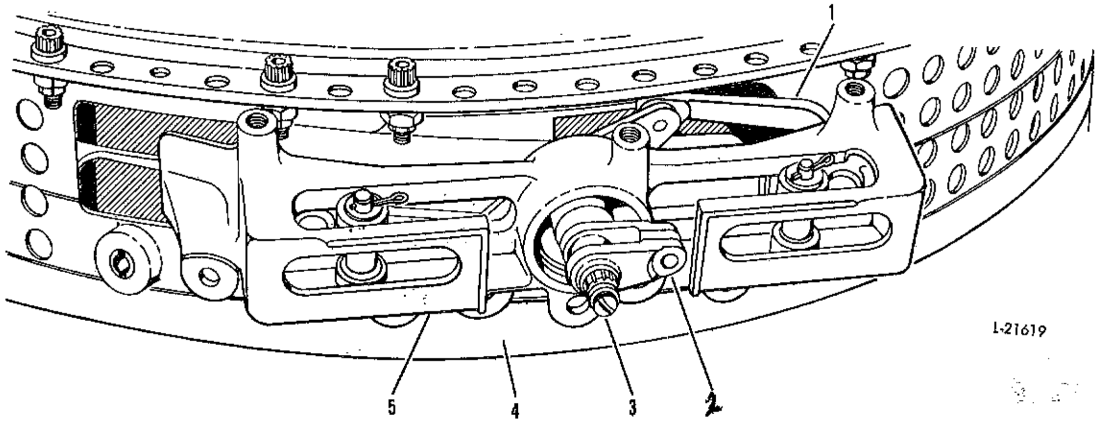
i. Position guide on lever assembly, inserting lever assembly bellcrank stem through guide bearing and link bearings through guide slots. Secure guide to inlet case with bolts. Fingertighten.



1. Inlet case
2. Clevis yoke
3. Connecting link bearing
4. Clevis pinhead
5. Strap

Figure 2-50A. Installing Bleed Strap into Clevis

Figure 2-50B. Deleted.



1. Connecting link
2. Bleed arm
3. Bellcrank stem
4. Inlet case
5. Bleed valve guide assembly

Figure 2-50C. Installing Bellcrank in Inlet Case

j. Install bearing and pin through bottom of left yoke and bearing and thrust washer on top. Secure with cotterpin. Repeat procedure for right yoke.

k. Tighten two locknuts on clevis assemblies to recommended torques.

l. Install bleed arm to splined shaft in center of guide, ensuring that splines are aligned. Install and tighten nut to recommended torque.

m. Actuate bleed strap to ensure proper assembly.

n. Tighten locknuts securing guide to inlet case. Tighten to recommended torque. If strap support and spring are being installed, secure left support and spring to bearing guide with washers, bolts, and lockwire.

NOTE

Crisscross bleed system mechanism operates entirely on antifriction bearings and should not be lubricated.

o. Attach spring and linkage assembly rod end connector (jamnut included) to bleed valve arm with bolt and nut. Tighten to recommended torque.

p. Install fuel control, fuel pump, low pressure fuel de-icing heater as unit by attaching fuel pump to gearbox with locknuts. Tighten locknuts to recommended torque.

CAUTION

Use care during installation to prevent disturbing fuel tubes connecting units. Do not allow fuel control and pump to hang by pump shaft during installation as damage to shaft splines may result. Support control and pump whenever pump is not secured to gearbox with locknuts.

q. Loosen bleed arm and pin bleed valve linkage in place. Retighten locknut securing bleed arm and torque.

r. Torque the linkage in accordance with paragraph 2-198A.

s. Connect all fuel and air lines to fuel control.

t. Install starter-generator and fuel control linkage.

u. Secure fuel de-icing heater to inlet case. Torque and lockwire bolts.

v. Install fuel de-icing heater valve and actuator on fuel heater. Position new gasket on valve flange.

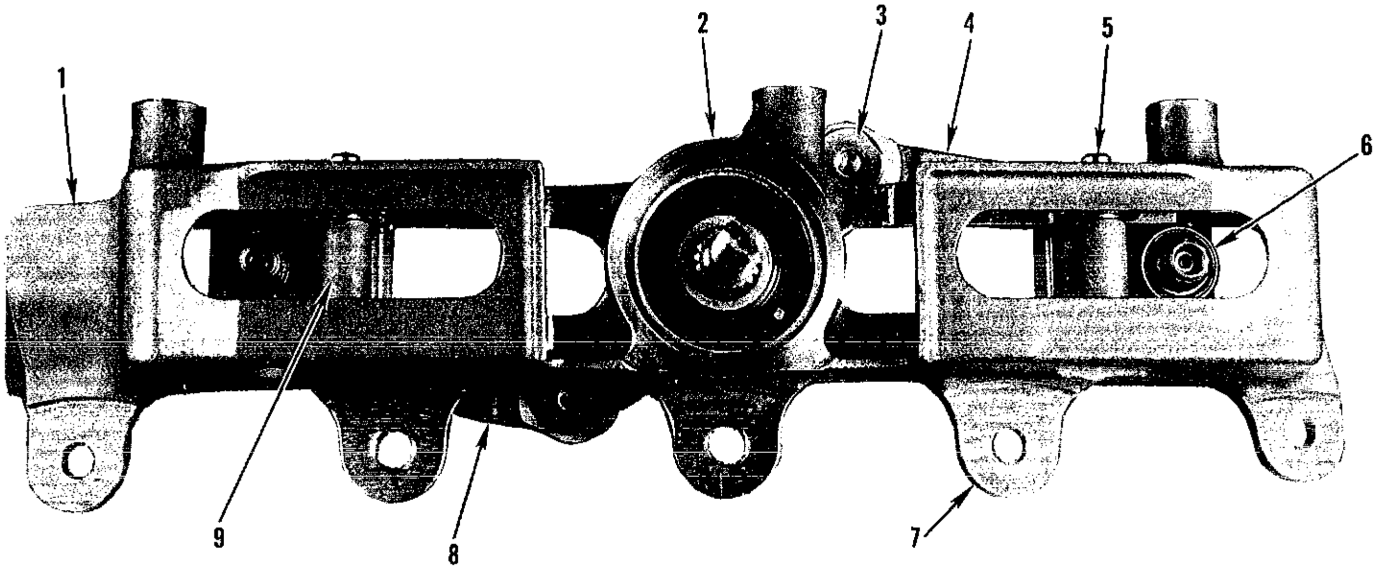
w. Position diffuser case-to-de-icing heater air supply tube flange on valve flange. Secure with bolts. Torque and lockwire.

x. Connect electrical leads to de-icing heater valve actuator, fuel pump differential pressure switch, and to right-hand ignition exciter. Torque and lockwire nuts.

2-196F. COMPRESSOR BLEED VALVE STRAP INSTALLATION - ALTERNATE PROCEDURE. (See Figures 2-50C-1, 2-50C-2, and 2-50C-3.)

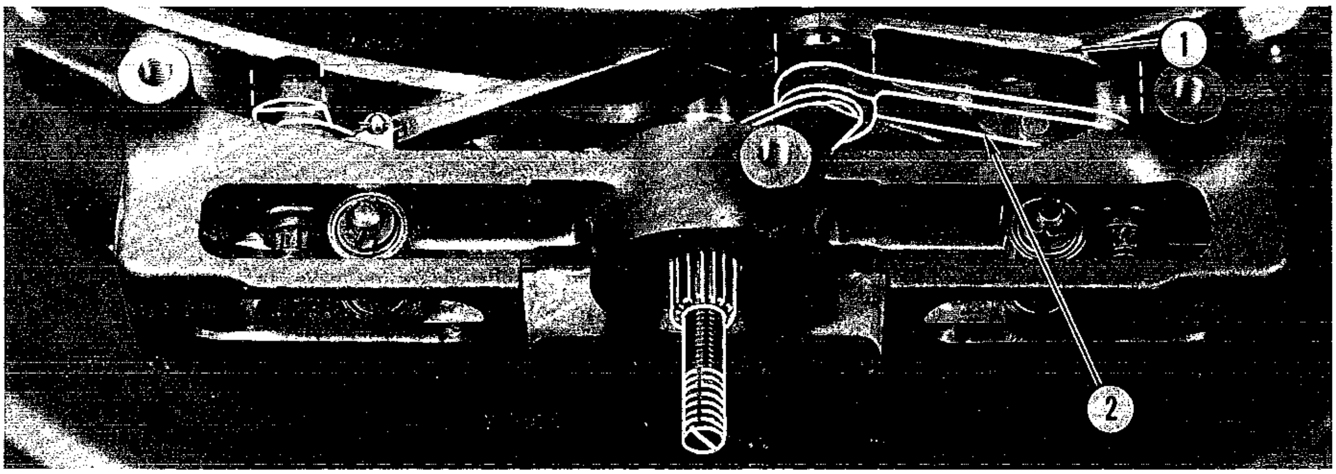
NOTE

This alternate procedure provides a means for nearly total assembly of bearing guide, clevises, and lever assembly prior to installation. This shall be performed only with inlet cases having front and rear clearance cuts in rectangular opening of bleed strap compartment.



1. Bleed strap bearing guide
2. Center boss
3. Lever
4. Right connecting link
5. Straight pin
6. Right clevis
7. Mounting lug
8. Left connecting link
9. Left clevis

Figure 2-50C-1. Assembly of Bearing Guide, Clevises, and Lever Assembly



1. Raised position
2. Seated position

Figure 2-50C-2. Bleed Valve Lever Assembly in Raised Position

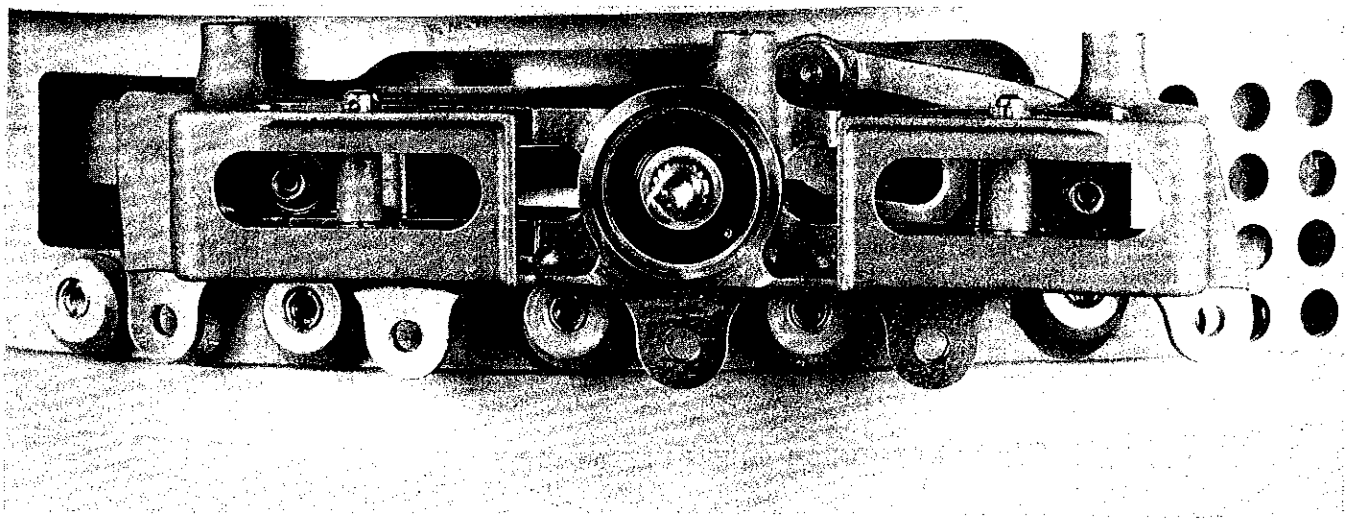


Figure 2-50C-3. Installation of Bleed Valve Lever Assembly into Inlet Case

a. Thread bleed strap through rectangular opening in compressor inlet case so that wide slotted end emerges from left side of opening.

NOTE

If difficulty is encountered when inserting bleed strap, a metal band (obsolete non-crisscross strap, if available) placed against strap cushions will facilitate installation. After strap is in place, pull out band.

b. Cross strap ends by inserting narrow end through slot in wide end.

c. For noncushioned bleed strap install right and left bleed strap springs as follows:

(1) With bleed strap held taut, insert right and left springs through rectangular opening into bleed strap compartment so that springs press on outside of bleed strap.

(2) Position right and left strap supports inside sharp bends of their respective springs.

(3) Secure right spring and support to inlet case with washers and bolts. Torque and lockwire.

NOTE

Left support and spring cannot be secured until bleed valve bearing guide is installed.

d. Place bleed valve bearing guide on bench with convex side down. Install bearing into center boss and secure with retaining ring.

e. Position right and left clevises in bearing guide so that clevis ears extend outward from convex side of guide and are adjacent to center boss.

f. Secure each clevis with two bearings, a straight pin (with head toward mounting lugs on bearing guide), washer, and cotterpin.

g. Position bleed valve guide on lever assembly, aligning center shaft on lever assembly with center boss bearing and shafts on connecting links with their respective clevis pinholes. To ensure correct assembly, see figure 2-50C-1.

h. Press lever assembly into guide far enough so that nuts may be threaded onto lever assembly to hold connecting links in clevises. Two full turns should be sufficient.

NOTE

Locknuts shall not be tightened at this time to allow for clearance required for clevis pin installation in step i. and for installation of lever assembly into bleed strap compartment.

i. Fasten assembly to bleed strap by securing ends of strap to clevises using clevis pins secured with cotterpins. Ensure that mounting lugs on guide are facing forward. Right clevis pin shall be installed with head rearward and left pin with head forward.

NOTE

Pins are installed, as above, for safety. Once clevis locknuts are tightened, connecting links will align with heads of clevis pins, preventing pins from falling out should cotterpins fail.

j. With lever assembly in raised position as shown in figure 2-50C-2, rotate lever, moving clevises outward; then with lever end aligned with front clearance cut, slip left connecting link and end of lever into rectangular opening of inlet case.

k. Move entire assembly forward and to right as shown in figure 2-50C-3 to obtain installation clearance for right connecting link; then, with lever end aligned with rear clearance cut, slip remainder of lever assembly into opening.

l. For engines incorporating bleed strap springs, secure left support and spring to bearing guide with washers, bolts, and lockwire.

m. Align bleed valve bearing guide mounting lug holes with mounting bosses on inlet case. Install bolts and handtighten.

n. Tighten locknuts on clevises to recommended torque. Ensure that during tightening procedure, lever assembly is properly seated in clevises and guide center boss bearing as shown in figure 2-50C-2.

o. Attach spring and linkage assembly rod end connector (jamnut included) to bleed valve arm with bolt and nut. Tighten to recommended torque.

p. Install bleed arm on splined shaft in center of bleed valve bearing guide ensuring that splines are aligned. Secure with nut and torque to 100 to 110 pound-inches.

q. Manually operate bleed strap assembly to ensure proper assembly.

r. Tighten bolts securing bleed valve bearing guide to inlet case.

NOTE

Crisscross bleed system mechanism operates on antifriction bearings and should not be lubricated.

2-197. COMPRESSOR AIR BLEED VALVE LINKAGE.

2-198. INSTALLATION (NONCRISSCROSS STRAP). (See Tool Group 2.)

a. Install compressor bleed valve arm (end pointing upward) on compressor valve bellcrank. Secure with bolt (head rearward) and locknut. Torque locknut.

CAUTION

Do not bend linkage during installation and adjustment.

b. Install the jamnut on rod end clevis and install clevis in the linkage spring housing.

NOTE

Do not tighten jamnut.

c. Secure housing to fuel control bleed valve lever with pin (head inboard), washer, and cotterpin.

d. Using required torque adapter and standard torque wrench, apply 200 pound-inches torque in clockwise direction to bleed valve arm.

NOTE

For engines incorporating Holley fuel control use PWA-13376 adapter. Use PWA-13417 handle and PWA-13551 adapter for engines incorporating Hamilton Standard fuel control.

CAUTION

Care must be exercised when installing and using installation tools to avoid damage to the adjacent tubes.

e. Holding torque on arm, move housing assembly attached to fuel control bleed valve lever forward as far as it will go. Adjust linkage length by turning rod end clevis until holes are aligned with hole in bleed valve arm.

f. Release torque on arm and shorten linkage by turning clevis end of rod three complete revolutions. Tighten rod jamnut against housing. Torque jamnut 20 to 30 pound-inches and lockwire.

g. Secure clevis to bleed valve arm with pin and cotterpin.

2-198A. INSTALLATION (CRISSCROSS STRAP). (See Tool Group 2.)

a. Install spring and linkage assembly by threading onto rod end connector. Do not tighten jamnut.

CAUTION

Do not bend linkage during installation and adjustment.

b. Using required torque adapter and standard torque wrench, apply 200 pound-inches torque in clockwise direction to bleed valve arm.

NOTE

For engines incorporating Holley fuel control, use PWA-13376 adapter. Use PWA-13417 handle and PWA-13551 adapter for engines incorporating Hamilton Standard fuel control.

CAUTION

Care must be exercised when installing and using tools to avoid damage to adjacent tubes. Following bleed strap malfunction or replacement, inspect linkage system for wear, and check fuel control arm to ensure that rotation does not appreciably exceed normal play of about three degrees before piston movement is evidenced by feeling piston seal drag.

c. Holding torque on arm, move fuel control bleed valve lever forward as far as it will go and adjust linkage length by turning linkage assembly until holes on spring housing are aligned with hole in fuel control bleed valve lever.

NOTE

Check alignment of hole by inserting and removing applicable pin.

d. Release torque on bleed valve arm and shorten linkage by turning spring and linkage assembly two complete revolutions. Tighten rod end connector jamnut against housing to 20 to 30 pound-inches and lockwire.

NOTE

For JFTD12A-4A and -5A engines, shorten linkage by turning linkage assembly three and one-half revolutions.

e. Secure spring housing to fuel control bleed valve lever with pin and cotterpin.

2-199. POWER LEVER CROSS SHAFT.

2-199A. REMOVAL.

a. Disconnect linkage from arms at each end of power lever cross shaft.

b. Remove bolts, nuts, and washers securing cross shaft brackets to compressor inlet case and remove power lever cross shaft assembly.

c. Loosen bolts securing lever arms at each end of cross shaft and remove lever arms.

d. Remove spacer from end of cross shaft.

e. Remove brackets from cross shaft.

2-199B. INSTALLATION.

a. Position right side power lever cross shaft attaching bracket on double splined end of power lever cross shaft.

b. Position spacer on inner spline on cross shaft.

c. Position lever arm on outer spline of shaft engaging master spline of arm with master spline of shaft.

d. Tighten bolt to secure arm on shaft.

e. Position left side bracket on cross shaft.

f. Position the lever arm on the end of the shaft engaging the master spline of the arm with the master spline of the shaft.

g. Tighten the bolt to secure the bracket on the shaft.

h. Position the shaft assembly on the engine and secure to the compressor inlet case with the bolts, washers, and nuts. Tighten the nuts to the recommended torque.

2–200. FUEL DE-ICING HEATER.

2–201. REMOVAL.

a. Disconnect the electrical lead from the anti-icing valve actuator.

b. Remove the diffuser case-to-anti-icing valve air supply tube.

c. Disconnect the fuel pump-to-heater fuel pressure tube at the heater.

d. Remove the nut, washer, and bolt securing the lower front mounting lug of the heater to the compressor inlet case.

e. Remove the nut securing the rear mounting stud of the heater support.

f. Remove the bolt securing the top front lug to the compressor inlet case.

g. Pull the heater forward, disengaging the fuel outlet tube, and remove the heater.

h. Remove the fuel outlet transfer tube.

i. Remove the anti-icing valve and actuator from the heater.

2–202. INSTALLATION.

a. Insert the end of the anti-icing valve air manifold into the air inlet port in the fuel de-icing heater cover.

b. Install new seals on the fuel outlet transfer tube and insert one end of the tube into the fuel pump elbow.

c. Secure the fuel de-icing heater support to the compressor inlet case rear flange with the bolts and nuts. Tighten the nuts to the recommended torque and lockwire.

d. Position the heater support expansion joint sleeve on the front of the support.

e. Install the sleeve spacer (ring groove forward) in the top front mounting lug of the heater. Secure with the retaining ring.

f. Install the sleeve spacer (ring groove rearward) in the lower front mounting lug. Secure with the retaining ring.

g. Position the heater on the support engaging the following:

(1) The sleeve spacer (passed through the case flange) into the expansion sleeve.

(2) The top rear mounting stud of the heater, into the hole in the support flange.

(3) The fuel outlet port on the fuel outlet transfer tube.

h. Secure the top front mounting lug to the case with the bolt.

i. Install the nut on the rear mounting stud.

j. Secure the lower front mounting lug to the compressor inlet case flange with the bolt (head forward), washer, and nut.

k. Tighten the nuts and bolts to the recommended torque.

l. Secure the fuel pump-to-fuel de-icing heater fuel supply tube to the fuel inlet port of the heater with the nuts and bolts. Tighten the nuts to the recommended torque.

m. Install a new gasket on the front flange of the diffuser case-to-anti-icing valve air supply tube. Secure the rear of the air supply tube to the diffuser case boss and secure the front flange of the tube to the anti-icing valve. Tighten the bolts to the recommended torque and lockwire.

n. Connect the electrical lead to the anti-icing valve and lockwire.

2–203. FUEL PUMP.

2–204. REMOVAL.

CAUTION

Do not allow the fuel pump to hang by the drive shaft during removal as damage to the shaft splines may result. Support the pump whenever it is not secured to the gearbox with the locknuts.

a. Remove the fuel de-icing heater.

b. Remove the fuel control from the fuel pump.

c. Disconnect the fluid pressure differential switch lead at the switch.

d. Remove the fuel supply line from the fuel pump inlet pad.

e. Remove the locknuts securing the fuel pump to the gearbox and remove the pump.

f. Remove the fluid pressure differential switch from the pump.

2–205. INSTALLATION.

CAUTION

Do not allow the fuel pump to hang by the drive shaft during installation as damage to the shaft splines may result. Support the pump whenever it is not secured to the gearbox with the locknuts.

a. Place two new seals on fluid pressure differential switch and install switch on fuel pump with electrical connector facing rearward.

b. Secure switch to pump with washers and bolts. Tighten bolts to recommended torque and lockwire.

c. Apply a coating of extreme pressure lubricating grease, Plastilube Moly No. 3 or equivalent, to pump drive spline.

NOTE

Excessive amounts of lubricant are not necessary. Apply an even coat on spline surface with a small, clean paste brush.

CAUTION

Do not apply lubricant to fuel pump drive splines of P/N 524383 (Ceco parts list 9489), P/N 524386 (Ceco parts list 9488), and P/N 500349 (Ceco parts list 9490) fuel pumps. Splines of these controls are lubricated internally by circulation of engine oil which may be retarded by application of grease.

d. Place new packing in ring groove in periphery of fuel pump driveshaft and install pump on mounting pad of gearbox and secure with washers and locknuts. Tighten locknuts to recommended torque.

CAUTION

Holley P/N 19A31029A fuel control burner pressure fitting shall not be removed to facilitate tightening fuel pump-to-fuel control attaching locknuts.

e. Install fuel control on mounting pad of fuel pump.

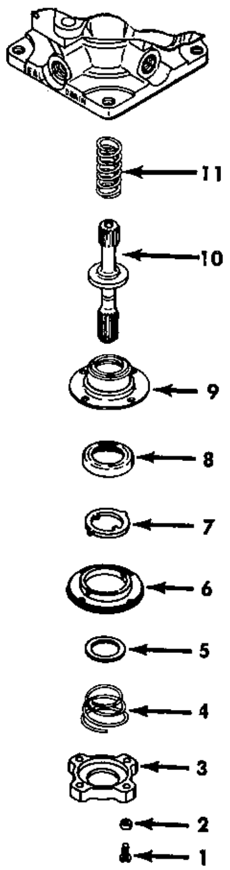
f. Connect fluid pressure differential switch lead to switch. Tighten to recommended torque and lockwire.

g. Install fuel supply line to fuel pump inlet pad.

h. Install fuel de-icing heater.

2-205A. FUEL PUMP DRIVESHAFT SEALS REPLACEMENT. (See Figure 2-50D.)

a. Remove screws, locking cups, cover, spring, washer, seal plate, universal washer, ring diaphragm assembly, and driveshaft.



1. Screw - four required
2. Locking cup - four required
3. Driveshaft seal cover
4. Spring
5. Washer
6. Seal plate
7. Universal washer
8. Diaphragm ring
9. Diaphragm assembly
10. Main driveshaft
11. Spring

Figure 2-50D. Fuel Pump Driveshaft Seals Replacement

b. Discard locking cups, ring, and diaphragm assembly.

c. Check sealing surface of driveshaft for scratches and/or nicks. Imperfections on this surface are cause for rejection of shaft and consequent rejection of pump.

d. Reinstall driveshaft, making sure it passes through ID of spring.

e. Install new diaphragm assembly.

CAUTION

Protect carbon sealing surface at all times. Scratches, nicks, or cracks will cause leaks in this area.

f. Install new ring, universal washer, seal plate, washer, spring, cover, new locking cups and screws. Torque screws to 30 pound-inches. Wait 45 minutes and retorque screws to 30 pound-inches. Stake locking cups by bending one edge into screw slot and another edge into slot in cover.

g. Coat external splines of driveshaft with extreme pressure lubricating grease, Plastilube Moly No. 3 or equivalent.

h. Protect shaft against shock or side loads which can cause shaft seal damage prior to engine installation.

a. Place two seals on fluid pressure differential switch and install switch on fuel pump with electrical connector facing rearward.

b. Secure switch to pump with washers and bolts. Tighten bolts to recommended torque and lockwire.

c. Apply a coating of extreme pressure lubricating grease, Plastilube Moly No. 3 or equivalent, to pump drive spline.

Note

Excessive amounts of lubricant are not necessary. Apply an even coat on spline surface with a small, clean paste brush.

CAUTION

Do not apply lubricant to fuel pump drive splines of P/N 524383 (Ceco parts list 9489), P/N 524386 (Ceco parts list 9488), and P/N 500349 (Ceco parts list 9490) fuel pumps. Splines of these controls are lubricated internally by circulation of engine oil which may be retarded by application of grease.

d. Install pump on mounting pad of gearbox and secure with washers and locknuts. Tighten locknuts to recommended torque.

CAUTION

Holley P/N 19A31029A fuel control burner pressure fitting shall not be removed to facilitate tightening fuel pump-to-fuel control attaching locknuts.

e. Install fuel control on mounting pad of fuel pump.

f. Connect fluid pressure differential switch lead to switch. Tighten to recommended torque and lockwire.

g. Install fuel supply line to fuel pump inlet pad.

h. Install fuel de-icing heater.

2—205A. FUEL PUMP DRIVE SHAFT SEALS REPLACEMENT.
(See ***Figure 2—50D***.)

a. Remove screws, locking cups, cover, spring, washer, seal plate, universal washer, ring diaphragm assembly, and drive shaft.

2-206. FUEL PRESSURIZING AND DUMP VALVE.

2-207. REMOVAL.

a. Remove fuel signal tube from fuel pressurizing and dump valve.

NOTE

Engines incorporating intent of SB 4178 do not have a fuel pressure signal tube. Pressurizing and dump valve port is plugged.

b. Remove cooler-to-pressurizing and dump valve fuel tube.

c. Remove bolts securing pressurizing and dump valve to bottom of diffuser case and remove valve.

d. Remove connectors from valve.

2-208. INSTALLATION.

a. Place a new seal on each connector and install connectors in fuel pressurizing and dump valve. Tighten connectors to recommended torque.

b. Place two packings on each transfer tube and install tubes in fuel pressurizing and dump valve.

c. Position pressurizing and dump valve on fuel transfer valve connector at bottom of diffuser case, aligning tubes with holes in fuel manifold.

d. Secure valve to connector with washers and bolts. Torque bolts to 75 - 85 pound-inches and lockwire.

e. Pressure check fuel pressurizing and dump valve parting surfaces.

f. Install fuel control-to-fuel pressurizing and dump valve fuel signal tube to connector at lower right side of valve. Tighten tube nut to recommended torque and lockwire.

NOTE

Engines incorporating intent of SB 4178 do not have a fuel pressure signal tube. Pressurizing and dump valve port is plugged.

g. Install a cap on connector on right side of valve and lockwire to adjacent plug.

h. Install oil-cooler-to-fuel pressurizing and dump valve fuel tube to connector on left side of valve. Tighten tube nut to recommended torque and lockwire.

2-209. PRESSURE CHECK OF PARTING SURFACES. (See Tool Group 9.)

NOTE

Combustion chambers must be removed from engine to perform this pressure check.

a. Attach fuel pressurizing and dump valve signal adapter to fuel signal connection on valve.

b. Attach fuel pressurizing and dump valve drain adapter to dump valve drain.

c. Connect fuel pressurizing and dump valve inlet adapter to inlet connector of valve.

d. Remove plug from secondary pressure tap and install adapter.

e. Install fuel nozzle sealing clamp on each fuel nozzle.

f. Connect test stand outlet ports to inlet adapter and signal adapter. Connect return port to secondary pressure tap adapter and close return port shutoff valve.

g. Supply test fluid at pressure of at least 200 psig to signal adapter to close dump valve.

h. Pressurize system through pressurizing and dump valve inlet and bleed trapped air from fuel manifolds by lifting one nozzle seal on nozzle in each manifold furthest away from pressurizing ana dump valve.

i. Increase pressure at test stand to 600 psig and maintain for five minutes.

j. Inspect for leakage at following locations.

(1) Joints between fuel manifolds.

(2) Between fuel manifold and fuel transfer valve adapter.

(3) Between fuel transfer valve adapter and fuel pressurizing and dump valve.

k. After completion of inspection, connect remaining fuel return hose to dump valve adapter and shut off stand to relieve pressure.

l. Shut off inlet and signal lines and start stand.

m. Open valve on secondary pressure tap line.

n. Drain manifold of fluid using ejector in the test stand.

o. Disconnect test stand and adapters.

p. Replace secondary pressure tap plug and lockwire.

CAUTION

Do not disturb any connections that have been pressure checked.

CAUTION

Do not disturb any connections that have been pressure checked.

2-210. THERMOCOUPLE CABLE. (See Figure 2-51.)

2-111. REMOVAL.

CAUTION

In all handling and storage, thermocouple cable should be hung on racks or laid on clean table free of oil and material with which it may become entangled. Severe repeated flexing and hard bending or twisting will break or fray exposed insulation. When cable is hung on racks, care must be taken not to place any small radius bends in any part of the assemblies. Racks should be similar to a segment of a two foot diameter circle.

a. Disconnect thermocouple cable from thermocouples in turbine exhaust case.

b. Remove brackets and clips securing cable to turbine exhaust case.

c. Remove nuts and bolts securing thermocouple cable connectors to bracket on turbine case.

d. Remove thermocouple cable from turbine exhaust case.

2-212. CLEANING.

a. Clean external surfaces of cable by wiping with cloth slightly dampened with trichlorethylene solvent.

b. Clean all terminal contact surfaces (if necessary) using 400 grit emery cloth.

CAUTION

Do not leave any foreign material on terminals.

2-213. INSTALLATION.

a. Place thermocouple cable in position around turbine exhaust case and secure in position with clips.

NOTE

Always work from center of cable toward the ends.

b. Connect each branch lead to indicating thermocouple. Arrange leads in large radius bends. Tighten nuts on larger diameter thermocouple studs (alumel) to ten to 15 pound-inches; tighten nuts on smaller diameter thermocouple studs (chromel) to eight to 12 pound-inches.

CAUTION

Care must be taken not to let lead terminals turn so as to take all slack out of branch leads.

c. Install cable connectors to bracket on turbine case and secure with nuts and bolts. Tighten nuts to recommended torque.

2-214. THERMOCOUPLES.

2-215. REMOVAL.

a. Remove branch leads from thermocouples.

b. Remove bolts and nuts securing thermocouples to exhaust case and remove thermocouples. Internal cleaning of thermocouple may be accomplished by directing air blast of approximately 100 psi through small nozzle. Insert nozzle into probe exhaust holes

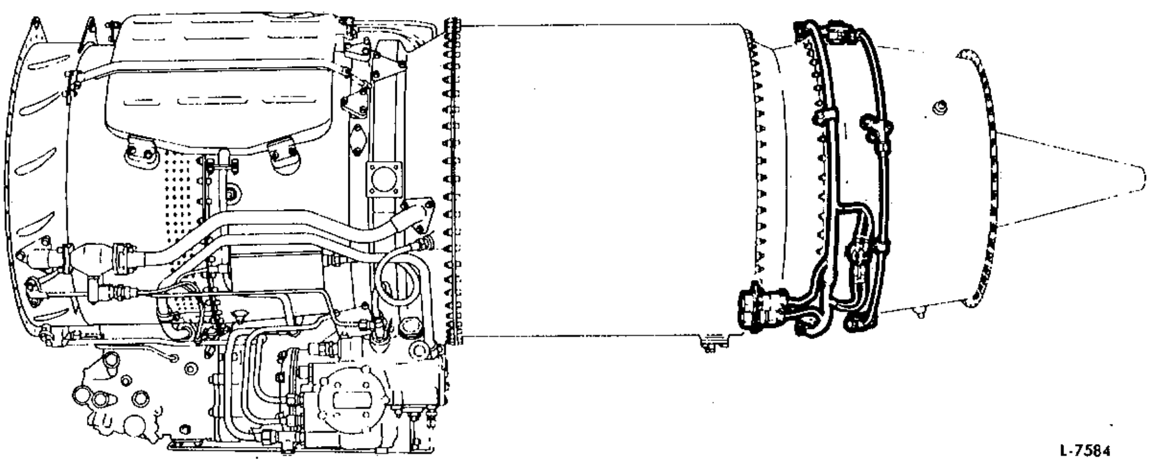


Figure 2-51. Engine Indicating Systems

2-206. FUEL PRESSURIZING AND DUMP VALVE.

2-207. REMOVAL.

a. Remove fuel signal tube from fuel pressurizing and dump valve.

b. Remove cooler-to-pressurizing and dump valve fuel tube.

c. Remove bolts securing pressurizing and dump valve to bottom of diffuser case and remove valve.

d. Remove connectors from valve.

2-208. INSTALLATION.

a. Place a new seal on each connector and install connectors in fuel pressurizing and dump valve. Tighten connectors to recommended torque.

b. Place new seals on ferrules in fuel transfer valve connector at bottom of diffuser case.

c. Position fuel pressurizing and dump valve on fuel transfer connector engaging ferrules in holes on pressurizing and dump valve.

d. Secure valve to connector with washers and bolts. Tighten bolts to recommended torque and lockwire.

e. Pressure check fuel pressurizing and dump valve parting surfaces.

f. Install fuel control-to-fuel pressurizing and dump valve fuel signal tube to connector at lower right side of valve. Tighten tube nut to recommended torque and lockwire.

g. Install a cap on connector on right side of valve and lockwire to plug just above.

h. Install oil-cooler-to-fuel pressurizing and dump valve fuel tube to connector on left side of valve. Tighten tube nut to recommended torque and lockwire.

2-209. PRESSURE CHECK OF PARTING SURFACES. (See Tool Group 9.)

NOTE

Combustion chambers must be removed from engine to perform this pressure check.

a. Attach fuel pressurizing and dump valve signal adapter to fuel signal connection on valve.

b. Attach fuel pressurizing and dump valve drain adapter to dump valve drain.

c. Connect fuel pressurizing and dump valve inlet adapter to inlet connector of valve.

d. Remove plug from secondary pressure tap and install adapter.

e. Install fuel nozzle sealing clamp on each fuel nozzle.

f. Connect test stand outlet ports to inlet adapter and signal adapter. Connect return port to secondary pressure tap adapter and close return port shutoff valve.

g. Supply test fluid at pressure of at least 200 psig to signal adapter to close dump valve.

h. Pressurize system through pressurizing and dump valve inlet and bleed trapped air from fuel manifolds by lifting one nozzle seal on nozzle in each manifold furthest away from pressurizing and dump valve.

i. Increase pressure at test stand to 600 psig and maintain for five minutes.

j. Inspect for leakage at following locations.

(1) Joints between fuel manifolds.

(2) Between fuel manifold and fuel transfer valve adapter.

(3) Between fuel transfer valve adapter and fuel pressurizing and dump valve.

k. After completion of inspection, connect remaining fuel return hose to dump valve adapter and shut off stand to relieve pressure.

l. Shut off inlet and signal lines and start stand.

m. Open valve on secondary pressure tap line.

n. Drain manifold of fluid using ejector in the test stand.

o. Disconnect test stand and adapters.

p. Replace secondary pressure tap plug and lockwire.

CAUTION

Do not disturb any connections that have been pressure checked.

CAUTION

Do not disturb any connections that have been pressure checked.

2-210. THERMOCOUPLE CABLE. (See Figure 2-51.)

2-111. REMOVAL.

CAUTION

In all handling and storage, thermocouple cable should be hung on racks or laid on clean table free of oil and material with which it may become entangled. Severe repeated flexing and hard bending or twisting will break or fray exposed insulation. When cable is hung on racks, care must be taken not to place any small radius bends in any part of the assemblies. Racks should be similar to a segment of a two foot diameter circle.

a. Disconnect thermocouple cable from thermocouples in turbine exhaust case.

b. Remove brackets and clips securing cable to turbine exhaust case.

c. Remove nuts and bolts securing thermocouple cable connectors to bracket on turbine case.

d. Remove thermocouple cable from turbine exhaust case.

2-212. CLEANING.

a. Clean external surfaces of cable by wiping with cloth slightly dampened with trichlorethylene solvent.

b. Clean all terminal contact surfaces (if necessary) using 400 grit emery cloth.

CAUTION

Do not leave any foreign material on terminals.

2-213. INSTALLATION.

a. Place thermocouple cable in position around turbine exhaust case and secure in position with clips.

NOTE

Always work from center of cable toward the ends.

b. Connect each branch lead to indicating thermocouple. Arrange leads in large radius bends. Tighten nuts on larger diameter thermocouple studs (alumel) to ten to 15 pound-inches; tighten nuts on smaller diameter thermocouple studs (chromel) to eight to 12 pound-inches.

CAUTION

Care must be taken not to let lead terminals turn so as to take all slack out of branch leads.

c. Install cable connectors to bracket on turbine case and secure with nuts and bolts. Tighten nuts to recommended torque.

2-214. THERMOCOUPLES.

2-215. REMOVAL.

a. Remove branch leads from thermocouples.

b. Remove bolts and nuts securing thermocouples to exhaust case and remove thermocouples. Internal cleaning of thermocouple may be accomplished by directing air blast of approximately 100 psi through small nozzle. Insert nozzle into probe exhaust holes

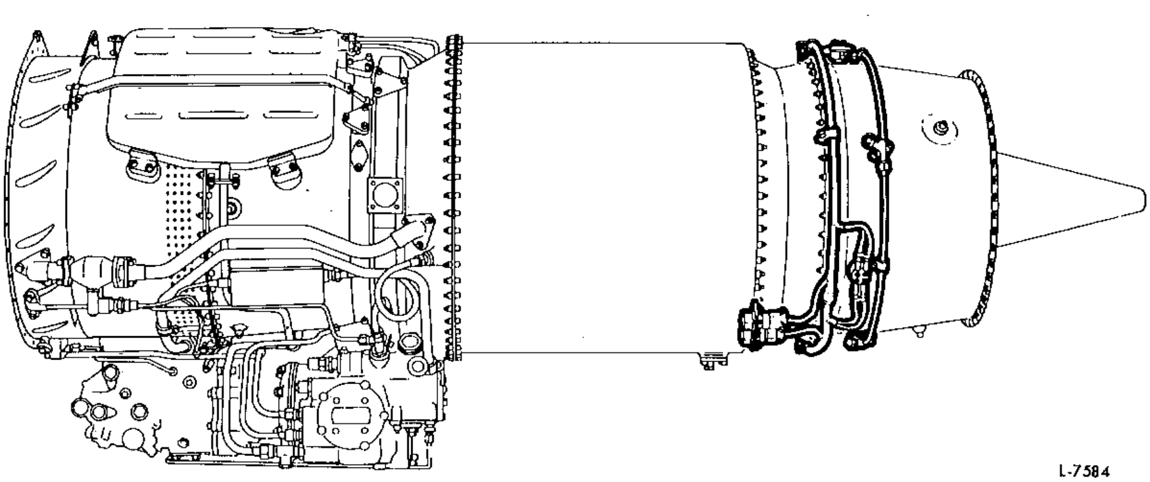


Figure 2-51. Engine Indicating Systems

and blast any carbon deposited around thermocouple lead. This carbon removal will aid in increasing insulation resistance of thermocouple.

NOTE

Form suggested nozzle from 0.040 inch ID and 0.058 inch OD stainless steel tubing. (See Figure 2-51-1.)

2-216. INSTALLATION.

a. Install thermocouples in bosses on turbine exhaust case.

b. Secure thermocouples to bosses with bolts and nuts. Tighten nuts to recommended torque.

c. Connect branch leads of thermocouple cable to thermocouples. Arrange leads in large radius bends. Tighten nuts to recommended torque.

2-217. TURBINE PRESSURE SENSING MANIFOLD.

2-218. REMOVAL.

a. Loosen manifold tube nuts at each probe.

b. Remove nuts and bolts securing manifolds to bosses on turbine exhaust case and remove manifolds.

2-219. INSTALLATION.

a. Install a manifold in each of the bosses in turbine exhaust case and secure with bolts and nuts. Tighten nuts to recommended torque.

b. Connect manifolds together with tube nuts. Tighten tube nuts to recommended torque and lockwire.

2-220. PRESSURE CHECK.

NOTE

When manifolds of turbine pressure indicating system have been removed or replaced, system must be checked for leakage.

a. Connect a source of clean dry air to manifolds.

b. Regulate air pressure at manifold to 100 psi gage pressure.

c. Check each connection with soap and water solution for leakage.

2-221. COMPONENT DRIVE GEARBOX.

2-222. REMOVAL.

a. Remove fuel system tubes.

b. Remove oil system tubes.

~~c. Remove fuel pump and fuel control.~~

d. Remove nuts and spacers securing gearbox mount bolts to diffuser case.

e. Support gearbox and remove bolts securing gearbox to diffuser case. Remove gearbox.

f. Remove main component drive tower shaft and positioning adapter from diffuser case.

2-223. INSTALLATION.

a. Position main component drive tower shaft in opening in bottom of diffuser case so that external splines in shaft engage splines in main component drive coupling.

b. Place a packing in each of the grooves in positioning adapter and insert adapter in opening in bottom of diffuser case.

c. Position gearbox on adapter so that splines of tower shaft engage internal splines of gearbox bearing adapter and mounting holes are between mounting lugs on diffuser case.

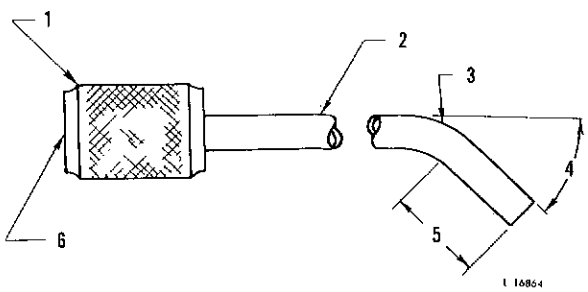
d. Insert two mount bolts (heads to rear) through mounting lugs and holes.

e. Secure mount bolts with washers and locknuts. Tighten locknuts to recommended torque.

CAUTION

Compressor must never be rotated in counterclockwise (view from rear of engine) direction.

f. Install turning adapter on starter drive gearshaft. Install suitable handle on adapter and slowly turn to rotate compressor and turbine. While rotating, check for any evidence of internal rubbing or binding.



1. Standard connector
2. 0.040 inch ID to 0.058 inch OD tube
3. 0.250 radius
4. 45°
5. 0.200 inch
6. 100 psig air pressure applied here

Figure 2-51-1. Thermocouple Probe Cleaner

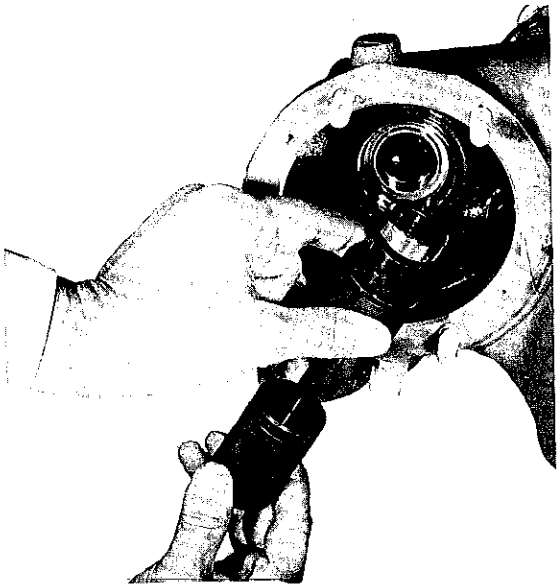


Figure 2-51A. Breather Oil Seal Removal

g. Install fuel pump and fuel control.

h. Install fuel system tubes.

i. Install oil system tubes.

2-223A. OIL PRESSURE RELIEF VALVE.

2-223B. REMOVAL.

a. Remove main oil pressure relief valve cap and gasket.

b. Remove relief valve from gearbox housing.

c. Remove gasket and seal from relief valve housing.

d. Back off nut on valve set screw and back out screw to relieve spring pressure.

e. Drill out rivet securing relief valve seat retainer to valve housing and screw out retainer.

f. Remove seat, spring, and set screw from valve housing; then remove packing from seat.

2-223C. INSPECTION.

a. Inspect detail parts of relief valve. (See Table of Limits.) Inspect mating sliding surfaces for grooves, scoring or steps. Replace worn part.

b. Required surface finish for all sliding surfaces is 10 RMS.

c. At each inspection, unless parts meet required finish, polish sliding surfaces of valve housing and cylinder with No. 400 crocus cloth soaked in oil. After polishing, clean thoroughly with petroleum solvent.

2-223D. INSTALLATION.
(See figure 2-35.)

a. Install set screw through ID of pressure relief valve housing and thread nut on set screw.

b. Install cylinder and spring; then place packing in recess on seat and install seat.

c. Install seat retainer full depth into valve housing.

NOTE

Back off seat retainer to align rivet hole, if necessary.

d. Install retaining rivet, rivet head toward OD, and flare rivet at ID. For PN 488661 and 511847 valve assemblies, use PN 488355 rivet. For PN 745113 and 745114 valve assemblies, use PN 745112 rivet.

e. Install gasket and relief valve cap on valve.

NOTE

Do not tighten cap until after relief valve pressure has been established at engine test.

f. Install gasket and seal on relief valve housing and thread housing into gearbox. Tighten valve until all sealing surfaces are in contact, then turn through angle of 180 degrees.

2-224. FLUID POWER PUMP DRIVE OIL SEAL.
(See Tool Group 5.)

2-225. REMOVAL.

a. Remove screws securing fluid power pump shaft bearing support to gearbox housing.

b. Move adjustable jaw of oil seal puller outward and engage fixed jaw in puller groove of support.

c. Position movable jaw in puller groove and secure in position. Remove support from housing.

d. Position support, front face up, on a bench and drift seal from support.

2-226. INSTALLATION.

a. Position fluid power pump shaft bearing support, bearing liner up, on seal assembly base.

b. Place fluid power pump driveshaft seal on seal assembly drift.

NOTE

Use PWA 13617 drift for PN 511196 and PN 511197.

c. Insert pilot of drift into hole in base and press seal into support.

d. Place guide in splined end of fluid power pump drive gearshaft.

e. Install new preformed packing in groove of support and position support over guide. Tap support into gearbox aligning holes in support with screw holes in housing.

f. Secure fluid power pump support to gearbox housing with screws.

2-227. BREATHER OIL SEAL.
(See Tool Group 1.)

2-228. REMOVAL.
(See Figure 2-51A.)

a. Remove fluid power pump gearshaft (with bearings) from gearbox.

b. Insert breather seal puller with jaws collapsed, into gearbox housing and through ID of breather oil seal.

c. Turn knurled nut until puller jaws engage seal and remove seal.

2-229. INSTALLATION.
(See Figure 2-51B.)

a. Position breather oil seal in breather seal drift so protruding carbon enters cavity of drift. Tap seal into liner in gearbox.

b. Coat gearshaft bearing rollers with petrolatum, Federal Specification VV-P-236.

c. Install gearshaft in gearbox, meshing gears and positioning bearing rollers as required.

2-230. FUEL CONTROL DRIVE OIL SEAL.
(See Tool Group 6.)

2-231. REMOVAL.

a. Remove locknut securing fuel control drive bearing support to gearbox.

b. Move adjustable jaw of seal puller outward and engage fixed jaw on lip of fuel control drive bearing support.

c. Position movable jaw and secure in position. Remove support from gearbox.

d. Position support (front face up) on bench and drift seal from support.

e. Install washer and locknut on stud at six o'clock position. Tighten locknut to recommended torque.

2-232. INSTALLATION.

a. Position fuel control drive bearing support (bearing liner up) on shaft seal base and place seal in shaft seal drift. Press seal into bearing support.

NOTE

Use PWA-13618 drift for P/N 511199 and P/N 511200.

b. Install new preformed packing in groove in support.

c. Place shaft seal guide in fuel control driveshaft and position support over guide. Tap support into gearbox.

2-233. STARTER-GENERATOR DRIVE OIL SEAL.
(See Tool Group 17.)

2-234. REMOVAL.
(See Figure 2-51C.)

a. Remove screws securing starter-generator drive bearing support to gearbox housing.

b. Move adjustable jaw of oil seal puller outward and engage fixed jaw under support.

c. Position movable jaw in puller groove and secure in position. Remove support from housing.

d. Position support (front face up) on a bench and drift seal from support.

2-235. INSTALLATION.
(See Figure 2-51D.)

a. Position starter-generator driveshaft bearing support (bearing liner up) on shaft seal base.

NOTE

Use PWA-13617 drift for P/N 511196 and P/N 511197. Use PWA-13718 drift with carbon seals. When installing carbon seals, lubricate seal face with engine lubricating oil, PWA-521B.

b. Place starter-generator drive oil seal on shaft seal drift. Position pilot of drift in hole in base. Press seal into support.

c. Place a new preformed packing in groove in support.

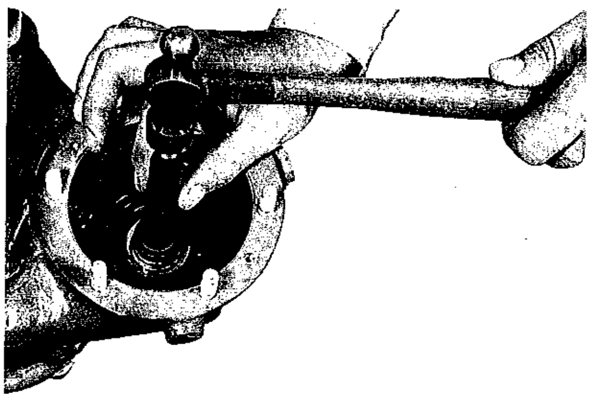


Figure 2-51B. Breather Oil Seal Installation

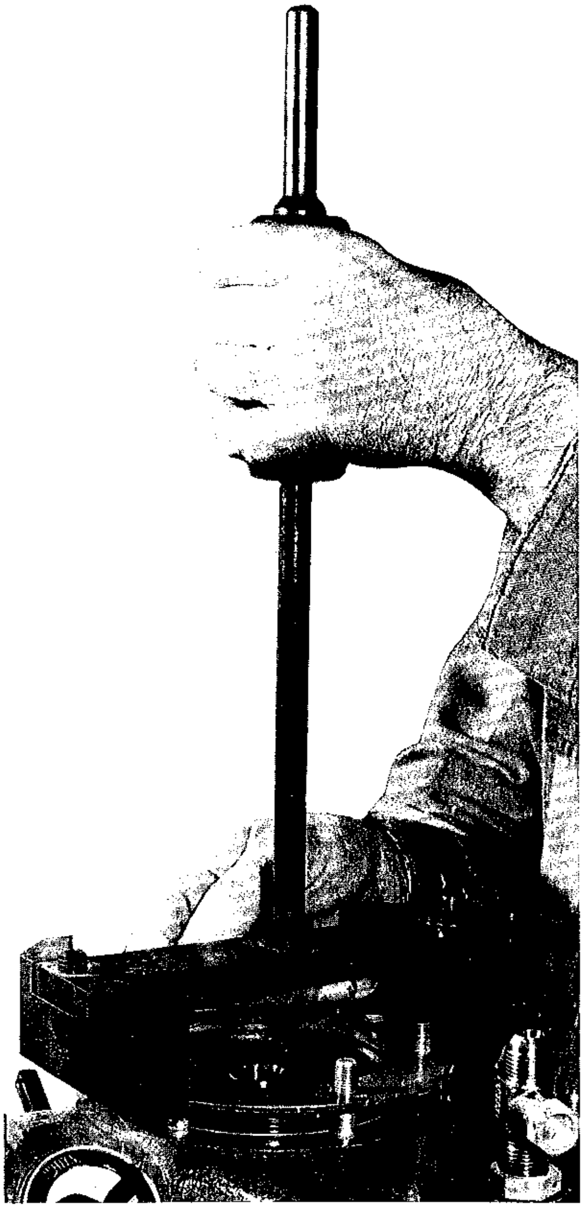


Figure 2-51C. Starter-Generator Oil Seal Removal

d. Place shaft seal guide on starter-generator drift shaft and position support over guide. Tap support into position aligning holes in support with screw holes in housing.

e. Secure support to gearbox housing with screws.

2-235A. TACHOMETER DRIVE OIL SEAL. (See Tool Group 18.)

2-235B. REMOVAL.

a. Remove retaining ring securing oil seal housing to tachometer drive support.

b. Insert jaws of puller through scallops in seal housing.

c. Turn puller to engage jaws with underside of housing and remove housing.

d. Drive seal from housing.

2-235C. INSTALLATION.

a. Place seal housing in cavity of base.

b. Position seal on seal housing.

c. Insert pilot of drift into base and press seal into housing.

NOTE

Use PWA 13048 drift for PN 365463.

d. Install new packing in seal housing groove.

e. Install seal housing and secure with retaining ring.

2-235D. COMPRESSOR INLET CASE. (See Tool Group 9B and 10A.)

2-235E. REMOVAL.

CAUTION

PWA 13489 stand adapter is designed to support engine with free turbine section removed. Free turbine oil breather tube, N_2 cable, and both igniter plug cables must be removed from engine prior to placing engine in stand incorporating adapter.

a. Position engine horizontally in adapter on build stand, per paragraph 4-2A, using rear mount. Secure PWA 13061 plate to inlet case with mount lug of plate at six o'clock position and lifting holes at 2 and 10 o'clock positions.

b. Disconnect electrical harness.

c. Remove following assemblies per procedures in this section.

(1) Oil tank.

(2) No. 1 bearing external oil tubes and manifold (pressure, scavenge and breather lines).

(3) Fuel - oil cooler and tubes.

(4) Anti-icing system.

(5) Power lever cross shaft.

(6) Fuel anti-icing system.

(7) Low pressure fuel filter (if applicable).

(8) Compressor bleed valve-to-fuel control linkage.

(9) Fuel control and fuel pump.

(10) Compressor air bleed valve and strap.

(11) Inlet air pressure probe and tube (or cover, as applicable).

(12) Ignition exciter (if applicable).

(13) Directional control valve and tubes (if applicable).

(14) Inlet nose cone (if applicable).

d. Remove nuts securing compressor inlet case cover, and remove cover and seal.

e. Install shim stock between first stage compressor blade tips and ID of compressor vane outer shroud at one, five, seven, and 11 o'clock positions.

f. Wrap PWA 13320 heater around inlet case and apply heat to case.

g. Remove bolts securing inlet case to diffuser case.

h. Using rubber mallet, tap PWA 13061 plate until case separates from compressor stator spacer.

NOTE

No. 1 bearing outer race, retaining nut, and bearing housing will come off with inlet case.

i. Remove inlet case. Remove heater from case.

j. Remove nuts securing No. 1 bearing oil nozzle. Remove oil nozzle and gasket. Discard gasket.

k. Remove nuts securing No. 1 bearing housing and remove housing, outer race, and retaining nut as one unit.

l. Remove all brackets and other hardware from inlet case.

2-235F. INSTALLATION.

a. Place engine in horizontal position, using PWA 13060 stand and PWA 13489 adapter, per paragraph 2-235D.

b. Install new packing on rear side of No. 1 bearing housing mounting flange. Lubricate packing with engine oil.

c. Install bearing housing (with outer race and nut) in compressor inlet case, aligning offset hole in housing with offset stud in case mounting flange. Secure bearing housing with drilled nuts. Tighten nuts to required torque. Lockwire.

d. Wrap PWA 13320 heater around inlet case and apply heat to case.

CAUTION

Use extreme caution when guiding No. 1 bearing outer race over bearing rollers when installing compressor inlet case.

e. Guide inlet case over compressor rotor, aligning offset lug on case ID with offset slot in fourth stage stator spacer, and engaging lugs in case with slots in spacer. Remove heater, remove shims under compressor blade tips.

f. Install bolts securing inlet case to diffuser case. Torque to required limits.

g. Install new packing on inlet case cover. Lubricate packing with engine oil. Install cover on inlet case and secure with washers and nuts. Tighten nuts to required torque. Lockwire.

h. Install following assemblies per procedures in this section.

(1) Inlet nose cone (if applicable).

(2) Directional control valve and tubes (if applicable).

(3) Ignition exciter (if applicable).

(4) Inlet air pressure probe and tube (or cover, as applicable).

(5) Compressor air bleed valve and strap.

(6) Fuel control and fuel pump.

(7) Compressor bleed valve-to-fuel control linkage.

(8) Fuel anti-icing system.

(9) Low pressure fuel filter (if applicable).

(10) Power lever cross shaft.

(11) Anti-icing system.

(12) Fuel-oil cooler and tubes.

(13) Oil tank.

(14) No. 1 bearing external oil tubes and manifold (pressure, scavenge, and breather lines).

i. Install remaining hardware on case.

2-236. COMBUSTION CHAMBER OUTER CASE.

2-237. REMOVAL.

a. Remove thermocouples, cables, and turbine pressure sensing manifolds.

b. Remove bolts and locknuts securing combustion chamber case to diffuser case rear flange.

c. Remove locknuts securing case to turbine case front flange.

d. Remove screws from jackscrew holes in combustion chamber outer case rear flange.

e. Insert jackscrews in jackscrew holes in combustion chamber case rear flange and in diffuser case flange. Turn jackscrew to loosen case.

f. Slide case rearward over turbine and exhaust cases.

g. Remove jackscrews and install screws in jackscrew holes in case.

2-238. INSTALLATION.

NOTE

If there is reason to anticipate air leakage at combustion chamber outer case front flange either due to prior engine testing or evidence of poor fit, apply sealant as described in paragraph 2-238A.

a. Position combustion chamber case on diffuser case rear flange so that offset hole in diffuser case rear flange is aligned with offset hole in combustion chamber case front flange.

b. Secure combustion chamber case to diffuser case with bolts and locknuts and to turbine case with locknuts. Tighten locknuts to recommended torque.

c. Install thermocouples, cable, and turbine pressure sensing probes on turbine exhaust case.

2-238A. COMBUSTION CHAMBER OUTER CASE FRONT FLANGE SEALANT APPLICATION. If there is reason to anticipate leakage problem apply sealant as follows; otherwise, procedure is optional.

a. Thoroughly clean rear surface of diffuser case rear flange with acetone and allow to dry for 30 minutes.

b. Apply Dow Corning 92-024 sealant to diffuser case flange just prior to mating of diffuser and combustion chamber cases.

NOTE

Sealant may be applied by hand. Primers need not be used to improve bonding.

2-239. COMBUSTION CHAMBERS.

2-240. REMOVAL.

a. Remove igniter plugs from diffuser case.

b. Remove combustion chamber case.

c. Remove retaining ring securing two sections of combustion chamber retaining ring segments to No. 1 combustion chamber and fuel nozzle air swirl guide. Remove split segments.

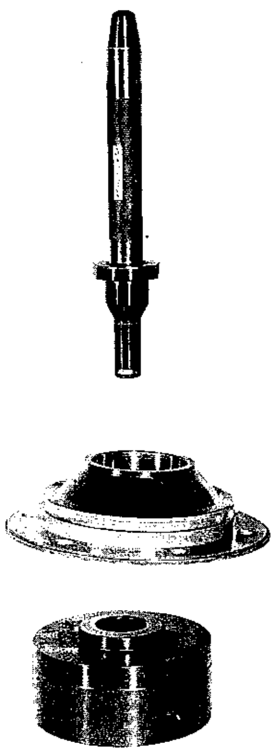


Figure 2-51D. Starter-Generator Drift, Bearing Support, and Base

d. Remove clamp securing rear of No. 1 combustion chamber to outlet duct.

e. Remove No. 1 combustion chamber.

f. Remove remaining combustion chambers in same manner.

NOTE

Nos. 1, 3, 5, and 7 combustion chambers must be removed prior to removing Nos. 2, 4, 6, and 8 combustion chambers.

2-241. INSTALLATION.

CAUTION

Combustion chambers incorporating front 360 degrees air scoop are not permitted. (See Service Bulletin No. 1584.)

a. Apply antiseize compound, Ease-Off 990, or equivalent to combustion chamber outlet duct in areas that mate with combustion chamber clamps.

CAUTION

Inspect combustion chambers and identify those marked with the numeral 1 or 8, on the combustion chamber dome. (See Service Bulletin No. 4414.) Install combustion chambers, identified with the numerals 1 and 8, at the No. 1 and No. 8 combustion chamber locations, respectively. Failure to do may result in hot section distress.

b. Position No. 2 combustion chamber on fuel nozzle air swirl guide and against outlet duct.

c. Place retaining clamp around rear of combustion chamber and outlet duct. Coat retaining clamp bolt threads with Fel-Pro C-200, and install bolt but do not tighten.

d. Position the two sections of retaining ring segments over air swirl guide and combustion chamber fuel nozzle cup adapter and secure in place with retaining ring.

CAUTION

Check retaining ring for proper fit in segment grooves. Replace any distorted rings.

e. Tighten retaining clamp bolts to 30 to 40 pound-inches and lockwire.

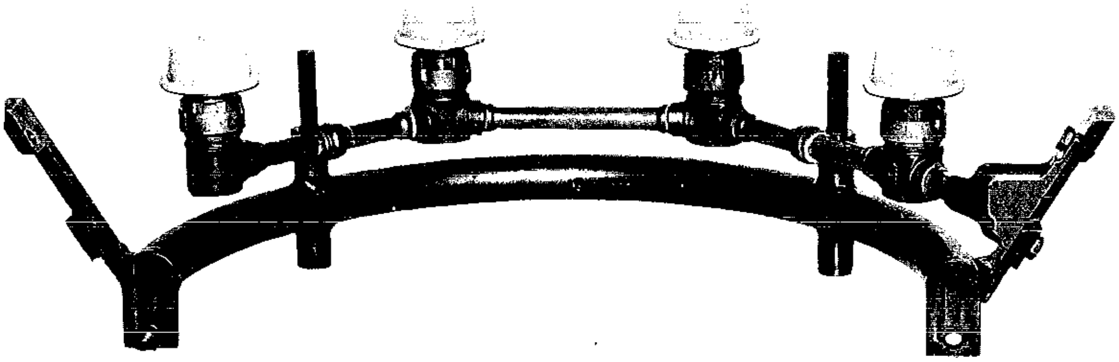


Figure 2-51E. Fuel Manifold in Holding Fixture

f. Install remaining combustion chambers in same manner.

NOTE

Nos. 2, 4, 6, and 8 combustion chambers must be installed prior to installing Nos. 1, 3, 5, and 7 combustion chambers.

g. Install combustion chamber case.

h. Install igniter plugs in diffuser case.

2-242. FUEL MANIFOLDS.

2-243. REMOVAL.
(See Tool Group 6A.)

a. Remove thermocouples, cable, and turbine pressure sensing manifolds.

b. Remove combustion chamber case.

c. Remove combustion chambers.

d. Remove fuel pressurizing and dump valve.

e. Remove screws securing fuel transfer valve connector to fuel manifolds and remove connector.

f. Remove bolts securing the right and left fuel manifolds to diffuser case and remove manifolds and spacers.

g. Install right and left fuel manifolds in fuel manifold holding fixtures. (See Figure 2-51E.)

CAUTION

Care must be taken during all handling and storage to prevent distortion of manifolds.

2-244. INSTALLATION.

a. Position right and left fuel manifolds into

Figure 2-51F. Crimping Air Swirl Guide Lock

b. Secure combustion chamber case to diffuser case with bolts and locknuts and to turbine case with locknuts. Tighten locknuts to recommended torque.

c. Install thermocouples, cable, and turbine pressure sensing probes on turbine exhaust case.

2-238A. COMBUSTION CHAMBER OUTER CASE FRONT FLANGE SEALANT APPLICATION. If there is reason to anticipate leakage problem apply sealant as follows; otherwise, procedure is optional.

a. Thoroughly clean rear surface of diffuser case rear flange with acetone and allow to dry for 30 minutes.

b. Apply Dow Corning 92-024 sealant to diffuser case flange just prior to mating of diffuser and combustion chamber cases.

NOTE

Sealant may be applied by hand. Primers need not be used to improve bonding.

2-239. COMBUSTION CHAMBERS.

2-240. REMOVAL.

a. Remove igniter plugs from diffuser case.

b. Remove combustion chamber case.

c. Remove retaining ring securing two sections of combustion chamber retaining ring segments to No. 1 combustion chamber and fuel nozzle air swirl guide. Remove split segments.

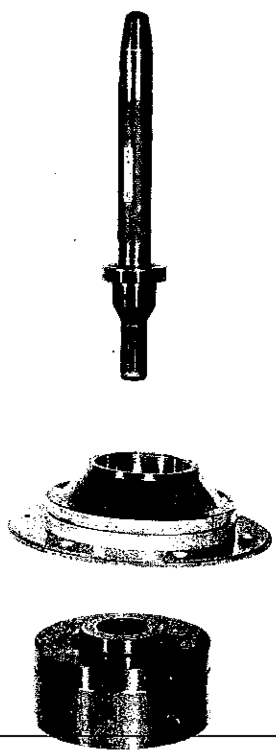


Figure 2-51D. Starter-Generator Drift, Bearing Support, and Base

d. Remove clamp securing rear of No. 1 combustion chamber to outlet duct.

e. Remove No. 1 combustion chamber.

f. Remove remaining combustion chambers in same manner.

NOTE

Nos. 1, 3, 5, and 7 combustion chambers must be removed prior to removing Nos. 2, 4, 6, and 8 combustion chambers.

2-241. INSTALLATION.

CAUTION

Combustion chambers incorporating front 360 degrees air scoop are not permitted. (See Service Bulletin No. 1584.)

a. Apply antiseize compound, Ease-Off 990, or equivalent to combustion chamber outlet duct in areas that mate with combustion chamber clamps.

CAUTION

Inspect combustion chambers and identify those marked with the numeral 1 or 8, on the combustion chamber dome. (See Service Bulletin No. 4414.) Install combustion chambers, identified with the numerals 1 and 8, at the No. 1 and No. 8 combustion chamber locations, respectively. Failure to do may result in hot section distress.

b. Position No. 2 combustion chamber on fuel nozzle air swirl guide and against outlet duct.

c. Place retaining clamp around rear of combustion chamber and outlet duct. Coat retaining clamp bolt threads with Fel-Pro C-200, and install bolt but do not tighten.

d. Position the two sections of retaining ring segments over air swirl guide and combustion chamber fuel nozzle cup adapter and secure in place with retaining ring.

CAUTION

Check retaining ring for proper fit in segment grooves. Replace any distorted rings.

e. Tighten retaining clamp bolts to 30 to 40 pound-inches and lockwire.

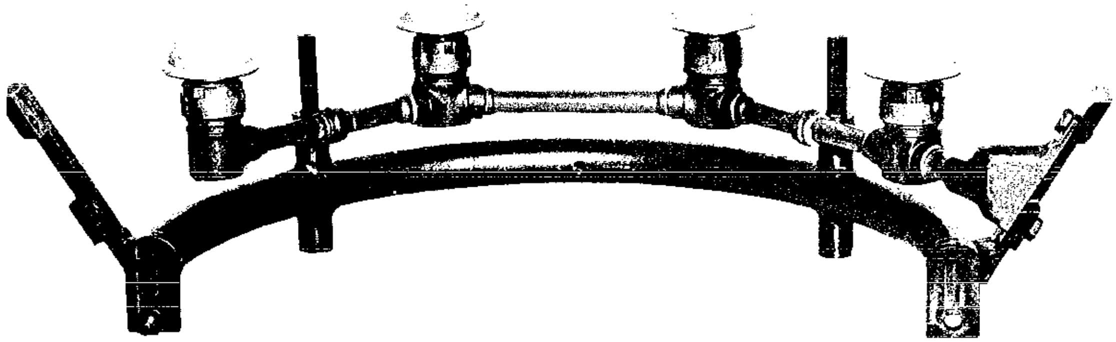


Figure 2-51E. Fuel Manifold in Holding Fixture

f. Install remaining combustion chambers in same manner.

NOTE

Nos. 2, 4, 6, and 8 combustion chambers must be installed prior to installing Nos. 1, 3, 5, and 7 combustion chambers.

g. Install combustion chamber case.

h. Install igniter plugs in diffuser case.

2-242. FUEL MANIFOLDS.

2-243. REMOVAL.
(See Tool Group 6A.)

a. Remove thermocouples, cable, and turbine pressure sensing manifolds.

b. Remove combustion chamber case.

c. Remove combustion chambers.

d. Remove fuel pressurizing and dump valve.

e. Remove screws securing fuel transfer valve connector to fuel manifolds and remove connector.

f. Remove bolts securing the right and left fuel manifolds to diffuser case and remove manifolds and spacers.

g. Install right and left fuel manifolds in fuel manifold holding fixtures. (See Figure 2-51E.)

CAUTION

Care must be taken during all handling and storage to prevent distortion of manifolds.

2-244. INSTALLATION.

a. Position right and left fuel manifolds into

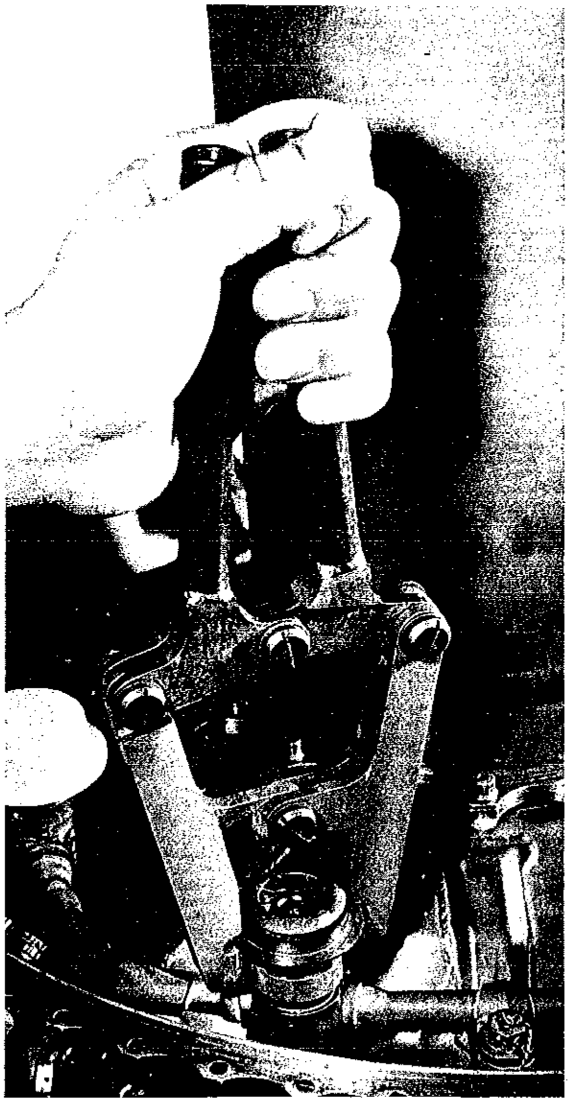


Figure 2-51F. Crimping Air Swirl Guide Lock opening on the bottom of the diffuser case and on the mounting bosses in the rear of the diffuser case.

b. Place a spacer between each mounting boss and the fuel manifolds. Secure the manifolds to the diffuser case with the tabwashers and bolts. Tighten the bolts to the recommended torque.

c. Bend tabwashers against a flat on the bolt. Lockwire to holes in case bosses.

d. Insert a ferrule in each opening in the fuel transfer valve adapter and place an "O" ring seal on each end of the ferrules.

e. Place an "O" ring seal in the groove on the outside of the connector.

f. Insert the connector in the opening in the bottom of the diffuser case engaging the pin in the connector into the fuel manifold adapter. Secure the adapter to the fuel manifold adapters with screws.

g. Install the fuel pressurizing and dump valve.

h. Pressure check the fuel nozzles, manifolds, and pressurizing and dump valve flange for leakage.

i. Install the combustion chambers.

j. Install the combustion chamber case.

k. Install the thermocouples, cable, and turbine pressure sensing manifolds.

2-245. FUEL NOZZLES.
(See Tool Group 7.)

2-246. REMOVAL.

a. Remove the combustion chambers.

b. Straighten the air swirl guide lock.

c. Clamp the torquing holder around the body of the nozzle being removed and another nozzle body in the same manifold.

d. Using the fuel nozzle retaining nut wrench, remove the fuel nozzle air swirl guide from the manifold.

e. Remove the fuel nozzle from the manifold.

f. Remove the remaining fuel nozzles in the same manner.

2-247. INSTALLATION.

a. Place a gasket on the fuel nozzle.

b. Position the fuel nozzle in the fuel manifold.

c. Clamp the torquing holder around the body of the nozzle being installed and another nozzle body in the same manifold.

d. Place the air swirl guide lock over the fuel nozzle and on the manifold.

e. Install the air swirl guide over the nozzle and on the manifold. Using the retaining nut wrench tighten the air swirl guide to the recommended torque. Using the crimper, dimple the lock into the slots of the guide in four places. (See Figure 2-51F.)

f. Install the remaining nozzles in the same manner.

2-248. PRESSURE CHECK.
(See Tool Group 8.)

NOTE

This pressure check determines whether there is any leakage between the primary and secondary fuel passages and between these passages and the outside of the manifolds.

a. Make certain that all the fuel nozzles are clean.

NOTE

The fuel nozzle sealing clamps required for this check could force carbon into the nozzles and clog them; therefore, it is important that the areas contacted by the clamps and the contacting surfaces of the clamps be clean.

b. Attach the fuel manifold leak check adapter to the adapter of the fuel manifold.

c. Install a nozzle sealing clamp on each fuel nozzle.

d. Set up the burette and valve assembly so that the midpoint of the burette scale is approximately level with the top of the fuel manifolds.

e. Attach the quick-disconnect connections to the connectors in the adapter attached to the fuel manifold inlet adapter.

f. Connect the test stand outlet line to the burette valve inlet.

g. Open valves Nos. 1, 2 and 3, and turn on the test fluid at low pressure.

h. Bleed the air out of the fuel manifolds by loosening and tightening the uppermost clamps on each manifold.

NOTE

The fluid level in the burette after the system is bled should equal the highest point in the fuel manifolds.

i. Shut off valve No. 2 and increase the pressure to 300 psi and observe the burette for five minutes. Leakage from the primary to secondary passages (as indicated by a rise in the fluid level) should not exceed 3 cc's.

j. When the leakage exceeds the specified amount, check to make certain that the clamps are in good condition and properly seated and tightened. If the leakage continues, inspect the sealing surfaces of the nozzles and manifolds. Replace parts as required to bring the leakage within limits.

k. Close valve No. 1 and open valve No. 2. This will subject both primary and secondary passages to 300 psi. Inspect for external leakage at the nozzles and at the manifolds-to-adapter parting surface. There should be no evidence of leakage. If leakage occurs, replace parts as necessary and repeat the check.

l. Disconnect quick disconnect from adapter on fuel inlet adapter of manifolds and drain fluid into a suitable container. While fluid is draining, remove nozzle clamps.

m. Remove fuel manifold leak check adapter.

2-248A. VISUAL FLOW CHECK. (See Tool Group 7A.)

NOTE

This check will permit inspection of fuel nozzle flow with as little disassembly of engine as possible. Check must be performed with engine in horizontal position.

a. Remove turbine exhaust temperature thermocouple and cable.

b. Remove turbine pressure sensing manifold.

c. Remove right and left igniter plugs.

d. Install engine in horizontal stand using the following procedure:

(1) Bolt horizontal stand to bench.

(2) Secure adapter to front flange of compressor inlet case with bolts and nuts (nuts must be against rear face of flange).

NOTE

Adapter is not needed on engines where oil tank or fuel flowmeter does not project forward of inlet case front flange.

(3) Attach plate to front face of adapter with narrow part of ring at 12 o'clock position and lifting eyes at two and ten o'clock positions.

NOTE

On engines where oil tank or fuel flowmeter does not project forward of inlet case, attach plate directly to front flange of compressor inlet case.

(4) Bolt test mounts to mount pads on each side of diffuser case.

(5) Suspend sling from hoist and secure sling hooks to test mounts.

(6) Raise engine and trunnion to horizontal position.

CAUTION

Steady engine while it is suspended from hoist.

(7) Lower engine into horizontal stand engaging lift and turn plate and test mounts in stand supports. Secure mounts and plate to stand.

e. Remove combustion chamber case.

f. Remove combustion chambers.

g. Cap fuel pressurizing and dump valve dump line.

h. Remove primary and secondary pressure plugs at fuel pressurizing and dump valve and install two adapters, one at each primary and secondary pressure tap port.

i. Admit low pressure air (30 to 60 psig) to adapter and brush nozzles to remove carbon deposits.

j. Bolt bottom half of cover to diffuser case rear flange.

k. Secure top half of cover to bottom half using clips.

l. Install adapter in bottom half of cover.

m. Connect static pressure stand to primary adapter on dump valve.

n. Connect pressure stand return fuel hose to adapter on bottom of spray check cover.

o. Install gage in test stand.

p. Supply test fluid at approximately five psi pressure. A uniform, bulb-like fuel pattern should spray from primary fuel nozzle passages. Note any streakiness or interrupted flow caused by clogged nozzles.

q. Disconnect primary adapter and connect test stand to secondary adapter.

r. Supply test fluid at approximately ten psi until secondary flow produces bulb-like pattern. Note any streakiness or interrupted flow caused by clogged nozzles.

s. Replace any nozzle that shows incorrect spray pattern.

NOTE

If any fuel nozzles are replaced manifold pressure check with nozzles installed should be performed.

t. Install combustion chambers.

u. Install combustion chamber case.

v. Install right and left igniter plugs.

w. Install turbine pressure sensing manifold.

x. Install turbine exhaust temperature sensing thermocouples and cable.

2-248B. FUEL NOZZLE CALIBRATION.

NOTE

When optimun performance and durability is desired, the following procedure may be performed on removed nozzles in lieu of visual flow check.

a. Purpose of Test. The purpose of the fuel nozzle calibration test is to determine that spray angle, alignment, and atomization are satisfactory, and that nozzle flow rate through both the primary and secondary orifices meets the requirements.

b. General Requirements.

(1) Use Calibrating Fluid, the specification for which is found in the Table of Consumable Materials.

(2) Test fluid temperature at nozzle entrance; 25° to 29°C (77° to 83°F).

(3) Test pressures: To be corrected for instrument error if error is in excess of + 0.1 psi below 50 psi or in excess of ± 0.3 psi above 50 psi.

(4) Fluid flows: To be corrected for instrument error if in excess of 0.25 percent.

(5) Spray cone angle: To be measured by a direct reading protractor in plane of the nozzle axis.

c. Calibration. If nozzle does not conform to calibration requirements, refer to TAILORING for corrective actions which may be taken. After nozzle has passed the test, etch the letter "R" (for Repaired) on the flange of the nozzle body.

d. Test Procedure.

(1) Spray pattern streakiness -- With 300 psi pressure applied to both primary and secondary, examine the spray pattern for streaks, preferably while the nozzle is slowly being rotated. The presence of one or more high contrast streaks which cannot be eliminated by external wiping of the orifice is cause for rejection.

(2) Flow rates -- Check the nozzle flow rate at the pressures listed below. Rates not within limits are cause for rejection of the nozzle.

(3) Spray cone angle -- Measure the spray cone angle during each of the flow check runs, at two positions approximately 90° apart. Deviation from the angles shown is cause for rejection.

(4) Spray cone alignment -- Determine the spray cone alignment with the nozzle axis during each of the flow check runs at two positions approximately 90° apart. Eccentricity or skewness in excess of 5 degrees total variation or resulting in spray outside the specified spray cone angle is cause for rejection.

Primary Pressure (psig)	Secondary Pressure (psig)	Flow Range (pph)	Spray Angle (Angular degrees)
25	0	33.8 -- 35.7	-----
250	0	106.7 -- 112.1	74-86
300	300	515 -- 535	74-86

2-248C. TAILORING.

a. If the spray has streaks or if the fluid flow is out of limits, clean and polish the metering set parts. Discard the metering set if cleaning and polishing does not eliminate the streaks. If re-cleaning and polishing fails to bring nozzle flow within limits, the metering set parts must then be mechanically "tailored" to increase the flow.

b. To increase fluid flow from the primary system, proceed as follows:

(1) Remove the primary metering plug and hold it firmly between the thumb and forefinger, the spring guide (stem) toward the operator, so that one of the metering slots appears to the RIGHT of the plug's centerline.

(2) Using a knife-edge type of fine India stone, lightly and with a short stroke, stone the full length of the LEFT HAND top edge of the metering slot.

NOTE

Do not allow the stone to touch the opposite, or right hand side of the metering slot while performing the stoning operation.

(3) Wash metering plug in cleaning fluid conforming to AMS 3160 and blow off with clean compressed air.

(4) Reassemble nozzle.

(5) Test nozzle for fluid flow.

c. To increase fluid flow from the secondary system, proceed as follows:

NOTE

In order to accomplish this operation it will be necessary to obtain a fine India stone ground to the cross-section form of a small trapezoid, i.e. with a base slightly narrower than the width of the secondary metering slot, sloping sides, and a top narrower than the base. The width of the trapezoid-shaped stone should be about 3/16 inch.

(1) Remove the secondary metering ring and hold it firmly between the thumb and forefinger, the metering slots facing upward. Using the fine India stone described above, place the base of the stone flat against the bottom of one of the metering slots and with short, firm strokes, stone the bottom of the slot. Turn the metering ring 180 degrees, and in the same manner, stone the opposite metering slot.

NOTE

The stoning of two metering slots should increase the flow sufficiently for another test.

(2) Wash the metering ring in cleaning fluid conforming to AMS 3160 and blow off with clean compressed air.

(3) Reassemble nozzle.

(4) Test nozzle for fluid flow.

d. To reduce fluid flow from the primary system, proceed as follows:

(1) Remove the primary metering plug and hold it firmly between the thumb and forefinger, the spring guide (stem) toward the operator so that one of the metering slots appears to the RIGHT of the plug's centerline.

(2) Using a knife-edge type of fine India stone, lightly and with a short stroke, stone the RIGHT HAND edge (or corner) of the metering slot at its junction with the small end of the plug (furthest from the operator).

NOTE

Do not allow the stone to touch the opposite, or left hand side of the metering slot while performing the stoning operation.

(3) Wash metering plug in cleaning fluid conforming to AMS 3160 and blow off with clean compressed air.

(4) Reassembly nozzle.

(5) Test nozzle for fluid flow.

e. To reduce fluid flow from secondary system, proceed as follows:

(1) Remove secondary metering ring and on good lapping plate, using Norbide Abrasive, Grain Size 600 (Boron Carbide) lapping compound, lap surface of ring in which metering slots are ground. Figure eight lapping motion shall be used, keeping face being lapped parallel to opposite face.

NOTE

Three strokes, using three or four inch figure eight stroke on lapping plate, should reduce fluid flow sufficiently for retest. After lapping of slot face, inside diameter of this face must be polished with Craytex rod to a radius of 0.003 to 0.005 inch. This may be done by holding ring, lapped face outward, in rotating collet.

(2) Wash metering ring in cleaning fluid conforming to AMS 3160 and blow off with clean compressed air.

(3) Reassemble nozzle.

(4) Using fuel nozzle holder (thumbscrew loosened), and standard dial indicator, check to ensure that sealing faces of main insert and nozzle body are in same plane within 0.0005 inch. If sealing faces of these two parts exceed 0.0005 inch tolerance, use lapping plate to remove required amount of stock from the sealing face of either part as indicated by fixture.

NOTE

Clean parts thoroughly after lapping.

(5) Test nozzle for fluid flow.

NOTE

Knife-edge type stone is called Fine India Stone and may be obtained from the Norton Pike Company of Littleton, New Hampshire. Designation of stone is FT-134, its size is 4 x 9/16 x 3/16 inches and its grit size is from 320 to 400 as measured by the Moh Scale.

2-249. FIRST STAGE TURBINE VANES.

2-250. REMOVAL.
(See Tool Group 4.)

NOTE

Replacement of 100 percent of vanes is permissible on a class for class basis.

a. Remove thermocouples, thermocouple cable, turbine pressure sensing manifolds, and igniter plugs.

b. Remove combustion chamber case.

c. Remove combustion chambers.

d. Install three turbine case supports (120 degrees apart), attaching one end of each support to diffuser case rear flange and other end to front flange of turbine case. (See Figure 2-51G.)

e. Install engine test mounts on mount pads on each side of diffuser case.

f. Attach engine lift and turn sling to a hoist and secure sling hooks to test mounts.

g. Raise engine and trunnion to horizontal position.

CAUTION

Steady engine while it is on hoist.

h. Bolt inlet case-to-front plate adapter to front of inlet case.

i. Bolt engine lift and turn plate to adapter with narrow part of ring at 12 o'clock position and lifting eyes at ten and two o'clock positions.

j. Lower engine into engine horizontal stand engaging lift and turn plate and test mounts into stand supports. Secure mounts and plate to stand.

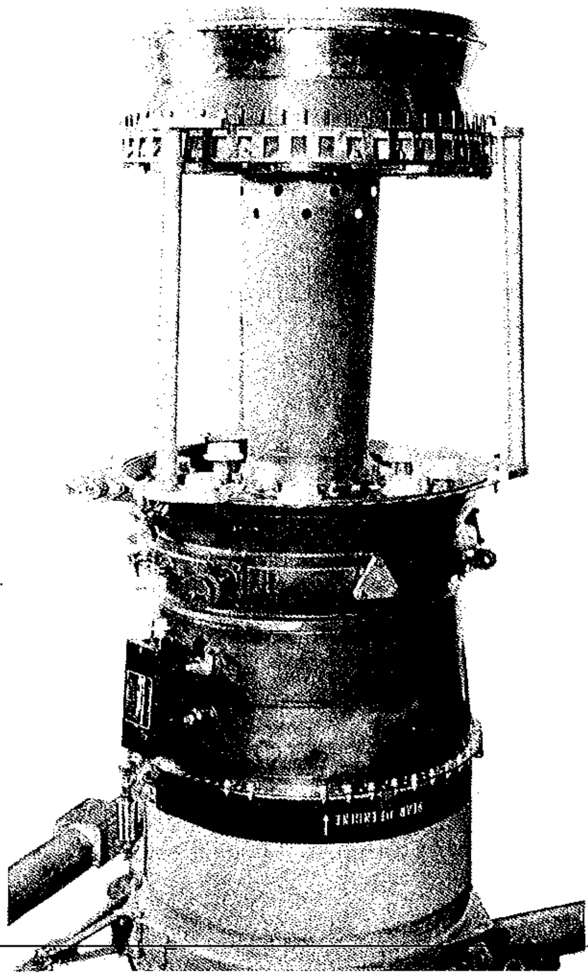


Figure 2-51G. Turbine Case Supports Installed

k. Remove bolts securing combustion chamber outlet duct to combustion chamber inner case rear flange. Install three aligning pins in holes in bolt circle.

l. Remove bolts securing combustion chamber outlet duct to outlet duct support.

m. Using layout dye, make aligning marks on outlet duct and combustion chamber inner case.

n. Slide outlet duct forward.

o. Remove pins securing first stage turbine vanes to turbine case. Remove vanes.

CAUTION

Do not remove more than six adjacent vanes at any one time. Vanes should be removed and replaced in groups of six or less around the circle whenever more than six adjacent vanes are to be replaced. Removal of too many vanes at one time will result in lack of proper support for the No. 3 bearing seal assembly and possible damage to seal.

2-250A. SELECTION OF VANES TO MEET NOZZLE FLOW AREA REQUIREMENTS.

a. Arithmetical class average of vanes for each nozzle assembly must conform to values specified in Section II, Table of Limits.

NOTE

Following class vanes were bought to support repair.

(1) First stage - Class 5, 6, 7, and 8.

(2) Second stage - Class 3, 4, 5, 6, 7, and 8.

b. Following is example for computing numerical class average of first stage complete assembly.

Example:

Problem: Select 58 vanes (total number in assembly) to give numerical class average of 6.69 to 6.72.

15 Class No. 5 vanes	15 x 5 - 75
5 Class No. 6 vanes	5 x 6 - 30
20 Class No. 7 vanes	20 x 7 - 140
<u>18</u> Class No. 8 vanes	18 x 8 - <u>144</u>
58	389

Total Numerical/Class

$$\frac{389}{58} = 6.70$$

As 6.70 (numerical class average) is within average class limit of 6.69 to 6.72, assembly will provide correct flow area requirement.

c. If average is too high, substitute sufficient number of vanes of lower classification to bring average within limits.

d. Tables 2-3-2 and 2-3-3 indicate maximum usability of various vane classes in 1st and 2nd stage nozzles. Enter chart horizontally from desired class to find maximum number of that class that maybe used, and then, reading vertical column, determine additional vane classes required to bring nozzle within specified limits.

Example:

In 1st stage nozzle, a maximum of 37 Class No. 8 vanes may be utilized if used with 16 Class No. 4 vanes, one Class No. 5 vane, and four Class No. 6 vanes.

e. If average is too low, substitute sufficient number of vanes of higher classification to bring average within limits.

f. If more than one classification of vane is used in single nozzle assembly, maximum of five consecutive classes may be used in any one assembly, provided spread between adjacent vanes is not more than three classes. Vanes of same class shall be distributed as equally as possible around nozzle assembly.

2-251. INSTALLATION (See Tool Group 3.)

a. Install inner end of a 1st stage turbine vane in an inner shroud slot aligning slot in vane with a hole in turbine case.

b. Position a turbine vane retaining pin in retaining pin drift. Drift exposed end of pin into hole in case until drift bottoms against turbine case.

TABLE 2-3-2. TURBINE VANE USABILITY

Class	FIRST STAGE				Class	SECOND STAGE							
3	2				2	22				17			
4		16			3		46				41		
5	4	1	31		4	4		70		4		65	
6	1	4		45	5		4		96		4		89
7	51		4	1	6	70		4		75		4	
8		37	1	4	7		46				51		4
9			22		8			22				27	
10				8	9								3

TABLE 2-3-3. TURBINE VANE USABILITY (JT12A-8 ONLY)

Class	FIRST STAGE			
3	7			
4	1	20		
5	4	3	36	
6		4	1	51
7	46		4	
8		31		4
9			17	1
10				2

c. Install combustion chamber outlet duct over aligning pins, aligning mark (made at disassembly) on duct with mark on combustion chamber inner case.

d. Secure outlet duct to combustion chamber inner case flange with bolts. Remove pins.

NOTE

Do not remove aligning pins until at least three bolts have been engaged.

e. Tighten bolts to recommended torque and lockwire.

f. Secure outlet duct to outlet duct support with bolts. Tighten bolts to recommended torque and lockwire.

NOTE

Clearance between outlet duct periphery and support must be uniform around circumference.

g. Attach engine lift and trunnion sling to a hoist and secure sling hooks to engine test mounts.

h. Raise engine from horizontal stand and trunnion to vertical position

CAUTION

Steady engine while it is on hoist.

i. Install engine in engine build and transport stand securing lift and turn plate to stand will ball lock pins. Remove sling.

j. Remove three turbine case supports.

k. Install combustion chambers.

l. Install igniters, turbine pressure sensing manifolds, thermocouples, and thermocouple cable.

2-251A. FREE TURBINE SECTION.

2-251B. REMOVAL.
(See Tool Group 5B.)

a. Install engine in shipping cradle securing front shipping support to diffuser case mounting pads, and rear support to rear engine mount.

b. Remove thermocouple cable.

c. Remove free turbine speed sense flexible shaft assembly.

d. Remove No. 4 bearing external oil pressure tube.

e. Remove No. 4 and No. 5 bearing external oil return tubes.

f. Remove No. 4 bearing rear external breather tube.

g. Install free turbine assembly sling as follows.

(1) Disconnect one end of cable and band from bracket on free turbine assembly sling.

(2) Position sling bracket at 12 o'clock position on free turbine case with cable immediately forward of case rear flange and band immediately rearward of case front flange.

(3) Pass band and cable around case, adjusting spreaders as necessary.

(4) Connect free ends of band and cable to bracket and tighten until secure.

(5) Attach a hoist to sling and apply slight tension.

h. Bolt engine lift and turn plate to front flange of compressor inlet case (with the single attaching eye at six o'clock position).

i. Secure engine front support to tubular cross piece of shipping cradle, aligning hole in front support with eye in lift and turn plate. Secure with ball lockpin.

j. Remove nuts and bolts securing free turbine section to turbine case.

k. Disconnect rear engine mount from rear support of shipping cradle.

l. Carefully move free turbine section rearward until disengaged from second stage turbine outer seal. Raise free turbine section.

m. Attach storage stand rear support to free turbine section rear flange. Attach front support to free turbine section front flange.

n. Lower free turbine section into base of storage stand, engaging front and rear supports in vertical support holders.

o. Secure with ball lockpins.

p. Remove sling.

2-251C. INSTALLATION.
(See Tool Group 5A.)

a. Install free turbine assembly sling using following procedure.

(1) Disconnect one end of band and cable from bracket of sling.

(2) Position bracket at 12 o'clock location on free turbine case (with cable just forward of case rear flange and band just rearward of front flange).

(3) Pass band and cable around case (adjusting spreaders as necessary) and connect to bracket. Tighten until secure.

b. Attach a hoist to lifting eye of sling.

c. Remove ball lockpins securing supports to storage stand.

d. Raise free turbine section from storage stand.

e. Remove supports from front and rear flanges of free turbine section.

f. Install engine in shipping cradle using following procedure.

(1) Bolt engine lift and turn plate to front flange of compressor inlet case (with single attaching eye at six o'clock position).

(2) Secure engine front support to tubular cross piece of shipping cradle.

(3) Lower engine into shipping cradle aligning eye in plate with hole in front support. Secure with ball lockpin.

(4) Attach support to diffuser case mount pads.

g. Install free turbine assembly aligning pins in holes at three and nine o'clock positions in turbine case rear flange.

h. Carefully guide free turbine section forward onto aligning pins until front flange meets with rear flange of turbine case.

i. Secure free turbine section to turbine case with bolts and nuts. Tighten nuts to recommended torque.

j. Attach rear support of shipping cradle to engine rear mount.

k. Remove free turbine assembly lifting sling.

Figures 2-51G-1 and 2-51G-2 deleted.

2-251C-1. FREE TURBINE SPEED SENSING FLEXIBLE SHAFT.

2-251C-2. REMOVAL.

NOTE

Flexible shaft core must be inspected, relubricated, and fuel control end of casing adjusted every 200 hours of operation. (100 hours of operation if substitute grease is used.)

NOTE

Whenever flexible shaft casing, core, fuel control, or free turbine gearbox are replaced, all adjustments specified for installation of flexible shaft (step g, paragraph 2-251C-5) must be made.

a. Remove all clip assemblies securing flexible shaft assembly to engine brackets. Remove bolts and nuts securing shield to free turbine. Remove all other aircraft or electrical cable clips.

NOTE

Shield should now be entirely free of engine or aircraft support.

CAUTION

Do not remove triangle shaped pad attached by three screws to the fuel control when removing flexible shaft. Fuel control must be replaced if this pad is removed.

b. Remove two screws securing flexible shaft end fitting at fuel control end.

c. Disconnect oil pressure tube at free turbine gearbox.

CAUTION

Gearbox and flexible shaft assembly must be lifted straight out radially with light force; otherwise, the internal driveshaft will be bent.

d. Remove three nuts securing free turbine gearbox to free turbine and carefully disengage gearbox and flexible shaft assembly from free turbine and fuel control as one unit.

e. Remove four nuts securing flexible shaft end fitting at free turbine gearbox.

f. Remove cable core by withdrawing core (with gearbox attached) from casing.

g. Remove end fitting and nut from casing at fuel control end. Slide casing from shield.

2-251C-3. CLEANING.

a. Wipe excess grease from core with clean cloth.

CAUTION

Plugging of this hole by grease will cause fuel to wash or dilute grease off core inside casing.

b. Check and clean out, if necessary, fuel drain hole in fuel control adjacent to two hole flange where casing is installed.

2-251C-4. INSPECTION.

a. Inspect flexible shaft casing for cut, broken, or torn braids. Scrap casing if any of these conditions exist.

b. Inspect rivet attaching core to gearbox gearshaft to ensure there is no obvious severe wear of rivet or rivet hole. Inspect rivet for proper crimping.

c. Inspect core for following:

(1) Severe twisting or unwinding of core.

(a) Separations or gaps at every 12 to 15 turns is acceptable.

(2) Flat or worn spots on outer surface of core not to exceed width of 0.030 inch on one strand.

(a) Wear on individual strands of core can also be measured by determining wear depth not to exceed 0.0165 inch.

NOTE

While measuring this core strand wear, care should be taken to assure that wires are not worn below maximum flat width (radius).

(3) Maximum square drive end wear limits are 0.090 inch at gearbox end (0.250 inch square) and 0.100 inch at control end (0.200 inch square). (See Figure 2-51G-3.)

(4) Inspect square drive of core for bend using following procedure: (See Figure 2-51G-4.)

(a) Position shaft as shown in illustration.

(b) Measure distances 1 and 2 and record.

(c) Subtract smaller distance from larger. Maximum allowable bend is 0.031 inch. If core end is bent in excess of limit, core shall be scrapped.

k. Install combustion chambers.

l. Install igniters, turbine pressure sensing manifolds, thermocouples, and thermocouple cable.

2-251A. FREE TURBINE SECTION.

2-251B. REMOVAL.
(See Tool Group 5B.)

a. Install engine in shipping cradle securing front shipping support to diffuser case mounting pads, and rear support to rear engine mount.

b. Remove thermocouple cable.

c. Remove free turbine speed sense flexible shaft assembly.

d. Remove No. 4 bearing external oil pressure tube.

e. Remove No. 4 and No. 5 bearing external oil return tubes.

f. Remove No. 4 bearing rear external breather tube.

g. Install free turbine assembly sling as follows.

(1) Disconnect one end of cable and band from bracket on free turbine assembly sling.

(2) Position sling bracket at 12 o'clock position on free turbine case with cable immediately forward of case rear flange and band immediately rearward of case front flange.

(3) Pass band and cable around case, adjusting spreaders as necessary.

(4) Connect free ends of band and cable to bracket and tighten until secure.

(5) Attach a hoist to sling and apply slight tension.

h. Bolt engine lift and turn plate to front flange of compressor inlet case (with the single attaching eye at six o'clock position).

i. Secure engine front support to tubular cross piece of shipping cradle, aligning hole in front support with eye in lift and turn plate. Secure with ball lockpin.

j. Remove nuts and bolts securing free turbine section to turbine case.

k. Disconnect rear engine mount from rear support of shipping cradle.

l. Carefully move free turbine section rearward until disengaged from second stage turbine outer seal. Raise free turbine section.

m. Attach storage stand rear support to free turbine section rear flange. Attach front support to free turbine section front flange.

n. Lower free turbine section into base of storage stand, engaging front and rear supports in vertical support holders.

o. Secure with ball lockpins.

p. Remove sling.

2-251C. INSTALLATION.
(See Tool Group 5A.)

a. Install free turbine assembly sling using following procedure.

(1) Disconnect one end of band and cable from bracket of sling.

(2) Position bracket at 12 o'clock location on free turbine case (with cable just forward of case rear flange and band just rearward of front flange).

(3) Pass band and cable around case (adjusting spreaders as necessary) and connect to bracket. Tighten until secure.

b. Attach a hoist to lifting eye of sling.

c. Remove ball lockpins securing supports to storage stand.

d. Raise free turbine section from storage stand.

e. Remove supports from front and rear flanges of free turbine section.

f. Install engine in shipping cradle using following procedure.

(1) Bolt engine lift and turn plate to front flange of compressor inlet case (with single attaching eye at six o'clock position).

(2) Secure engine front support to tubular cross piece of shipping cradle.

(3) Lower engine into shipping cradle aligning eye in plate with hole in front support. Secure with ball lockpin.

(4) Attach support to diffuser case mount pads.

g. Install free turbine assembly aligning pins in holes at three and nine o'clock positions in turbine case rear flange.

h. Carefully guide free turbine section forward onto aligning pins until front flange meets with rear flange of turbine case.

i. Secure free turbine section to turbine case with bolts and nuts. Tighten nuts to recommended torque.

j. Attach rear support of shipping cradle to engine rear mount.

k. Remove free turbine assembly lifting sling.

2-251C-1. FREE TURBINE SPEED SENSING FLEXIBLE SHAFT.

2-251C-2. REMOVAL.

NOTE

Flexible shaft core must be inspected, relubricated, and fuel control end of casing adjusted every 200 hours of operation. (100 hours of operation if substitute grease is used.)

NOTE

Whenever flexible shaft casing, core, fuel control, or free turbine gearbox are replaced, all adjustments specified for installation of flexible shaft (step g, paragraph 2-251C-5) must be made.

a. Remove all clip assemblies securing flexible shaft assembly to engine brackets. Remove bolts and nuts securing shield to free turbine. Remove all other aircraft or electrical cable clips.

NOTE

Shield should now be entirely free of engine or aircraft support.

b. Remove two screws securing flexible shaft end fitting at fuel control end.

CAUTION

Do not remove triangle shaped pad attached by three screws to the fuel control when removing flexible shaft. Fuel control must be replaced if this pad is removed.

c. Disconnect oil pressure tube at free turbine gearbox.

d. Remove three nuts securing free turbine gearbox to free turbine and carefully disengage gearbox and flexible shaft assembly from free turbine and fuel control as one unit.

CAUTION

Gearbox and flexible shaft assembly must be lifted straight out radially with light force; otherwise, the internal driveshaft will be bent.

e. Remove four nuts securing flexible shaft end fitting at free turbine gearbox.

f. Remove cable core by withdrawing core (with gearbox attached) from casing.

g. Remove end fitting and nut from casing at fuel control end. Slide casing from shield.

2-251C-3. CLEANING.

a. Wipe excess grease from core with clean cloth.

b. Check and clean out, if necessary, fuel drain hole in fuel control adjacent to two hole flange where casing is installed.

CAUTION

Plugging of this hole by grease will cause fuel to wash or dilute grease off core inside casing.

2-251C-4. INSPECTION.

a. Inspect flexible shaft casing for cut, broken, or torn braids. Scrap casing if any of these conditions exists.

NOTE

Breaks or cracks in outer teflon coating of casing are acceptable if braid is not broken.

b. Inspect flexible shaft end fittings for thread damage and looseness. Replace end fittings if either of these conditions exists.

c. Inspect rivet attaching core to gearbox gearshaft to ensure that there is no obvious severe wear of rivet and gearshaft rivet hole. Inspect rivet for proper crimping.

d. Inspect fuel control flexible shaft core for the following and scrap core if, as removed from engine, any of these conditions exists:

(1) Obvious severe twisting or untwisting of core spirals. (See Figure 2-51G-1.)

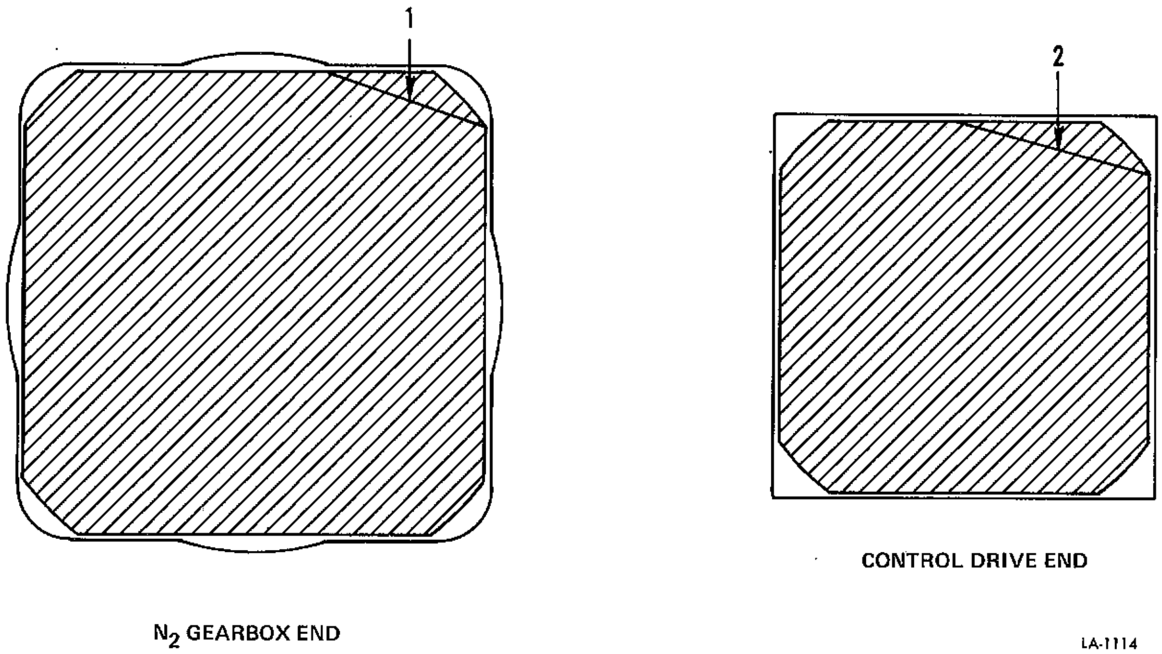
(2) Obvious flat spots or worn spots on outer surface of core. (See Figure 2-51G-2.)

(3) Square ends of core obviously worn or rounded off.

(4) Obviously bent core drive ends. (See Figures 2-51G-3 and 2-51G-4.)

NOTE

If core is rejected for any of above conditions, remove core by drilling out rivet attaching core to gearshaft.



Maximum serviceable wear:

1. Flat, 0.090 inch
2. Flat, 0.100 inch

Figure 2-51G-3. Free Turbine Speed Sensing Flexible Shaft - Square Drive Ends

(d) Repeat steps (b) and (c) at 90 degrees from first measurement.

d. Casing may be reused once after core is rejected. Mark such casings indicating a second core is being used. Replace casing in which second core was used and then rejected. Mark casings as follows:

(1) New casing with acceptable core, mark as Cycle No. 1.

(2) Casings marked Cycle No. 1 with first unacceptable core, remark as Cycle No. 2.

(3) Casings marked Cycle No. 2 with unacceptable core require casing replacement.

2-251C-5. INSTALLATION.

NOTE

If casing is replaced, perform following additional steps:
1. Remove end fitting from old casing at free turbine gearbox end.
2. Install end fitting on new casing.
3. Tighten casing to end fitting to 400 to 450 pound-inches, torque and lockwire.

NOTE

If core is replaced, perform following additional steps:
1. Lubricate square drive of core at gearbox end with grease.
2. Install square drive of core into gearshaft of free turbine gearbox.
3. Secure core to gearshaft with rivet. Crimp rivet.

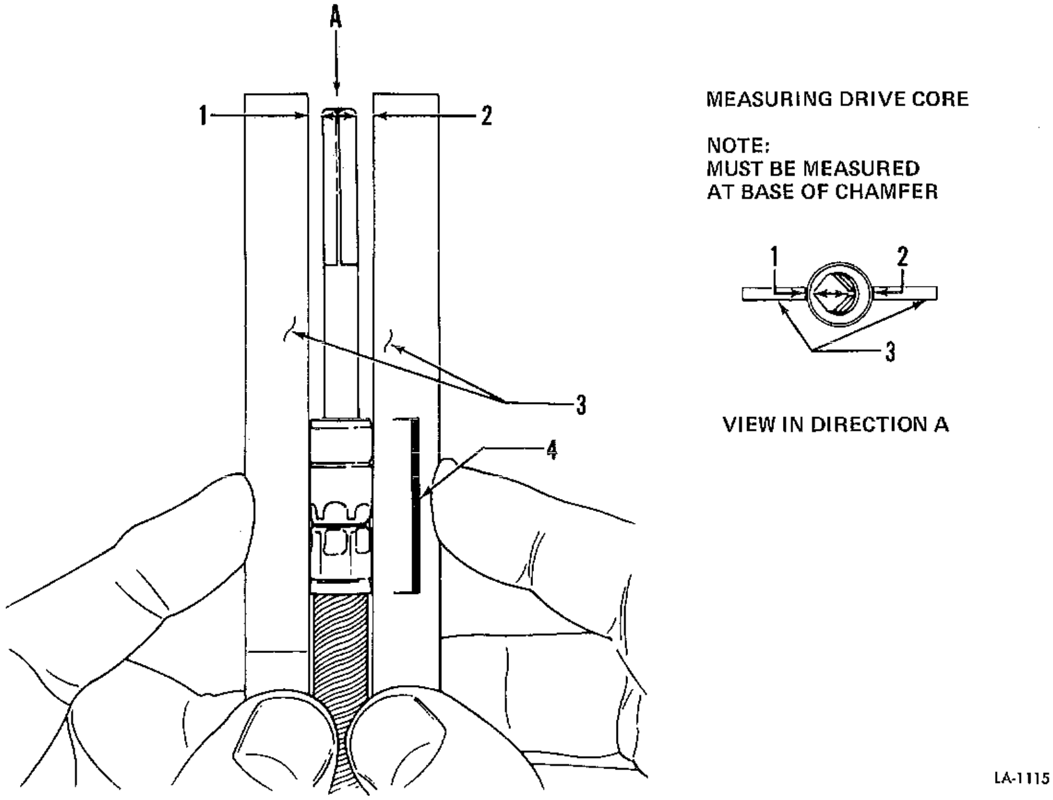
CAUTION

Gearbox and flexible shaft core must be replaced straight in radially onto free turbine with light force; otherwise, internal driveshaft will be bent.

a. Install gearbox packing and then carefully position free turbine gearbox (with core attached) on free turbine.

NOTE

If necessary, rotate core to align spline in free turbine gearbox with splines on shaft inside free turbine case.



1. 0.031 inch maximum bend from centerline of square drive
2. 0.031 inch maximum bend from centerline of square drive
3. Straight edges
4. Straight edges contacting end fitting at two maximum diameter sections of fitting, both sides

Figure 2-51G-4. Free Turbine Speed Sensing Flexible Shaft Inspection

b. Secure gearbox with nuts and torque nuts to 65 to 85 pound-inches.

c. Lubricate entire core and square drive at fuel control end uniformly with 0.7 to 1.0 ounce of Lubriplate Molith No. 2 grease.

d. Slide gasket, flexible shaft end fitting, and flexible shaft casing over installed core. Secure end fitting to free turbine gearbox with washers and nuts. Torque nuts to 65 to 85 pound-inches.

e. Secure flexible shaft casing to end fitting if not already secured. Torque casing to end fitting to 400 to 450 pound-inches and lockwire.

f. Slide shield over flexible shaft casing. Do not secure shield to engine at this time.

g. Connect and adjust fuel control end of flexible shaft as follows:

(1) Attach nut and end fitting to fuel control end of casing.

(2) Place flexible shaft shield in the approximate fore and aft position it will be in when attached to engine.

(3) Place fuel control end fitting along side of fuel control as shown in Figure 2-51G-5.

(4) Turn fuel control end fitting to align rear end of square section of core end to be flush within plus or minus 1/16 inch with front face of fuel control end fitting as shown in figure 2-51G-5.

(5) Turn fuel control end fitting minimum amount required to align screw holes with mating holes in fuel control. When holes are aligned, tighten checknut fingertight against end fitting.

(6) Place preformed packing on end fitting.

(7) Visually align square drive on end of core with mating square drive hole in fuel control. If necessary during assembly, turn female square drive in fuel control to align core square drive with square hole in fuel control.

(8) Slide flexible casing shield all way to rear towards free turbine gearbox, to give fuel control end of flexible cable as much freedom of motion as possible.

(9) Refer to Figures 2-51G-6 and 2-51G-7 for procedure for inserting fuel control end of flexible cable assembly into fuel control. See Figure 2-51G-8 for cross-sectional view of installed flexible cable assembly at fuel control end.

CAUTION

Do not bend flexible shaft casing sharply. Take extreme care not to bend small diameter and square end section fo flexible shaft core.

(10) Secure end fitting with screws. Torque screws to 22 to 24 pound-inches and lockwire. Torque checknut to end fitting to 120 to 150 pound-inches and lockwire.

h. Place flexible shaft shield in position and secure with bolts and clips. Attach aircraft brackets if any.

i. Install oil pressure tube to free turbine gearbox and torque nut to 70 to 80 pound-inches.

2-251C-6. INSTALLATION - OIL PRESSURE LUBRICATED.
(See Tool Group 5C.)

NOTE

This assembly must be done in a relatively dirt and dust free environment. It is recommended that these parts be preassembled and be available prior to installation on engine or held for future parts replacement.

a. Assemble flexible cable assembly as follows:

(1) Install packings on fuel control flexible shaft bearing assembly. (See Figure 2-51G-9.)

CAUTION

Lubricate threads on bearing assembly with engine oil and thread flange onto bearing assembly carefully to avoid thread damage.

(2) Thread flexible shaft flange onto bearing assembly, handtight, as far as it will go.

(3) Slide assembled flange and bearing assembly over flexible shaft core and clamp swaged portion of flexible core in a soft jaw vise in vertical position.

(4) Heat bearing in hot oil and install onto core. Drift to seat.

(5) Install snapring.

(6) Install bearing and flexible core in flange using drift and base; then secure with snapring.

(7) Install seal with drift, only far enough to expose snapring groove in flange; then secure with snapring.

(8) Remove assembly from base.

(9) Thread adapter, with attached preformed packing, into flange.

b. Install flexible shaft as follows:

(1) Feed shaft casing through metal heat shield from free turbine end, until it extends beyond lower end of heat shield. (See figure 2-51G-9.)

NOTE

Care must be taken not to bend casing at its flange junctions. Prior to installing core in casing, lightly clean pilot diameter and chamfer with crocus cloth; then clean core with petroleum base solvent such as Varsol No. 1. Coat core and bearing with engine oil with emphasis on pilot diameters at free turbine gearbox end. (See Figure 2-51G-10.) Also, core should be inserted into N_2 gearbox bevel gearshaft to ensure free and complete engagement. Without free and full movement of core in bevel gearshaft, adjustment required in figure 2-51G-10 will be very difficult to obtain.

(2) Feed shaft core into casing at lower end of heat shield until casing lower flange and bearing assembly threads engage.

CAUTION

Threads of bearing assembly must be lubricated with engine oil, and care must be taken to avoid thread damage while assembling onto bearing assembly.

(3) Hold bearing assembly and rotate shaft casing to thread casing into bearing assembly. Thread casing fully but do not tighten. Bearing assembly, with left and right-hand threads, will be used to adjust shaft core length extending from casing. (See figure 2-51G-9.)

(4) Install preformed packing on flexible shaft flange and align shaft core square end with fuel control square slot. Guide shaft core and flange into fuel control housing and secure with two previously used bolts. Lockwire bolts.

NOTE

Do not bend shaft core casing at flange junction. If necessary, slide assembly up metal heat shield and guide core straight into fuel control.

(5) Position packing against shoulder of nut on free turbine gearbox end of flexible shaft casing.

(6) Install gasket between free turbine gearbox and flange.

NOTE

At this point of assembly, bearing assembly must have no gap on either side of wrench flats. Flexible shaft casing must be fully threaded into fuel control flexible shaft flange.

(7) With minimum bending of core, insert core into free turbine gearbox bevel gearshaft, ensuring that both pilot diameters of core (figure 2-51G-10) fully engage gearshaft with free axial movement of core. Secure flange to gearbox housing with nuts. Tighten and torque nuts.

NOTE

Ensure that flange oil port is aligned with manifold assembly before securing gearbox.

(8) Install free turbine gearbox on free turbine case. Adjust bearing assembly to ensure proper alignment of gearbox driveshaft in free turbine with mating gearbox shaft. Free turbine will have to be rotated to align drive splines before gearbox is installed. Secure with nuts.

(9) Install preformed packing with adapter and thread into porthole on flange.

(10) To ensure free movement of core in bevel gearshaft, press drift or small diameter rod against core through bevel gearshaft. Slight core movement must be felt with core springing back.

(11) Secure pressure manifold assembly to adapter and gearbox housing. Lockwire nut to adapter.

c. Core length adjustment.

(1) Prior to core length adjustment, ensure that following are secure:

(a) Metal heat shield.

(b) Free turbine gearbox to free turbine case.

(c) Flange to flexible shaft casing.

(d) Flange to fuel control.

(e) Gearbox rear flange to free turbine gearbox.

NOTE

Interference or contact may exist between area adjacent to wrench flats on flexible shaft casing and fuel pump filter housing flange. Fuel pump flange may be filed to obtain 0.003 to 0.005 inch clearance. Rotating wrench flats can assist in achieving necessary clearance with minimum material removal from pump flange.

(2) Secure flange of free turbine gearbox temorarily with two nuts to allow for accurate cable length adjustment. (See Figure 2-51G-11.)

(3) Insert a one to two inch depth micrometer into exposed open end of bevel gearshaft to contact cable core end. Adjust coupling assembly until distance between gearshaft end and cable is 1.890 ±0.050 inches. (See figure 2-51G-10.)

NOTE

The maximum adjusted gap on either side of bearing assembly is 0.370 inch. Repeat adjustment procedure if gap on either side is greater. (See figure 2-51G-9.)

(4) Lockwire bearing assembly in both directions after completing adjustment.

(5) With petroleum vasoline or engine oil, liberally coat packing and plug threads and install these details into free turbine bevel gearshaft. (See figure 2-51G-10.)

(6) Install fuel control flexible shaft oil drain tube assembly and secure to brackets with clamps.

2-251D. INSTALLING ENGINE COVERS. (SeeTool Group 9A.)

a. Install PWA-13389 cover over turbine exhaust case.

b. Install PWA-13393 cover over compressor inlet case.

2-252. ADJUSTMENT AND TESTING.

2-253. GENERAL.

2-254. The operational procedures in this section are presented in a form suitable for use by personnel during ground operation and checking of the engine. The applicable airframe manufacturer's trim curves must be used for engine trim speed adjustment when the engine is installed in the airframe.

2-255. GROUND SAFETY PRECAUTIONS.

2-256. GENERAL.

2-257. The operating characteristics of jet engines have made it necessary to modify existing safety precautions against injury to personnel and damage to property. Areas of extreme danger are the air intake and jet wake. (See Figures 2-51H, 2-51H-1-1, or 2-51H-1-2.) The air intake is capable of generating enough suction to pull a person partially into the intake duct. Always respect the danger potential present at the air intake duct when the engine is being run-up. The suction at the intake duct of an idling jet engine is capable of pulling off eye-glasses, removing hats, tearing off loose clothing, and even pulling small tools and wipe rags from coverall pockets. Make sure that everything about your person is securely anchored. On airframes equipped with spring-loaded access doors, remove the doors prior to doing any maintenance work that will require doors to be held open any length of time.

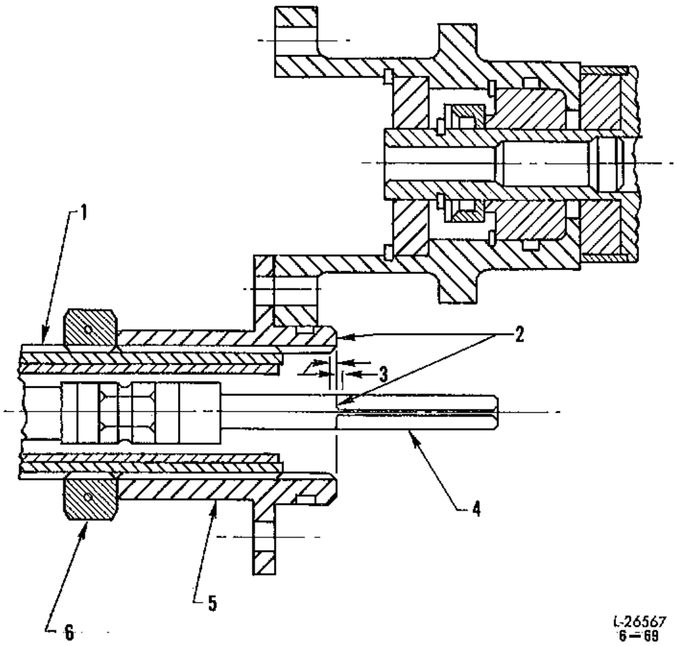
2-258. Another important hazard introduced by the jet engine is high temperature and high velocity of exhaust gases discharged at the tailpipe. At high engine speeds jet wake may propel loose dirt, sizable stones, sand, and debris for a distance of several hundred feet. A blast fence is recommended in areas where extensive engine run-ups will be made and sufficient space is not available to dissipate the force of the jet wake. High temperatures will exist for a considerable distance aft of exhaust duct. These temperatures are sufficiently high to deteriorate bituminous pavement; thus concrete aprons are recommended for run-up areas.

2-259. Occasionally upon starting a jet engine, an accumulation of excess fuel in the tailpipe will be blown out as long streamers of flame. Personnel shall observe proper fire precautions and remove all flammable materials to a safe distance.

2-260. Tests have indicated that the carbon monoxide content of the jet wake is relatively low but that other gases, irritating in effect and having disagreeable odors, are present. Exposure will usually result in watering and burning of the eyes. Less noticeable, but equally important, is the respiratory irritation that results from breathing in the exhaust gases. Exposure shall be avoided, particularly in confined spaces where the exhaust gas concentration may build up.

2-261. COOL-DOWN. After engine operation, no work or inspection shall be done on the tailpipe for at least one-half hour (preferably longer). If work is necessary immediately after shutdown, asbestos gloves must be worn. All other engine parts usually may be worked on without danger.

2-262. COMPRESSOR BLEED VALVE. When checking bleed operation or doing other work on, or adjacent to compressor bleed while engine is running, care shall be taken to stand clear during "bleed open" operation. When bleed opens, high pressure air at high velocity is dumped overboard.



1. Casing
2. These surfaces must be flush within ±1/16 inch prior to attachment to fuel control.
3. 1/16 inch maximum
4. Core
5. End fitting
6. Checknut

Figure 2-51G-5. Flexible Shaft End Fitting Alignment

2-262A. COMPRESSOR BLEED STRAP. Avoid operation of engine above 12,600 rpm if bleed strap is broken or if bleed valve assembly fails to close. Engine operation in area where bleeds are normally closed may induce adverse stresses in compressor rotor component parts. Engine with symptoms indicative of a broken strap should be investigated and strap replaced if found to be broken. Symptoms of a broken strap during engine operation at normal power settings are low exhaust pressure ratio or higher rpm required to maintain the exhaust pressure ratio setting with resultant increase in fuel flow and exhaust gas temperature.

CAUTION

Engines operated above 12,600 rpm for extended period of time with bleed valve open causes excessive stress on 5th stage steel compressor blades and, therefore, requires that these blades shall be replaced.

2-263. ENGINE NOISE. Modern jet engines produce noise capable of causing temporary or permanent loss of hearing. Even short exposure to extreme noise may result in damage to eardrums and all personnel shall use some means of protection.

2-264. JET FUELS AND LUBRICATING OILS. All fuels have a drying effect which can injure skin. Avoid contact as much as possible.

2-265. PREPARATION OF ENGINE FOR TEST.

2-266. DRESSING ENGINE (TURBOJET ENGINES). ~~(See Tool Group 2B.)~~

a. Install test starter on left front side of gearbox.

b. Install tachometer generator on tachometer driveshaft pad.

CAUTION

The tachometer generator must have gear ratio which will record an actual rotor rpm on tachometer gage. An N speed of 16,030 rpm represents 100 percent for engines with a tachometer drive ratio of 0.262:1. An N speed of 15,909 rpm represents 100 percent for engines with a tachometer drive ratio of 0.264:1. (See Figure 2-51H-1.)

c. Remove plug from upper front of gearbox (in-line with the main oil screen) and install oil temperature thermocouple.

d. Attach anti-icing air thermocouple to one of bolts which secure anti-icing air elbow to inlet case.

e. Install drain lines at all overboard fuel drain connections.

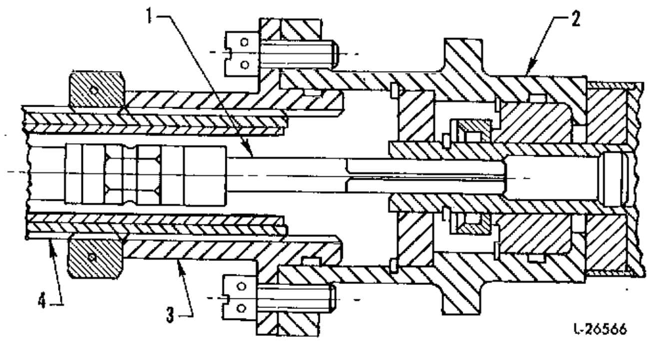
f. Install fuel pump inlet adapter on fuel pump.

g. Install vibration pickup mount brackets and vibration pickups at following locations (viewed from rear of engine). (See Figure 2-51H-2.)

(1) Compressor inlet case front flange at second ~~and third hole clockwise from 12 o'clock position~~ hole.

Figure 2-51G-6. Flexible Shaft Assembly - Approach to Insertion into Fuel Control

Figure 2-51G-7. Flexible Shaft Assembly - Alignment for Insertion into Fuel Control



1. Core
2. Fuel control
3. End fitting
4. Casing

Figure 2-51G-8. Fuel Control Flexible Shaft Assembly and Fuel Control, Engaged

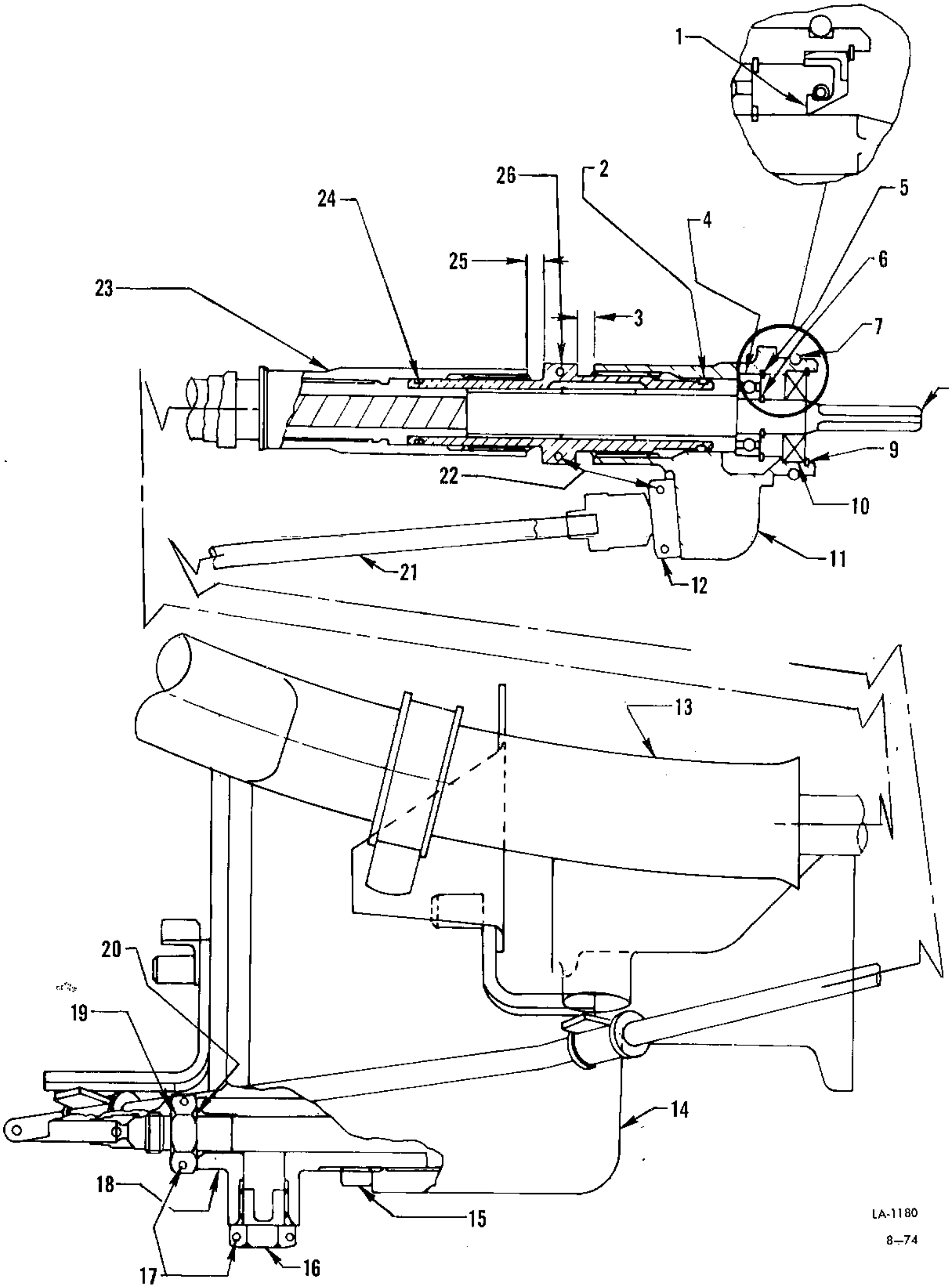
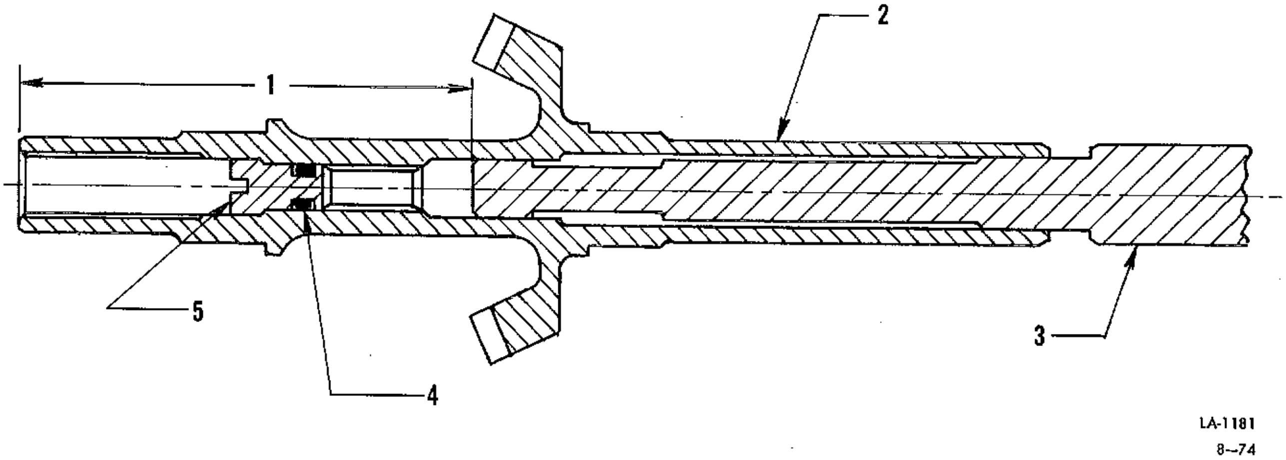


Figure 2-51G-9. Fuel Control Flexible Shaft Assembly

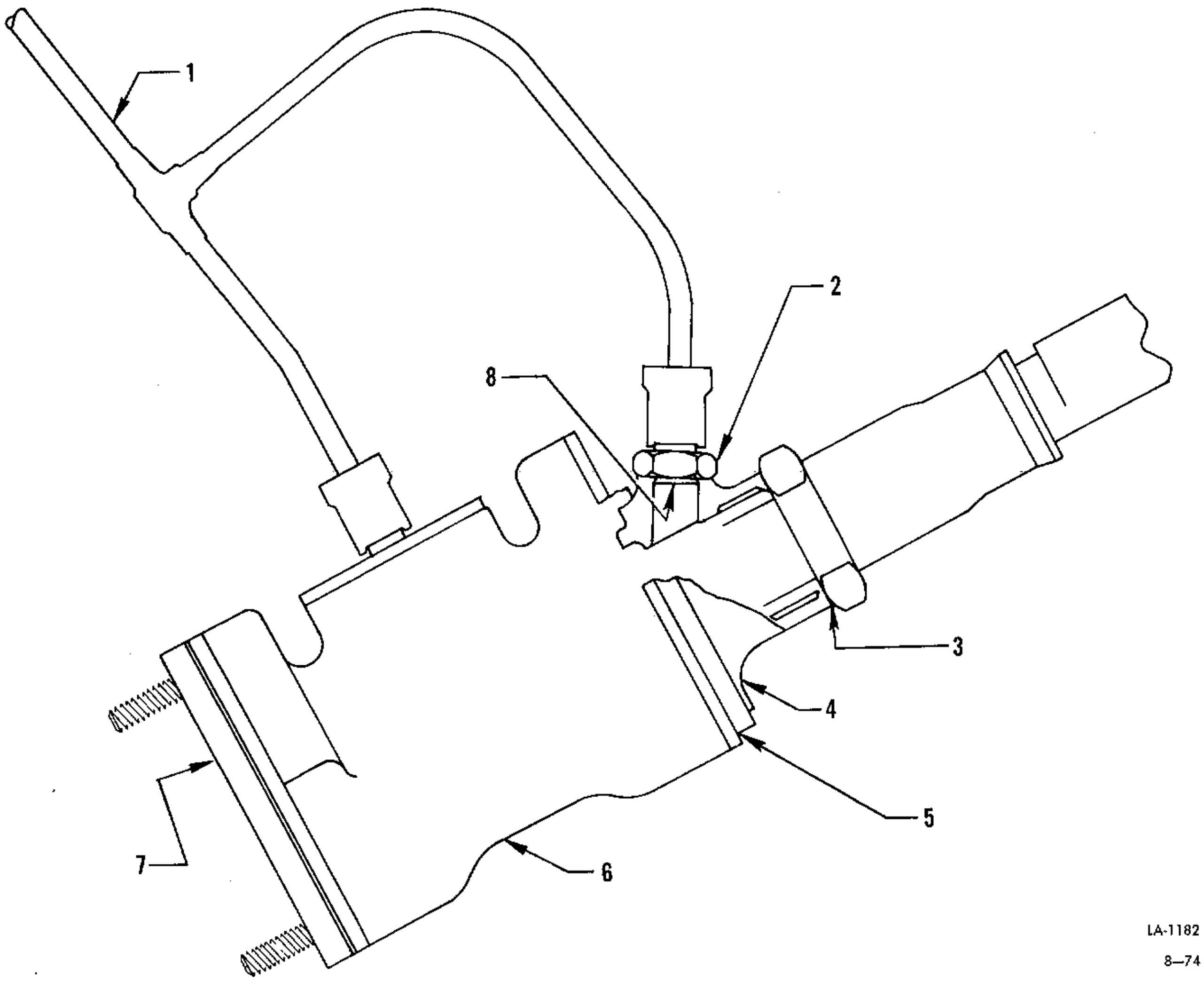
Key to figure 2-51G-9

1. Assemble with seal element in position shown.
2. Packing
3. 0.370 inch maximum
4. Bearing
5. Snapring - outer
6. Snapring - inner
7. Packing
8. Flexible shaft core
9. Snapring
10. Seal
11. Fuel control flexible shaft flange
12. Adapter and packing
13. Metal heat shield
14. Main gearbox assembly
15. Locknut and packing
16. Plug and packing
17. Lockwire
18. Tee assembly
19. Adapter
20. Packing
21. Drain tube assembly
22. Lockwire, both directions.
23. Flexible shaft casing
24. Packing
25. 0.370 inch maximum adjusted gap
26. Bearing assembly



1. Distance after adjustment, 1.890 ±0.050 inches
2. Free turbine bevel gearshaft assembly
3. Flexible shaft core
4. Packing
5. Plug

Figure 2-51G-10. Bevel Gearshaft Assembly



1. Manifold assembly
2. Adapter
3. Packing
4. Flange
5. Gasket
6. Free turbine gearbox assembly
7. Secure this flange with two nuts prior to taking cable length measurement.
8. Packing

Figure 2-51G-11. Manifold Assembly Installation

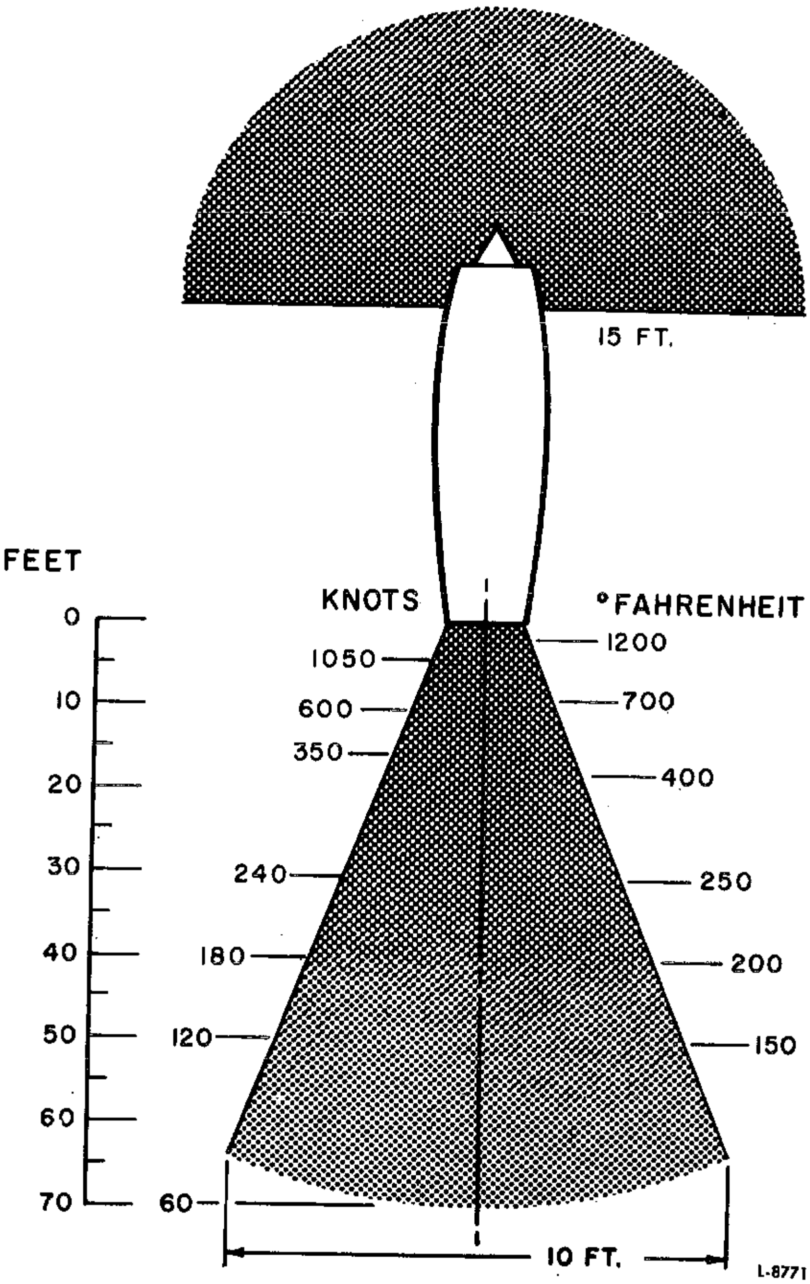


Figure 2-51H. Intake and Exhaust Danger Area at Take-off Rating

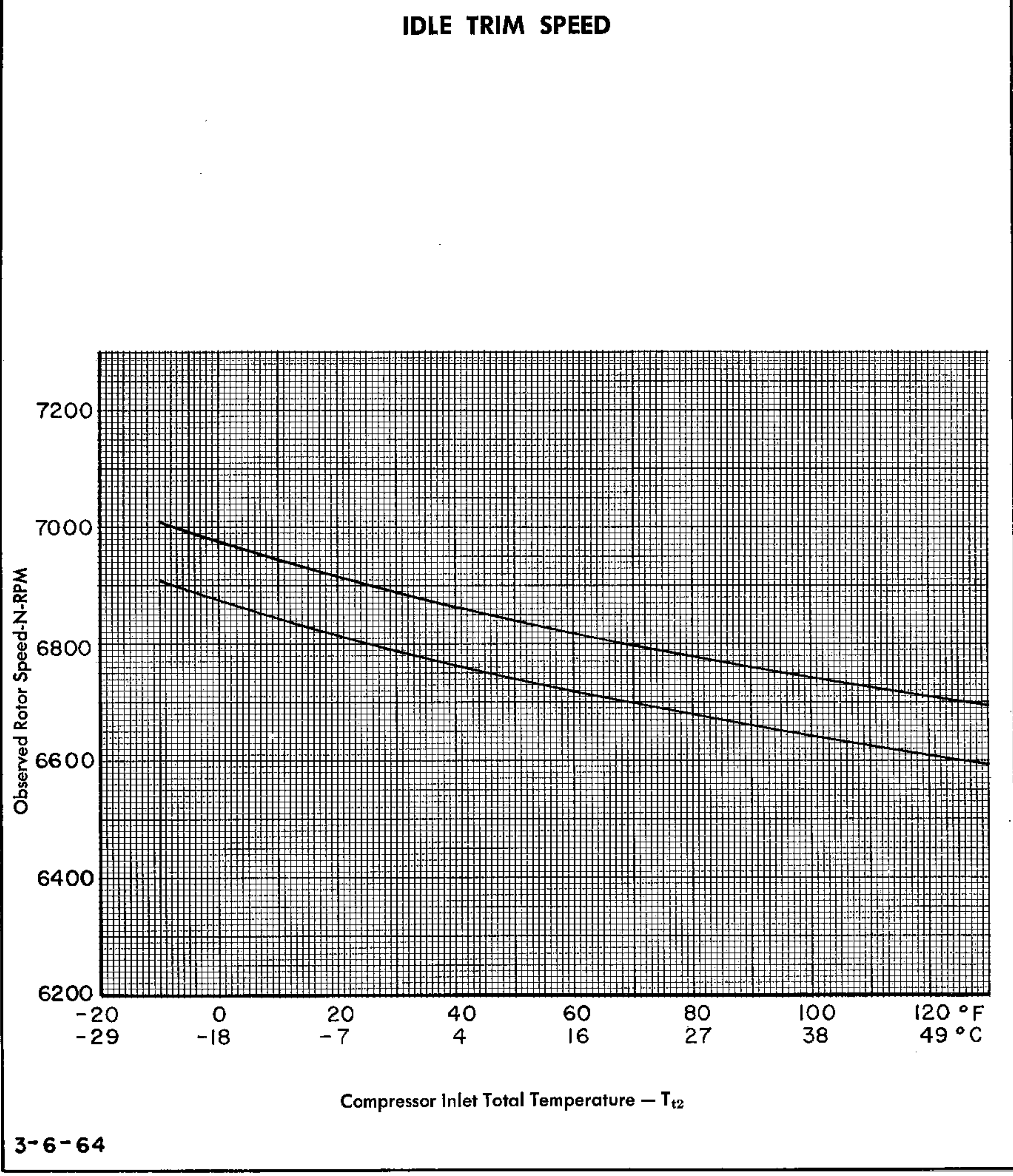


Figure 2-51R. Idle Trim Speed Curve

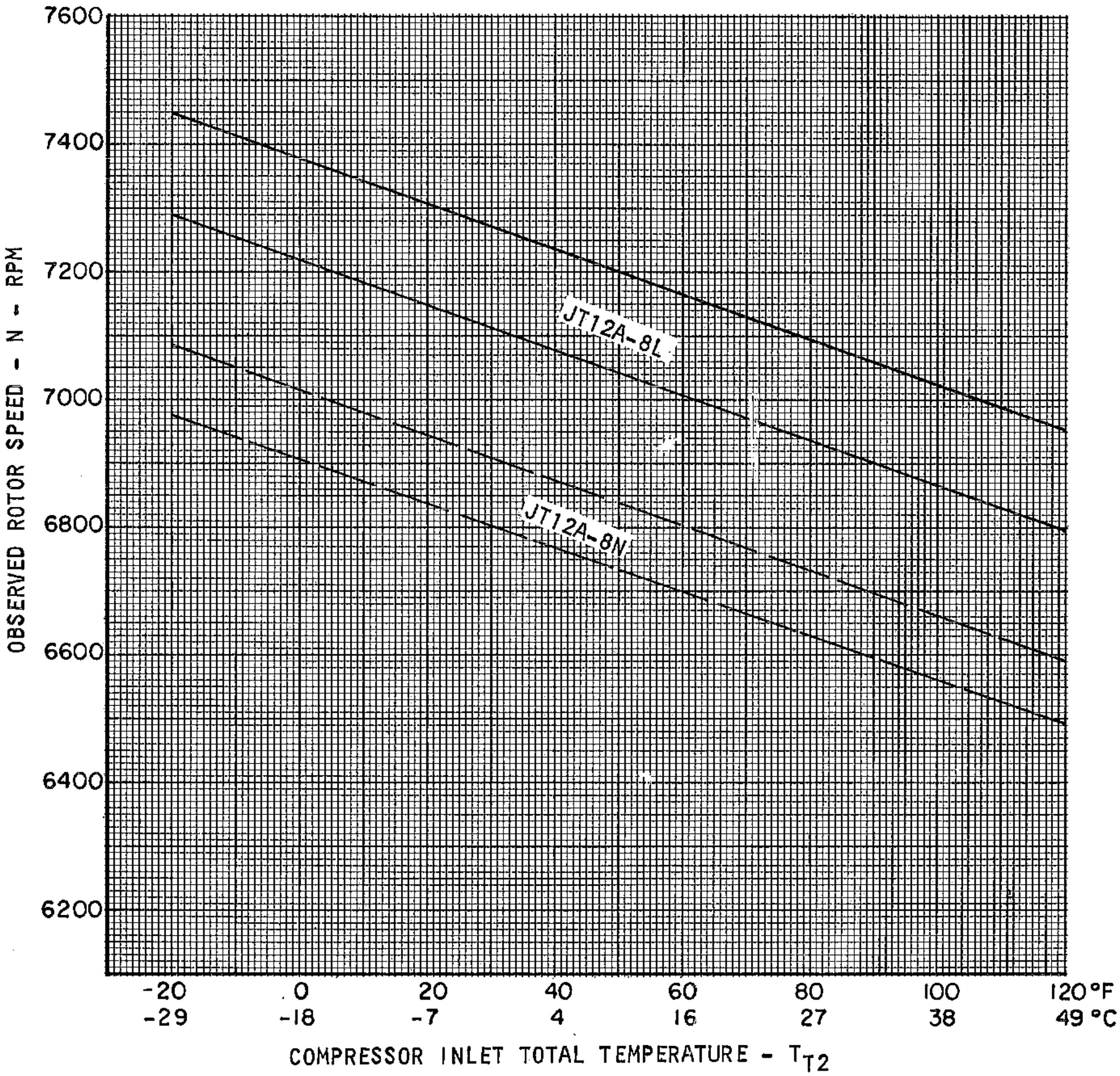


Figure 2-51S. JT12A-8 Idle Speed Trim Curve

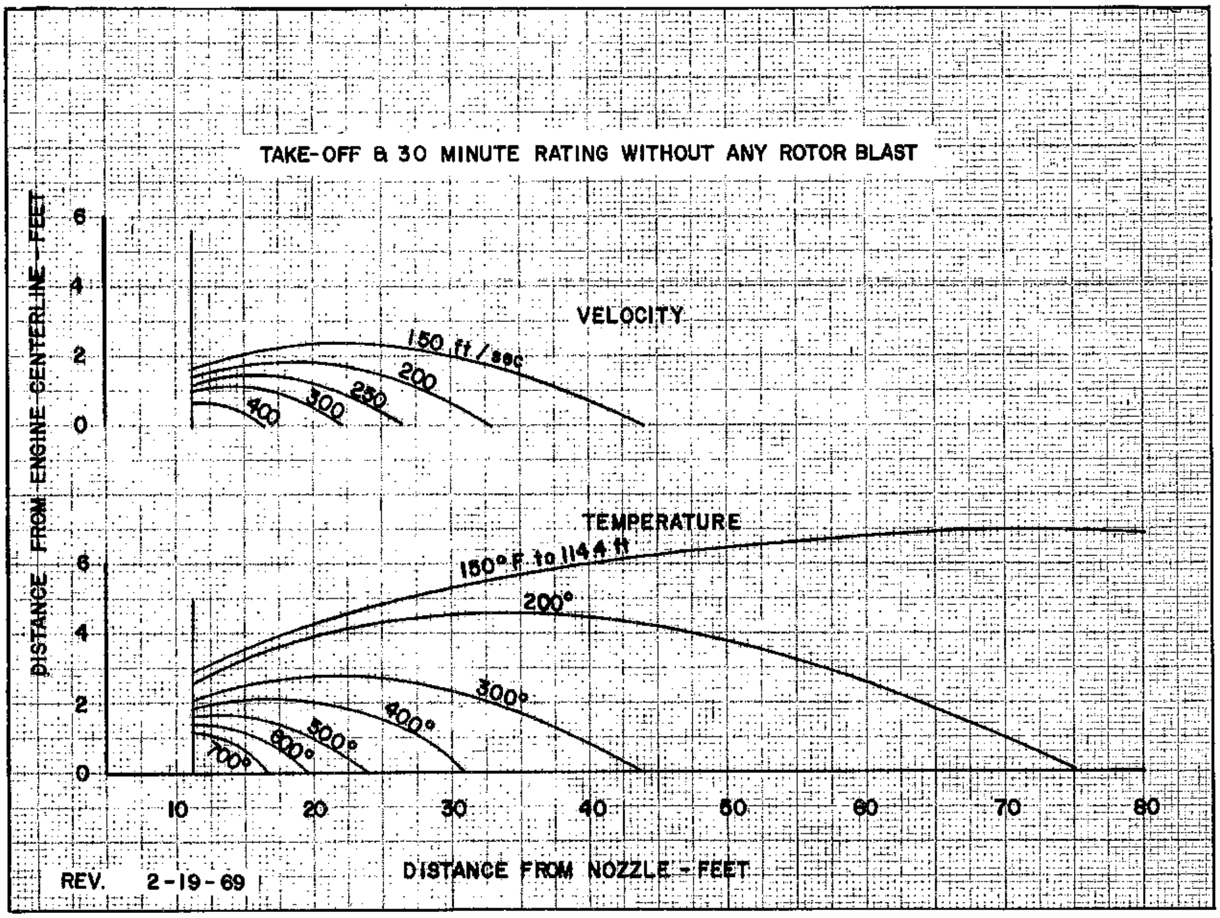


Figure 2-51H-1-1. Exhaust Danger Areas at Take-off Rating (JFTD12A-4A)

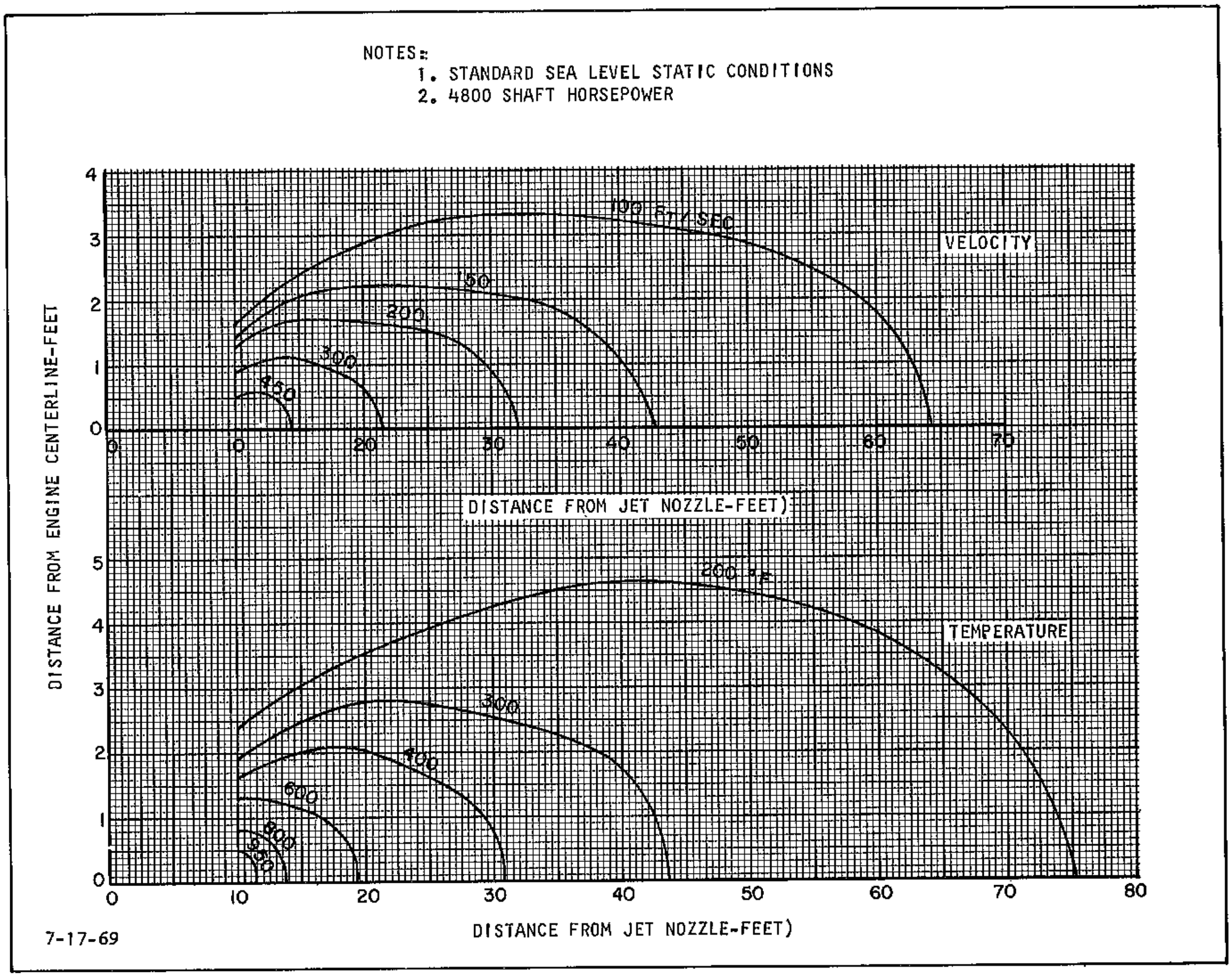


Figure 2-51H-1-2. Exhaust Danger Areas at Take-off Rating (JFTD12A-5A)

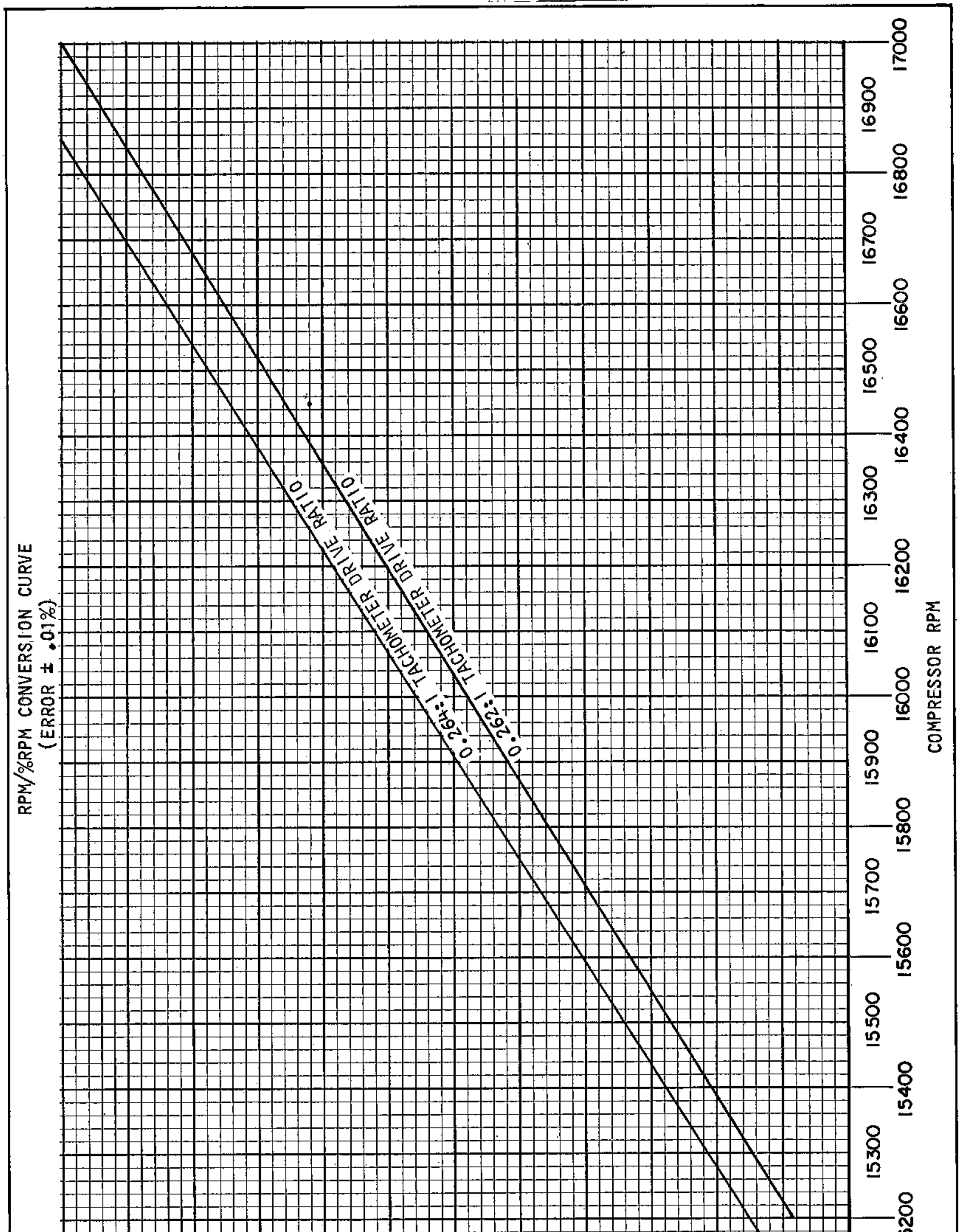


Figure 2-51H-1. RPM to Percent RPM Conversion Curve

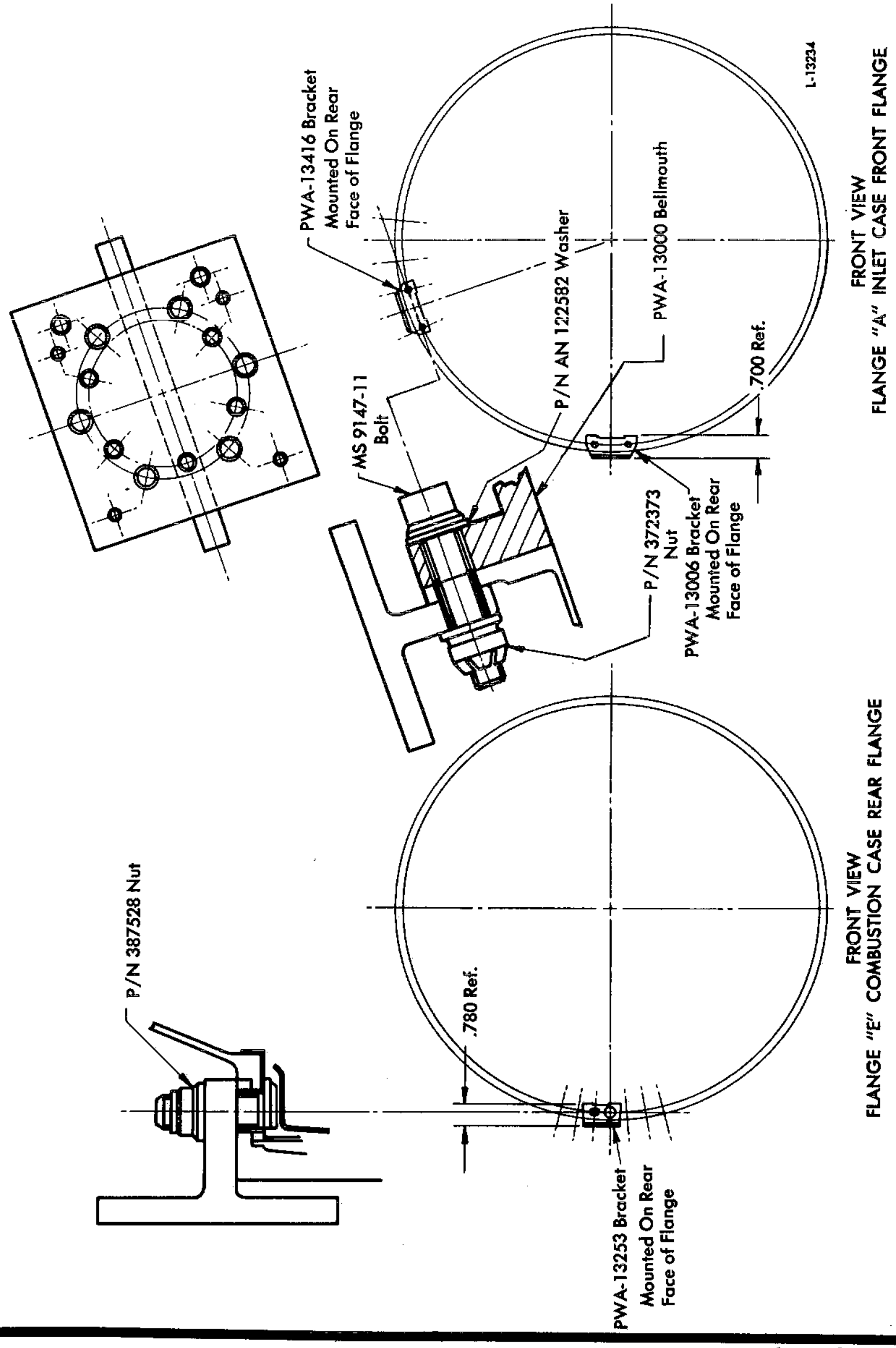


Figure 2—51H-2. Vibration Pickup Mount Bracket Locations (Sheet 1 of 2)

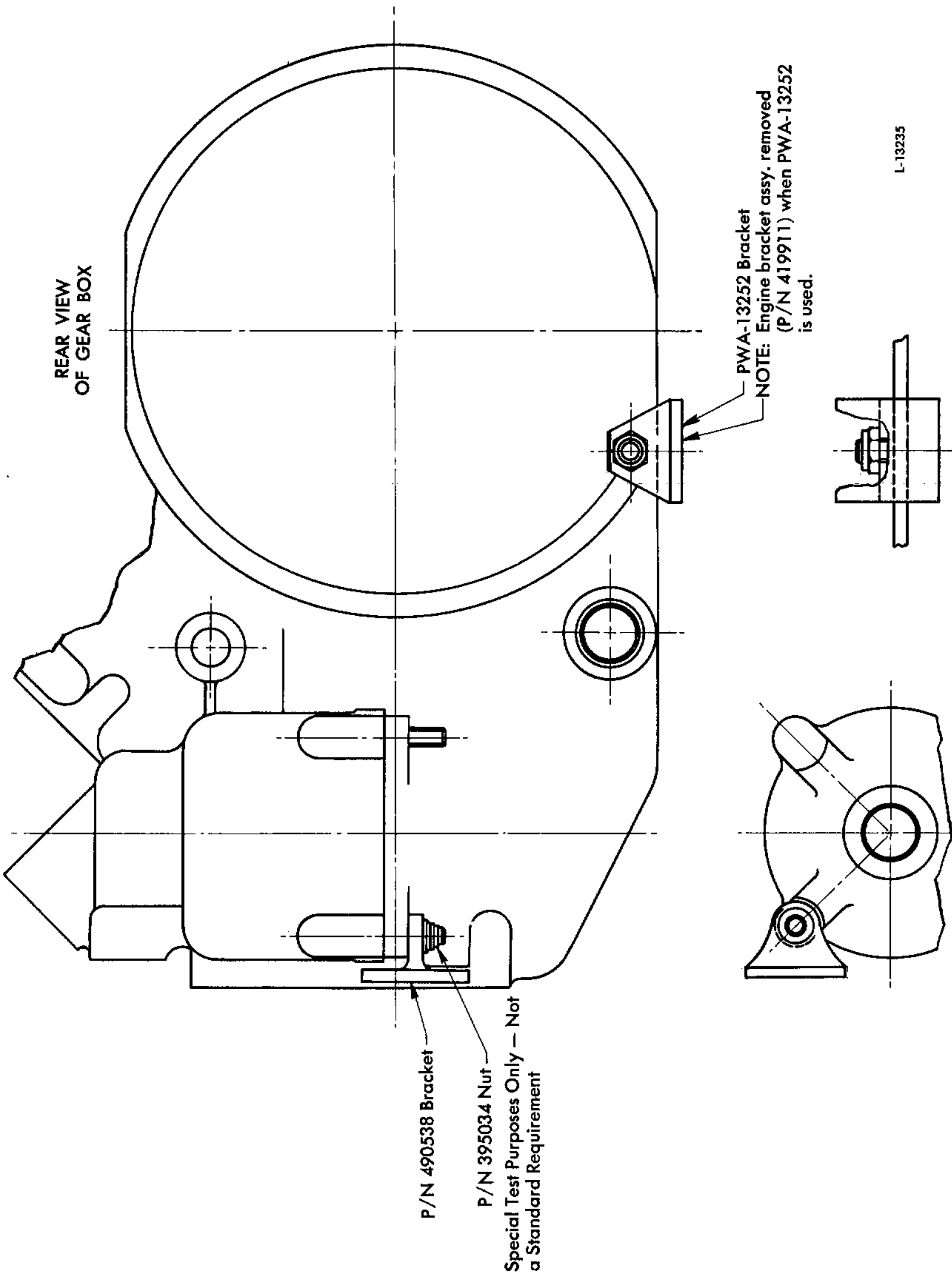


Figure 2–51H-2. Vibration Pickup Mount Bracket Locations (Sheet 2 of 2)

(2) Compressor Inlet Case Front Flange - on right-hand side of engine at horizontal centerline.

(3) Combustion Chamber Case Rear Flange - on right-hand side of engine at horizontal centerline.

(4) Component Drives Gearbox - on bottom left-hand stud of gearbox cover (on rear of gearbox).

h. Install oil pressure transmitter at oil pressure gage connection (located near oil temperature thermocouple). Tighten transmitter to required torque. (See Reference 833, Table of Limits.)

i. Attach inlet screen to bellmouth.

j. Install inlet pressure probes in bellmouth.

k. Attach test thermocouple harness to bellmouth screen with long lead toward bellmouth. Position leads equally around screen.

l. Install bellmouth and screen.

m. Bolt turbine exhaust nozzle to turbine exhaust case.

2-267. INSTALLATION OF ENGINE IN TEST STAND (TURBOJET ENGINES).

a. Lift engine from transport stand and attach left and right rear test mounts to diffuser case pads with bolts. Install two rear mount adapters.

b. Install test mount at 12 o'clock position on combustion chamber case and secure engine in test stand.

c. Level engine.

d. Connect fuel supply to fuel pump inlet.

e. Connect engine power control lever to linkage of operator's power lever.

CAUTION

On engines equipped with Holley fuel controls, do not disturb fuel control quadrant pointer. Resultant misindexing of internal parts requires control recalibration.

CAUTION

When rigging power lever linkage on engines equipped with Hamilton Standard fuel controls, and before tightening shaft nut, bottom the index pin with head or pointer end flush against power lever shaft to ensure proper contact of index pin with power lever stop.

f. If remote trimmer is to be used, install at this time.

NOTE

It is suggested that a remote trimmer, as is available from Lear Siegler Inc., be employed when trimming engine.

g. Attach instrumentation leads to turbine discharge temperature and pressure connections.

h. Connect all test stand lines to test accessories and instrumentation installed when engine was dressed.

i. Connect electrical lead to wiring harness.

2-268. PRESTARTING INSPECTION.

2-269. FUEL SYSTEM.

a. Visually inspect all fuel system tubes and components for security and leakage.

b. Remove, replace if contaminated, and install fuel pump filter.

c. Remove, clean if necessary, and install fuel control inlet screen.

d. Check fuel system for presence of water.

2-270. OIL SYSTEM.

a. Remove, disassemble, clean, and reinstall main oil strainer.

b. Visually check all of oil system tubes and components for security and leakage.

c. Check oil level at tank.

(1) If tubing and scavenge sections are "dry" it will require approximately one quart of oil to wet the system. After first start, run engine one minute at idle, shut down, and recheck oil level at tank.

(2) If oil system was not disturbed during maintenance, it is possible that excess oil may have drained into scavenge compartment. After first start, run engine for one minute at idle, shut down, and recheck oil level at tank.

CAUTION

An excessive oil supply may result in a buildup of oil tank internal pressure, loss of oil through breather, and internal gas path leakage.

2-271. ELECTRICAL SYSTEM.

a. Check ignition system components for security.

b. Remove both igniter plugs, check, and reinstall.

WARNING

Because the voltage to the igniter plugs is dangerously high, ignition switch must be in OFF position before removal of any of ignition system components. Ignition must be inoperative for at least three minutes before disconnecting igniter leads. Touch end of lead to shell of igniter to dissipate residual energy.

CAUTION

Insufficient torque on high tension lead nut at igniter plug end can cause ignition radiated noise to be picked up by the aircraft radio equipment.

2-272. INSTRUMENTATION SYSTEM.

a. Check engine instrumentation for security and general condition.

b. Inspect pressure sensing probes for security.

c. Visually check all indicating thermocouples for security.

d. Check thermocouples and all lead insulation and shieldings for chafing and security.

2-273. ENGINE CONTROLS. Check power lever for full travel, ease of movement, and security.

CAUTION

To prevent dilution of bearing lubricating medium, protect pre-packed bearings used in power lever cross shaft and compressor bleed valve during any washing process. Same precautions must be taken when fuel lines near these assemblies are disconnected and fuel is, or may be, in these lines.

2-274. RUN-UP AREA AND ENGINE INLET DUCT.

a. Engine inlet must be thoroughly inspected and cleaned of loose nuts, bolts, tools, and other objects which could cause engine damage and possible subsequent failure.

b. Inspect inlet and exhaust areas and remove any loose objects which might possibly be ingested by engine or be blown rearward by high velocity of jet wake.

2-275. ENGINE TEST LIMITS.

NOTE

Due to the phase out of the JFTD12A-1 engine, test data for this engine has been deleted.

2-276. GENERAL.

2-277. Pratt & Whitney Aircraft has consistently recommended measurement and setting of engine thrust by use of turbine discharge pressure and compressor inlet pressure as primary parameters, while using engine speed, tailpipe temperature, and fuel flow as secondary parameters to monitor engine condition, and as limits. Engine speed is not sufficiently accurate indicator of thrust to provide adequate control of engine thrust and internal conditions under normal service operation. Therefore, engine fuel control is adjusted to obtain desired turbine discharge pressure (P_{t5}) shown on applicable engine trim curves. Engine trim curves supplied with this manual are applicable for test stand operation with specified fuel, using:

a. PWA exhaust nozzle, inlet bellmouth, and screen.

b. Calibrated P_{t5} gage and tachometer.

c. No compressor airbleed.

d. No load on accessory drives.

e. Tapered P_{t5} probe assembly of P/N 443 series only.

2-278. If it is desired to trim engine installed in airframe, airframe manufacturers trim curves, corrected for specific inlet duct losses, must be used.

2-279. Accuracy of instrumentation used for test cell shall conform to the following.

Ambient temperature	±1°F
Ambient pressure	±0.01" Hg
(engine installed)	±0.05" Hg
Turbine discharge pressure (P_{t5})	±0.10" Hg
(engine installed)	±0.25" Hg
Turbine discharge temperature (T_{t5})	±5°F
Fuel Flow	±1%
Compressor Speed (N)	±0.1%

NOTE

PWA-15222 trimmer, or other equipment having same accuracy, may be used for trim purposes with engines installed in aircraft.

2-280. Following symbols have been designated for various stations within engine and external working pressures and temperatures:

Amb - Ambient Temperature (T) or Pressure (P)
T_{t2} - Compressor Inlet Total Temperature
P_{amb} - Compressor Inlet Ambient Pressure
N - Compressor Rpm
T_{t5} - Turbine Discharge Total Temperature
P_{t5} - Turbine Discharge Total Pressure
P_{t5}/P_{amb} - Engine Pressure Ratio
TB - True Barometer (Inches Hg Absolute)

2-281. Tables 2-3A, 2-3A-1, 2-3A-3, and 2-3A-4 show engine operating limits.

2-282. FUEL SYSTEM.

a. Fuel conforming to Specification PWA-522 shall be used.

NOTE

Engine must be tested using same grade fuel that will be used for flight operations. Slight variations in thrust for any given power lever position will result if alternate grade fuels are employed. If different grade of fuel is used for flight operation, engine should be retrimmed.

b. Inlet pressure at fuel pump shall be five to 20 psig.

c. During engine run overboard drain seal leakage from main engine fuel control, fuel pump, and pressurizing and dump valve shall be collected in individual containers. Individual leakage of listed components shall not exceed the following limits:

(1) Pressurizing and dump valve - 300 cc/hr (measured only during engine run).

(2) Fuel control - 20 cc/hr.

2-283. OIL SYSTEM.

a. Oil conforming to Service Bulletin No. 238 shall be used.

b. Oil consumption shall not exceed 0.11 gallons per hour during Test No. 3.

NOTE

Due to short duration of test, newly repaired engines may initially consume slightly greater amount of oil. Therefore, if initial oil consumption figure from acceptance test is greater than 0.11 gallons per hour but less than 0.35 recheck should be made involving two hours of continuous engine operation including two acceptance runs plus balance of time at normal rate power.

TABLE 2-3A. JT12A-6 AND JT12A-6A ENGINE STATIC GROUND CHECK CHART

THRUST SETTING	LIMITS			
	Time Limits (Minutes)	Maximum Indicated Exhaust Gas Temp.	Normal Oil Pressure (Psig)	Oil Temperature
Take-Off	5	See Figure 2-51H-2-1 for JT12A-6 and Figure 2-51H-2-1A for JT12A-6A.	40 to 50	121°C (250°F) Max.
Maximum Continuous	Continuous			
Idle	Continuous	515°C (959°F)	35 Minimum	
Starting	Momentary	525°C (977°F)		
Acceleration	2	666°C (1230°F)	40 to 50	121°C (250°F) Max.

TABLE 2-3A-1. ENGINE STATIC GROUND CHECK CHART FOR JT12A-8

Operating Condition	Time Limits (Minutes)	Maximum Indicated Turbine Discharge Temperature	Normal Oil Pressure (Psig)	Oil Temperature (Inlet)
Take-Off	5	Must fall below line on Figure 2-51H-2-2	40 to 50	121°C (250°F) Max.
Maximum Continuous	Continuous			
Idle	Continuous	515°C (959°F)	35 Minimum	
Starting	Momentary	525°C (977°F)		
Acceleration	2	707°C (1305°F)		121°C (250°F) Max.

TABLE 2-3A-2. Deleted.

c. Breather pressure, measured at oil tank, shall not exceed two inches Hg during steady state operation or four inches Hg during acceleration.

d. Engine Oil Temperature Operating Limits.

(1) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 120°C (248°F) for less than ten minutes and does not exceed 145°C (293°F), engine may continue in service only after cause of overtemperature has been determined and corrected.

(2) If oil-in temperature exceeds maximum steady state temperature limit of 121°C (250°F) for more than ten minutes or exceeds 145°C (293°F) for less than 15 minutes but does not "peg out" to 150°C (302°F), engine oil shall be drained, all external oil screen elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature.

(3) After complying with above and provided no engine damage is indicated, engine may be continued in service.

TABLE 2-3A-3. JFTD12A-4A ENGINE STATIC GROUND CHECK CHART

OPERATING CONDITION		OPERATING LIMITS		
Power Rating	Time Limits (Minutes)	Maximum Indicated Exhaust Gas Temperature	Oil Pressure (PSIG) Normal	Oil Temperature Range
Take-Off	5	See Figure 2-51H-2-4.	45 to 55	15° to 121°C (59° to 250°F)
30 Minute Power	30			
Maximum Continuous	Continuous			
Ground Idle (1)		515°C (959°F)	20 Minimum	-10° to 121°C (14° to 250°F)
Flight Idle (2)		515°C (959°F)	40 Minimum	
Starting		525°C (977°F)	5 to 25	
Acceleration		688°C (1270°F)	45 to 55	15° to 121°C (59° to 250°F)

NOTE

(1) At approximately 6560 rpm.

(2) At approximately 11,000 rpm.

TABLE 2-3A-4. JFTD12A-5A ENGINE STATIC GROUND CHECK CHART

OPERATING CONDITION		OPERATING LIMITS		
Power Rating	Time Limits (Minutes)	Maximum Indicated Exhaust Gas Temperature	Oil Pressure (PSIG) Normal	Oil Temperature Range
Take-Off	5	See Figure 2-51H-2-5.	45 to 55	15° to 121°C (59° to 250°F)
30 Minute Power	30			
Maximum Continuous	Continuous			
Ground Idle (1)		515°C (959°F)	20 Minimum	-10° to 121°C (14° to 250°F)
Flight Idle (2)		515°C (959°F)	40 Minimum	
Starting	Momentary	525°C (977°F)	5 to 25	

NOTE

(1) At approximately 6560 rpm.

(2) At approximately 11,000 N_1 rpm.

(4) If oil-in temperature exceeds 150°C (302°F) at any time or is above 145°C (293°F) for more than 15 minutes, remove engine to overhaul and inspect all main and accessory drive bearings for hardness and condition. All main shaft seals shall be inspected for condition.

2-284. ELECTRICAL SYSTEM. Test stand electrical system shall provide normal voltage of 24 volts DC to engine ignition system. Maximum voltage at input terminals of ignition system shall be 14 to 29 volts DC with maximum five ampere current load at 29 volts.

2-285. ENGINE VIBRATION.

a. Vibration monitoring provides indication of correct assembly.

b. Vibration amplitude must be observed during steady state operation at all speeds in operating range and must not exceed limits listed below. (See Table 2-3B.) During transient operating conditions, momentary vibration peaks in excess of listed limits are not cause for rejection provided steady state vibration is within limits.

2-285A. VIBRATION MEASURING EQUIPMENT.

a. Standard vibration measuring equipment for engine test consists of following or suitable equivalent combination:

TABLE 2-3B. VIBRATION LIMITS FOR ENGINES IN TEST STAND WITH STANDARD PWA-13000 BELLMOUTH OR REMOTE MOUNTED BELLMOUTH INSTALLED

Location	Below Normal Rated (Double Amplitude)	At or Above Normal Rated (Double Amplitude)
Inlet Case (Horizontal)	3.2	2.4
Inlet Case (Vertical)	3.2	2.4
Combustion Chamber Case	2.4	2.4
Accessory Case	3.2	2.4

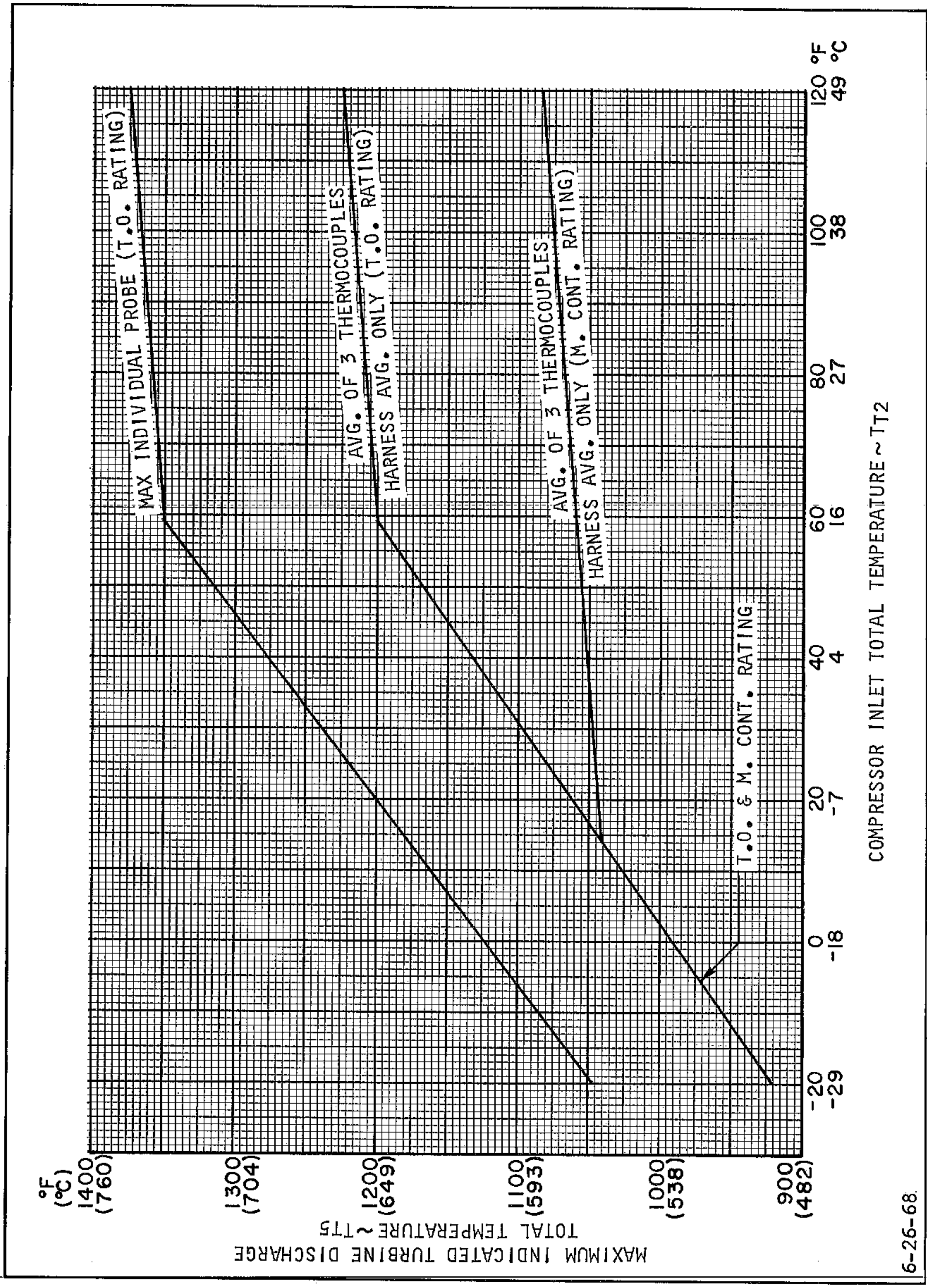


Figure 2-51H-2-1. Maximum Indicated Average Turbine Discharge Total Temperature (JT12A-6 and -6A)

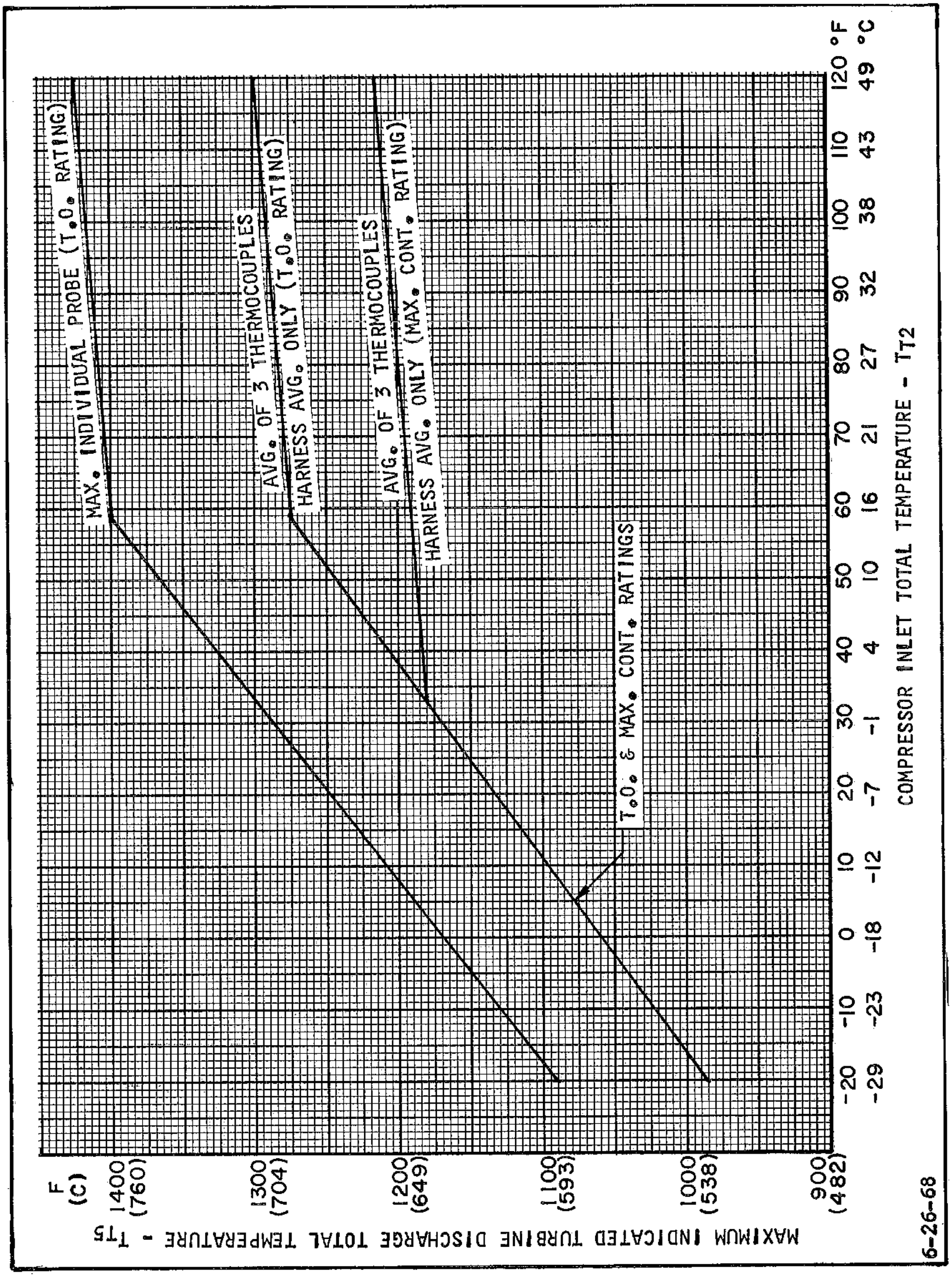


Figure 2-51H-2-2. Maximum Indicated Turbine Discharge Total Temperature (JT12A-8)

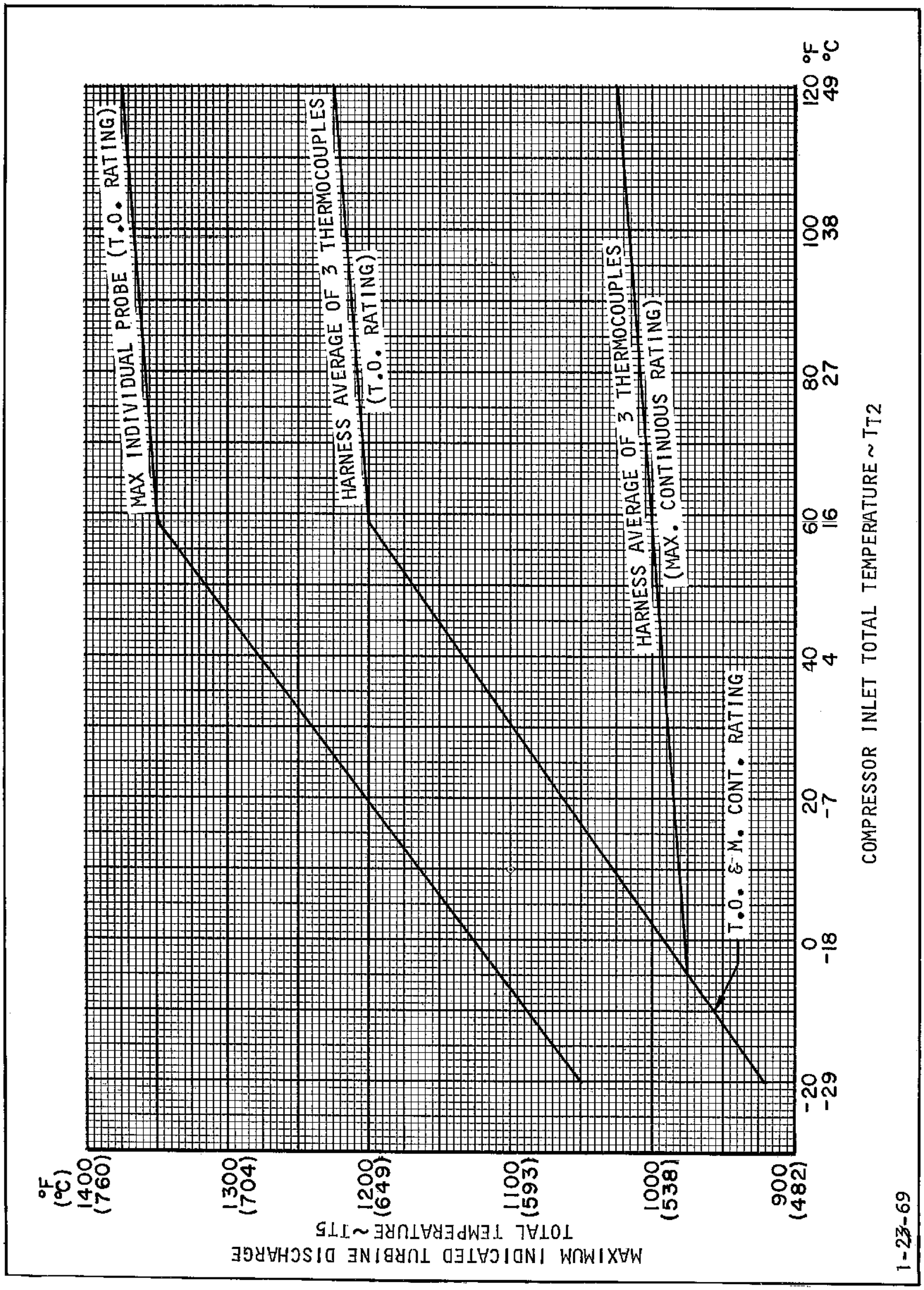


Figure 2-51H-2-1. Maximum Indicated Turbine Discharge Total Temperature (JT12A-6)

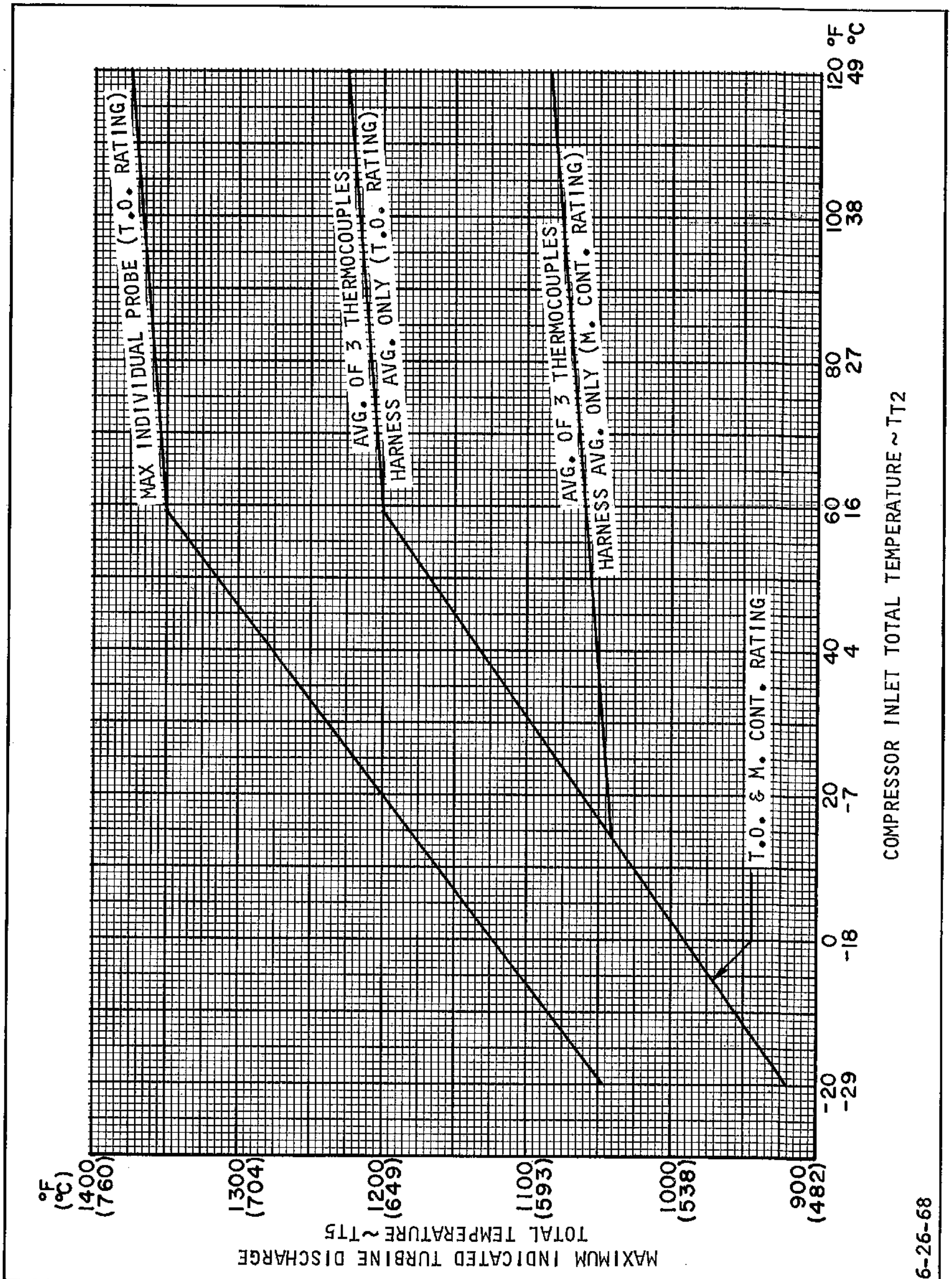


Figure 2-51H-2-1A. Maximum Indicated Turbine Discharge Total Temperature (JT12A-6A)

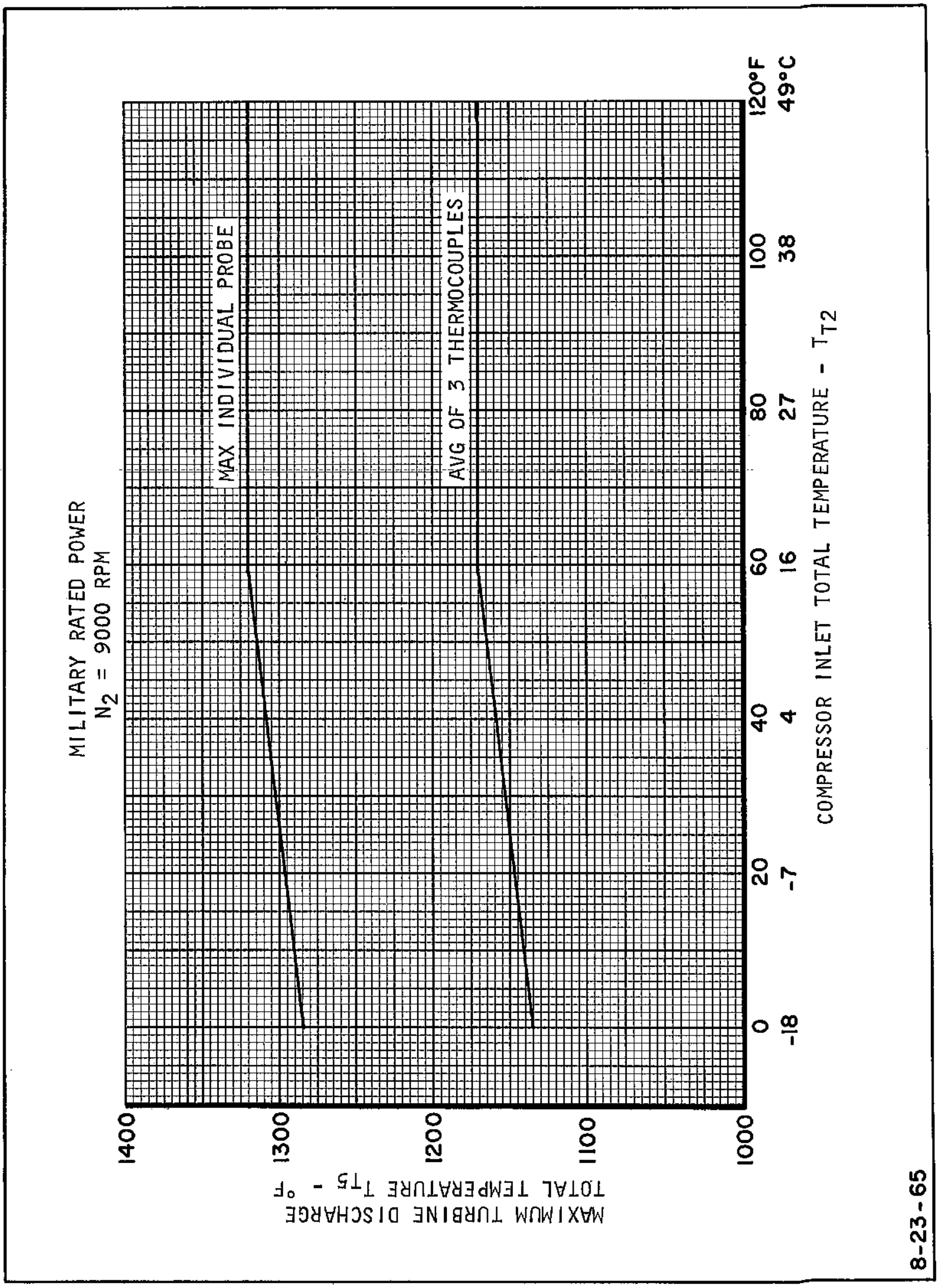


Figure 2-51H-2-3. Maximum Indicated Turbine Discharge Total Temperature (JFTD12A-1)

(1) Model ED-156-4 vibration meter manufactured by Glenn Hathaway Electronics, Box 979, Canaan, Connecticut.

(2) Compatible 40 cps filter for the vibration meter.

(3) Model 4-118 or 4-123 vibration pickup manufactured by Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, California.

b. The vibration indicator and filter must be calibrated often enough to ensure accuracy. The frequency (in cps) versus the relative frequency response (in percent) shall fall within the band of Figure 2-51H-3.

c. A transite, or equivalent, pad must be placed between the pickup and the bracket at the combustion chamber outer case location.

2-286. ENGINE OVERSPEED.

TABLE 2-3C. ENGINE OVERSPEED PROCEDURE FOR TURBOJET ENGINES

Condition	Action Required
If observed N_1 rotor speed exceeds 16700 rpm but does not exceed 16900 rpm	(a) Check compressor for free rotation and visually inspect inlet and exhaust ducts for foreign particles or evidence of rubbing. Check compressor and turbine blades and vanes for damage. If found satisfactory, continue engine in service. (b) If any abnormal condition is evident, perform teardown inspection.
If observed N_1 rotor speed exceeds 16900 rpm	Shut down engine as soon as possible and send to overhaul for complete inspection of all rotating and associated parts (bearings, carbon seals, etc.).

NOTE

For engines with a 0.262:1 tachometer drive ratio:
16700 rpm = 104.2 percent
16900 rpm = 105.4 percent
For engines with a 0.264:1 tachometer drive ratio:
16700 rpm = 105 percent
16900 rpm = 106.2 percent

2-286A. The following tables (Tables 2-3C and 2-3C-1) list overspeed conditions and action to be taken when an overspeed occurs. If rotor speed falls within a category in the left-hand column of the table proceed in accordance with the applicable instructions in the right-hand column.

2-287. ENGINE OVERTEMPERATURE.

2-288. Overtemperature conditions usually are preceded by an excessively rapid rise in fuel flow, compressor speed, and/or temperature. Several momentarily high overtemperatures affect engine service life as seriously as a single prolonged lower temperature condition. The higher the temperature, the sooner serious engine damage occurs, and, therefore, the more extensive is the inspection required.

2-289. When an overtemperature condition is anticipated, or has occurred, perform engine shutdown per paragraph 2-300. Avoid an emergency shutdown unless it is obvious that continued operation will result in more than overtemperature damage.

2-290. Overtemperature limits and corresponding inspection procedures are presented in Tables 2-3D, 2-3D-1, 2-3E, and 2-3E-1 through 2-3E-5, and duplicated in Figures 2-51J, 2-51K, and 2-51K-1 through 2-51K-6.

2-291. The tables list overtemperature conditions in left-hand column and action to be taken in the right-hand column. If T_{t5} observed for a given length of time falls within a category listed in the left-hand column, proceed in accordance with the corresponding instructions in the right-hand column.

TABLE 2-3C-1. FREE TURBINE OVERSPEED PROCEDURE

Condition	Action Required
If observed N_2 rotor speed exceeds 10350 rpm but does not exceed 10800 rpm	(a) Remove and inspect N_2 speed sense cable. Inspect N_2 gearbox for positive rotation of cable drive output shaft during rotation of free turbine. (b) Check free turbine for free rotation and visually inspect exhaust ducts for particles or evidence of rubbing. Check turbine blades for damage. If found satisfactory, continue engine in service. (c) If any abnormal condition is evident, remove free turbine and send to overhaul.
If observed N_2 rotor speed exceeds 10800 rpm	Shut down free turbine as soon as possible and send to overhaul for complete inspection of all rotating and associated parts (bearings, carbon seals, etc.).

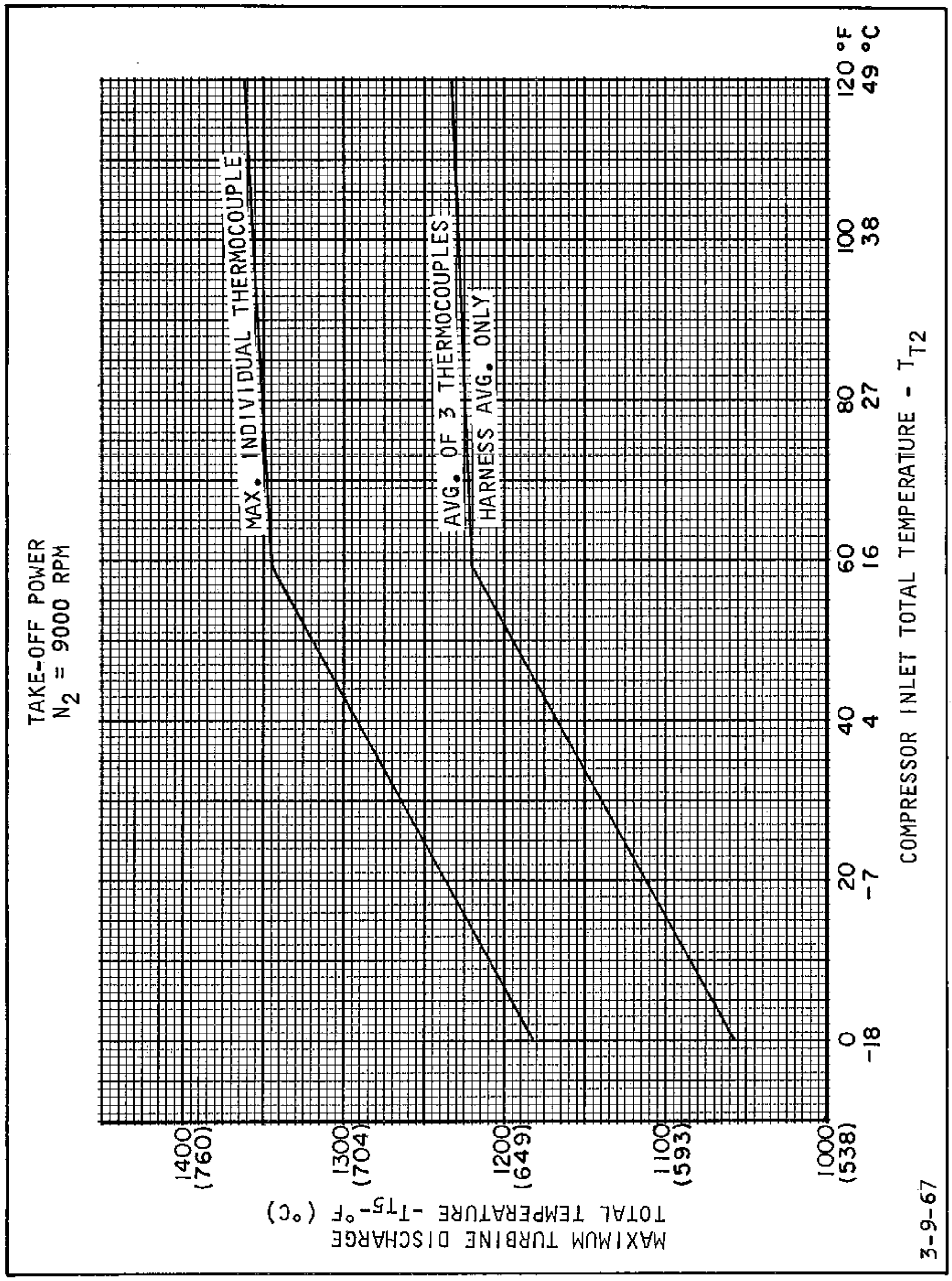


Figure 2-51H-2-4. Maximum Indicated Turbine Discharge Total Temperature (JFTD12A-4A)

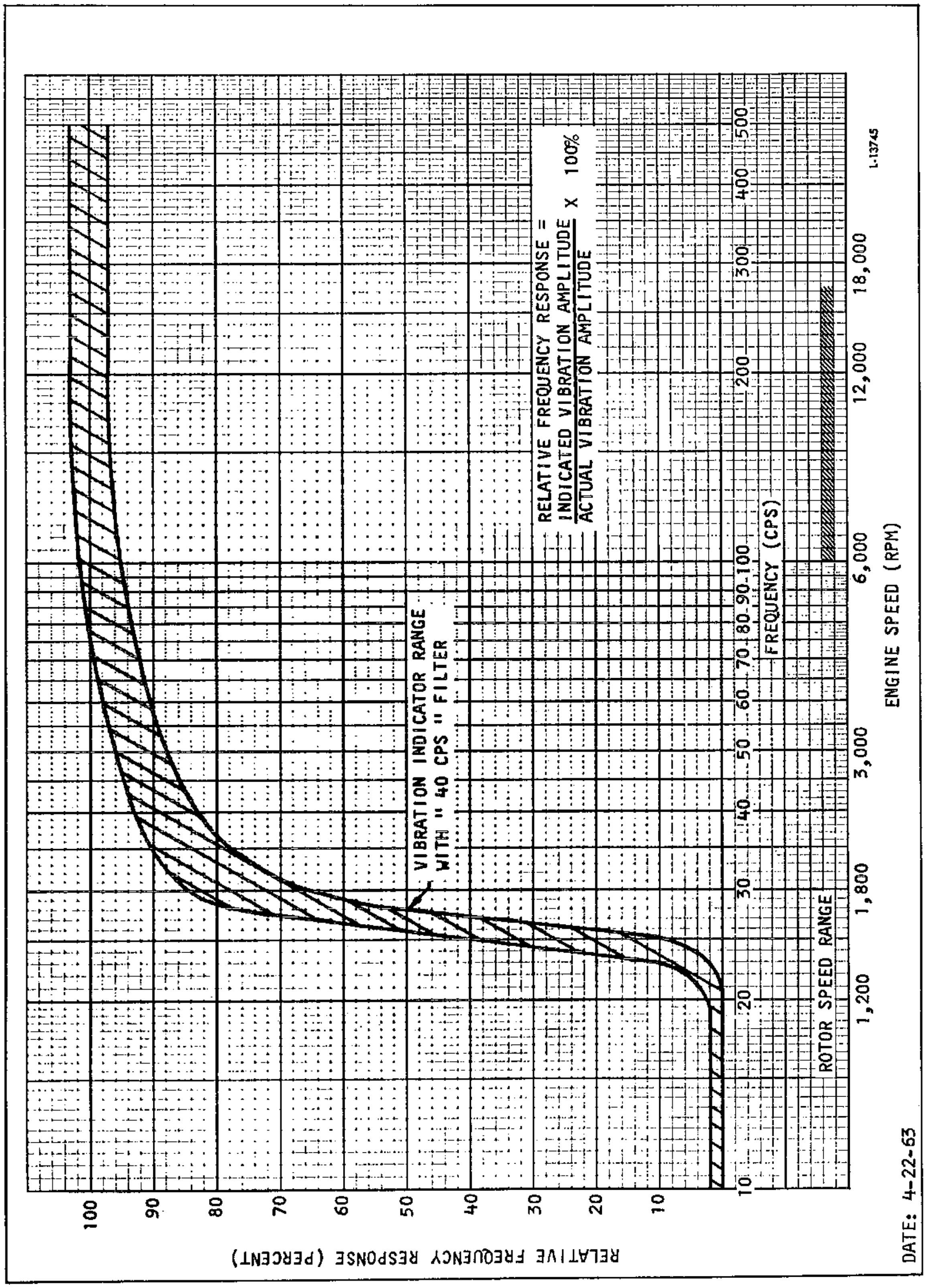


Figure 2-51H-3. Vibration Indicator and Filter Characteristics

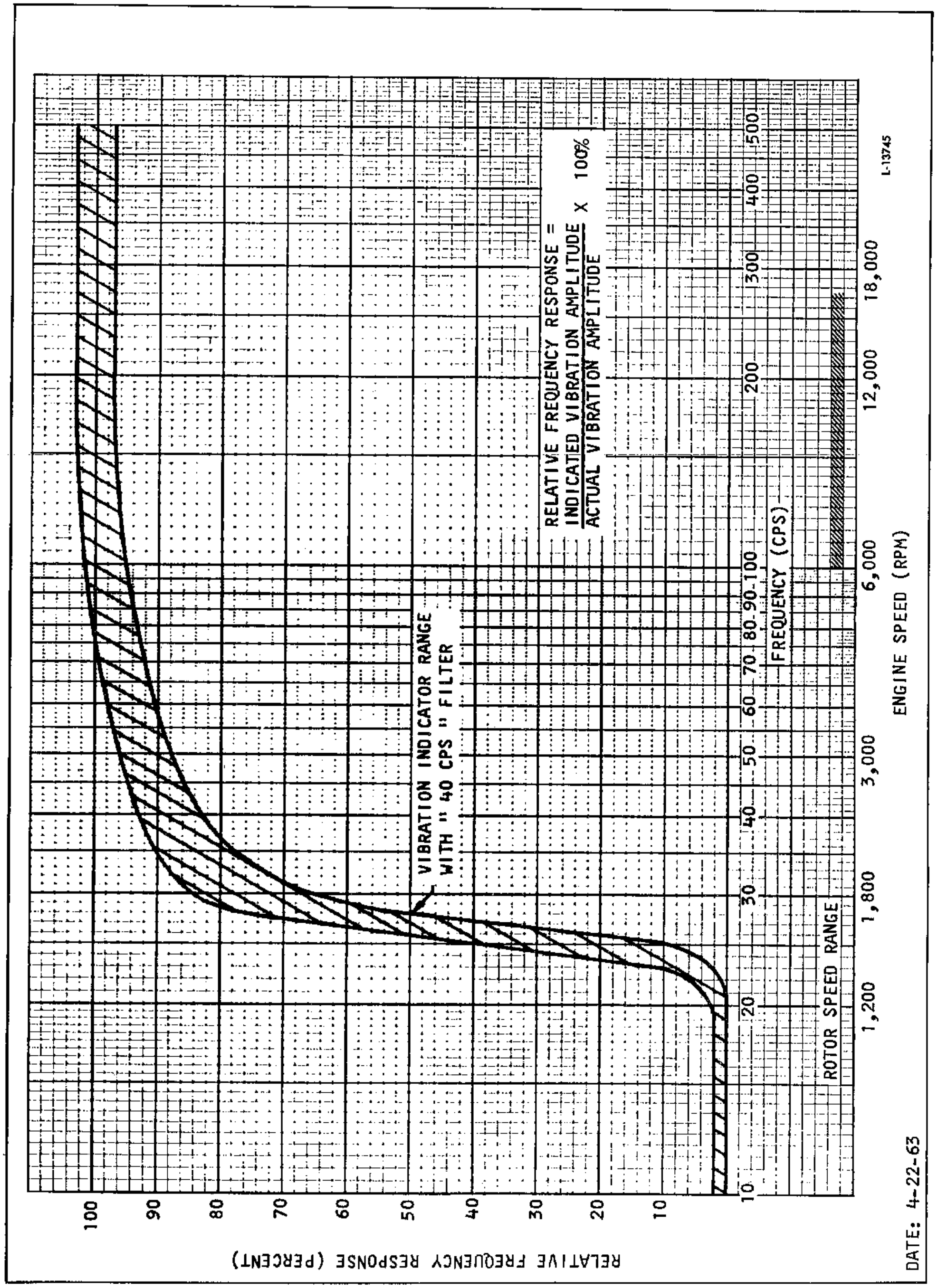


Figure 2-51H-3. Vibration Indicator and Filter Characteristics

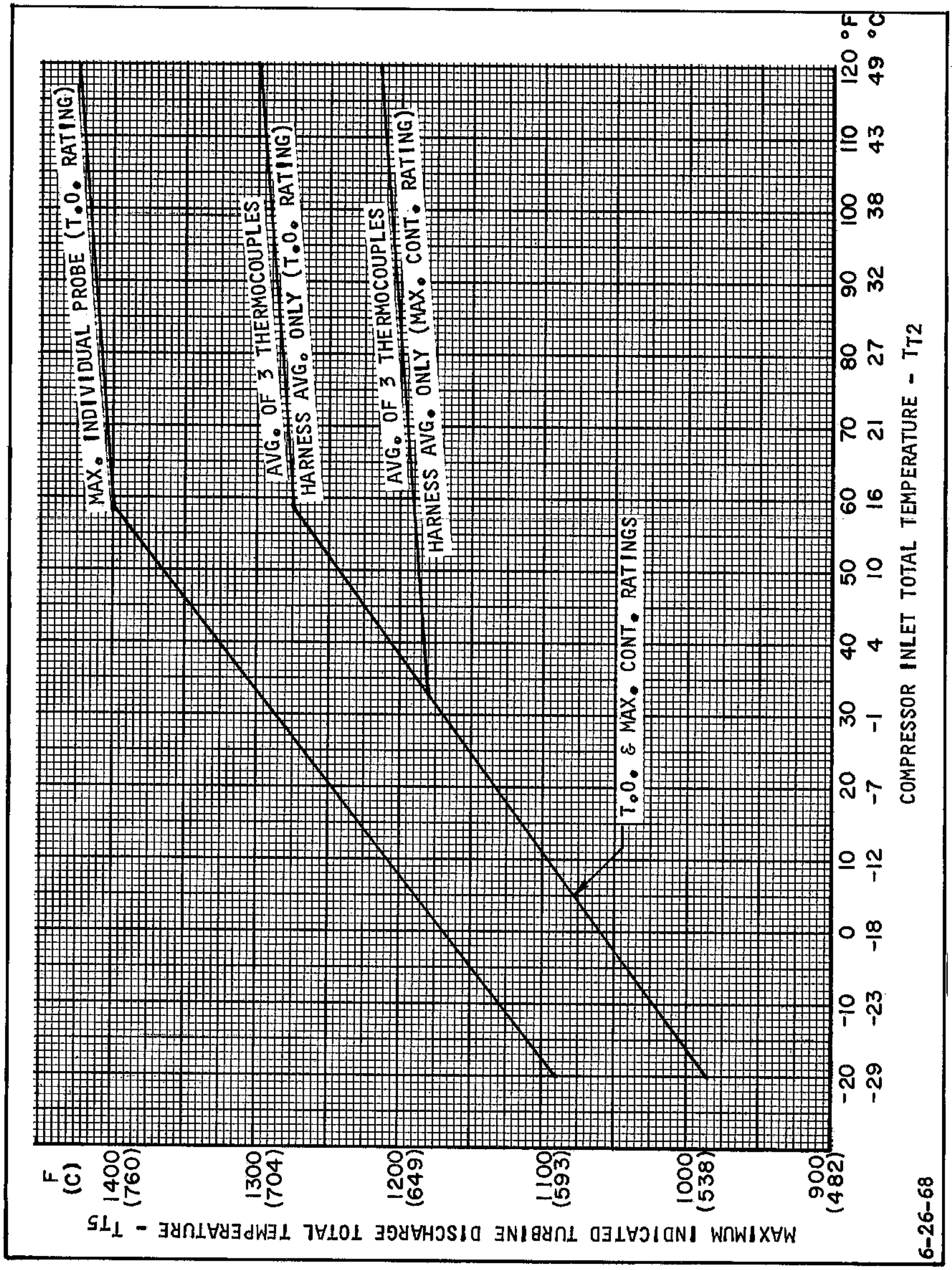


Figure 2-51H-2-2. Maximum Indicated Turbine Discharge Total Temperature (JT12A-8)

Figure 2-51H-2-3. Deleted.

All data on page 2-58F-7/2-58F-8 deleted.

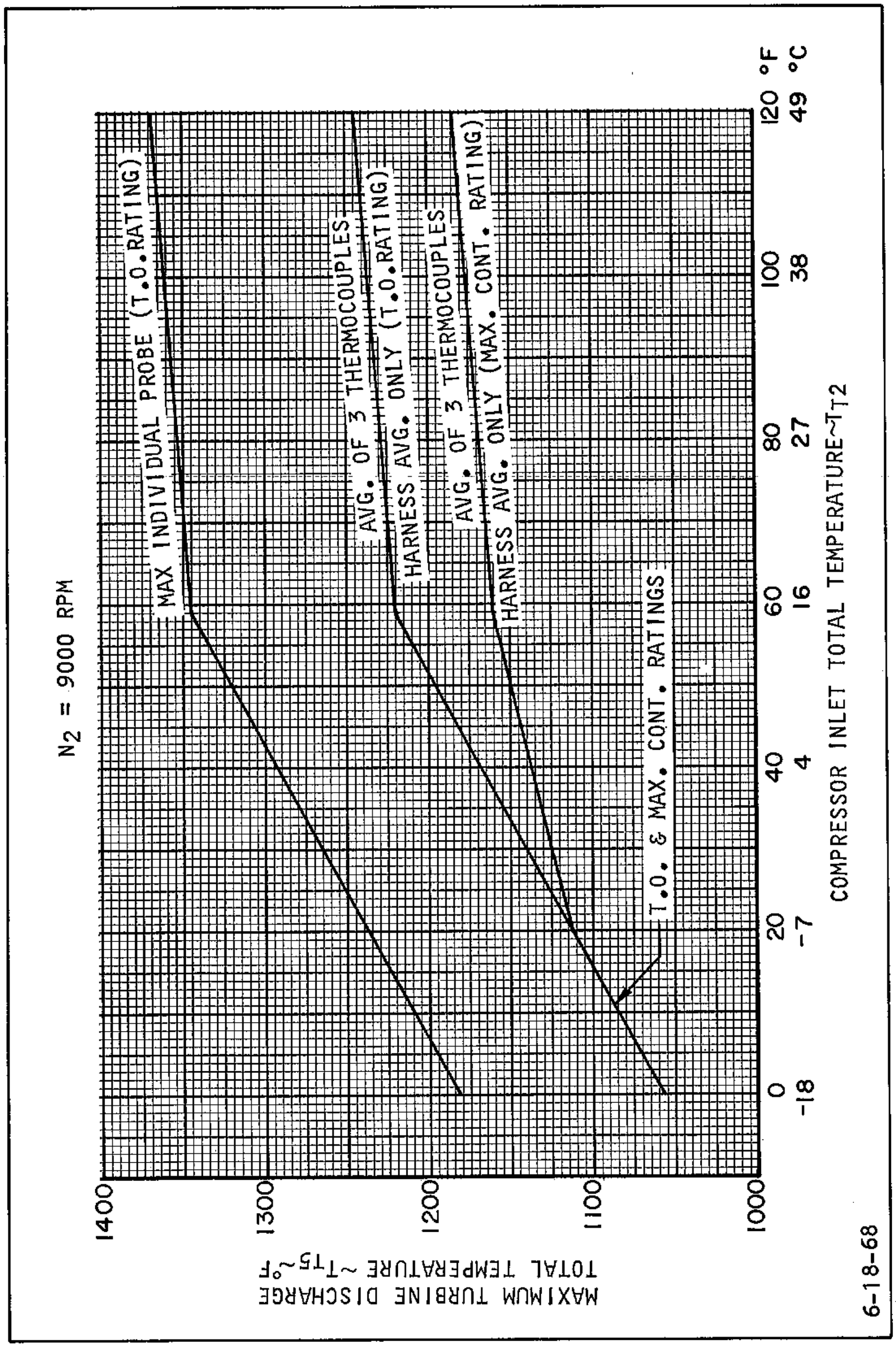


Figure 2-51H-2-4. Maximum Turbine Discharge Total Temperature (JFTD12A-4A)

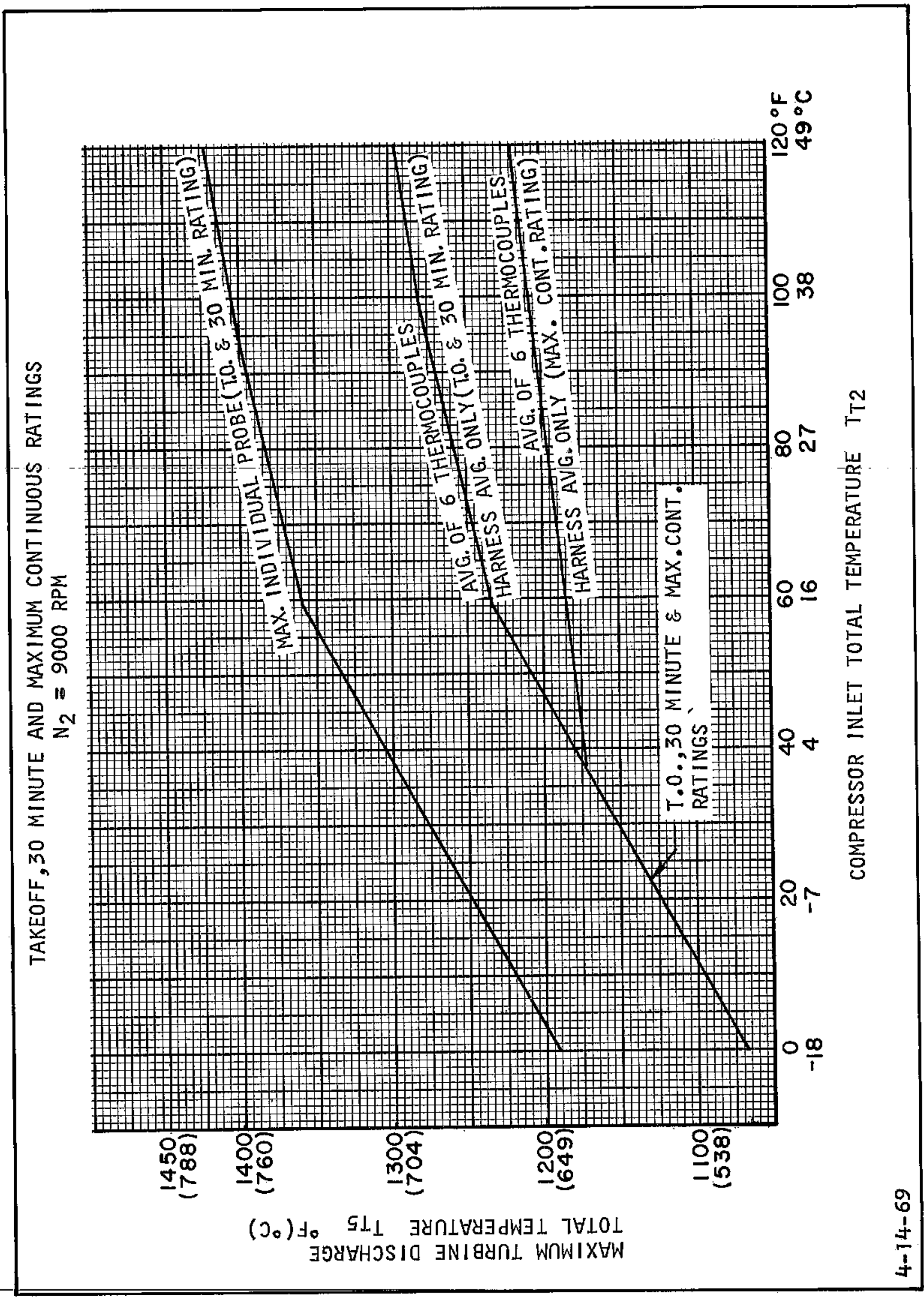


Figure 2-51H-2-5. Maximum Indicated Turbine Discharge Total Temperature (JFTD12A-5A)

(1) Model ED-156-4 vibration meter manufactured by Glenn M. Hathaway Electronics Inc., Box 978, Canaan, Connecticut 06018.

(2) Compatible 40 cps filter for the vibration meter.

(3) Model 4-118 or 4-123 vibration pickup manufactured by Consolidated Electrodynamics, 360 Sierra Madre Villa, Pasadena, California 91109.

b. The vibration indicator and filter must be calibrated often enough to ensure accuracy. The frequency (in cps) versus the relative frequency response (in percent) shall fall within the band of Figure 2-51H-3.

c. A transite, or equivalent, pad must be placed between the pickup and the bracket at the combustion chamber outer case location.

2-286. ENGINE OVERSPEED.

TABLE 2-3C. ENGINE OVERSPEED PROCEDURE

Condition	Action Required
If observed N_1 rotor speed exceeds 16700 rpm but does not exceed 16900 rpm	(a) Check compressor for free rotation and visually inspect inlet and exhaust ducts for foreign particles or evidence of rubbing. Check compressor and turbine blades and vanes for damage. If found satisfactory, continue engine in service. (b) If any abnormal condition is evident, perform teardown inspection.
If observed N_1 rotor speed exceeds 16900 rpm	Shut down engine as soon as possible and send to overhaul for complete inspection of all rotating and associated parts (bearings, carbon seals, etc.).
NOTE For engines with a 0.262:1 tachometer drive ratio: 16700 rpm = 104.2 percent 16900 rpm = 105.4 percent For engines with a 0.264:1 tachometer drive ratio: 16700 rpm = 105 percent 16900 rpm = 106.2 percent	

2-286A. The following tables (Tables 2-3C and 2-3C-1) list overspeed conditions and action to be taken when an overspeed occurs. If engine rotor speed falls within a category in the left-hand column of the table proceed in accordance with the applicable instructions in the right-hand column.

2-287. ENGINE OVERTEMPERATURE.

2-288. Overtemperature conditions usually are preceded by an excessively rapid rise in fuel flow, compressor speed, and/or temperature. Several momentarily high overtemperatures affect engine service life as seriously as a single prolonged lower temperature condition. The higher the temperature, the sooner serious engine damage occurs, and, therefore, the more extensive is the inspection required.

2-289. When an overtemperature condition is anticipated, or has occurred, perform engine shutdown per paragraph 2-300. Avoid an emergency shutdown unless it is obvious that continued operation will result in more than overtemperature damage.

2-290. Overtemperature limits and corresponding inspection procedures are presented in Tables 2-3D, 2-3D-1, 2-3E, and 2-3E-1 through 2-3E-5, and duplicated in Figures 2-51J, 2-51K, and 2-51K-1 through 2-51K-7.

2-291. The tables list overtemperature conditions in left-hand column and action to be taken in the right-hand column. If Tt_5 observed for a given length of time falls within a category listed in the left-hand column, proceed in accordance with the corresponding instructions in the right-hand column.

TABLE 2-3C-1. FREE TURBINE OVERSPEED PROCEDURE

Condition	Action Required
If observed N_2 rotor speed exceeds 10350 rpm but does not exceed 10800 rpm	(a) Remove and inspect N_2 speed sense cable. Inspect N_2 gearbox for positive rotation of cable drive output shaft during rotation of free turbine. (b) Check free turbine for free rotation and visually inspect exhaust ducts for particles or evidence of rubbing. Check turbine blades for damage. If found satisfactory, continue engine in service. (c) If any abnormal condition is evident, remove free turbine and send to overhaul.
If observed N_2 rotor speed exceeds 10800 rpm	Shut down free turbine as soon as possible and send to overhaul for complete inspection of all rotating and associated parts (bearings, carbon seals, etc.).

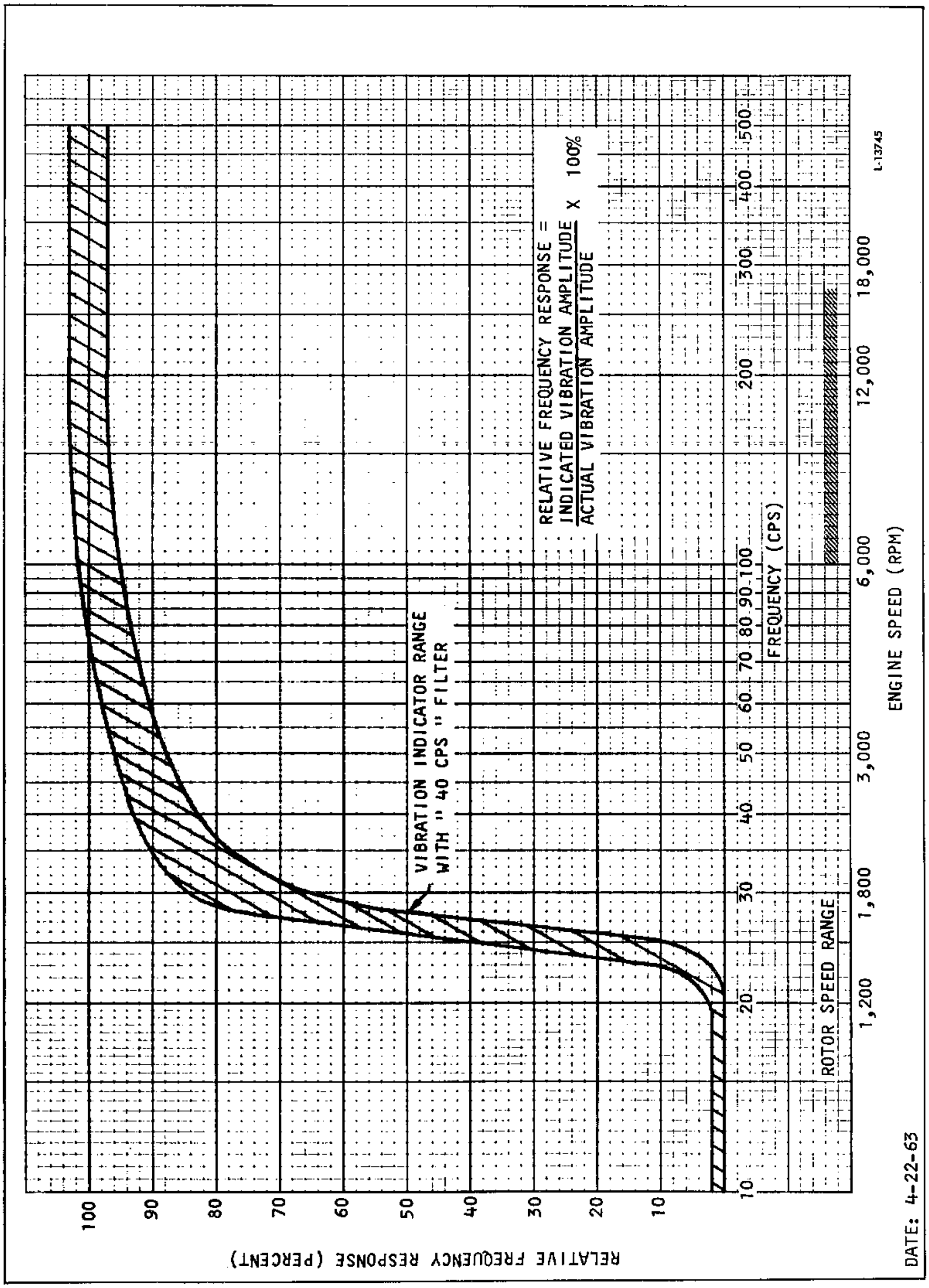


Figure 2-51H-3. Vibration Indicator and Filter Characteristics

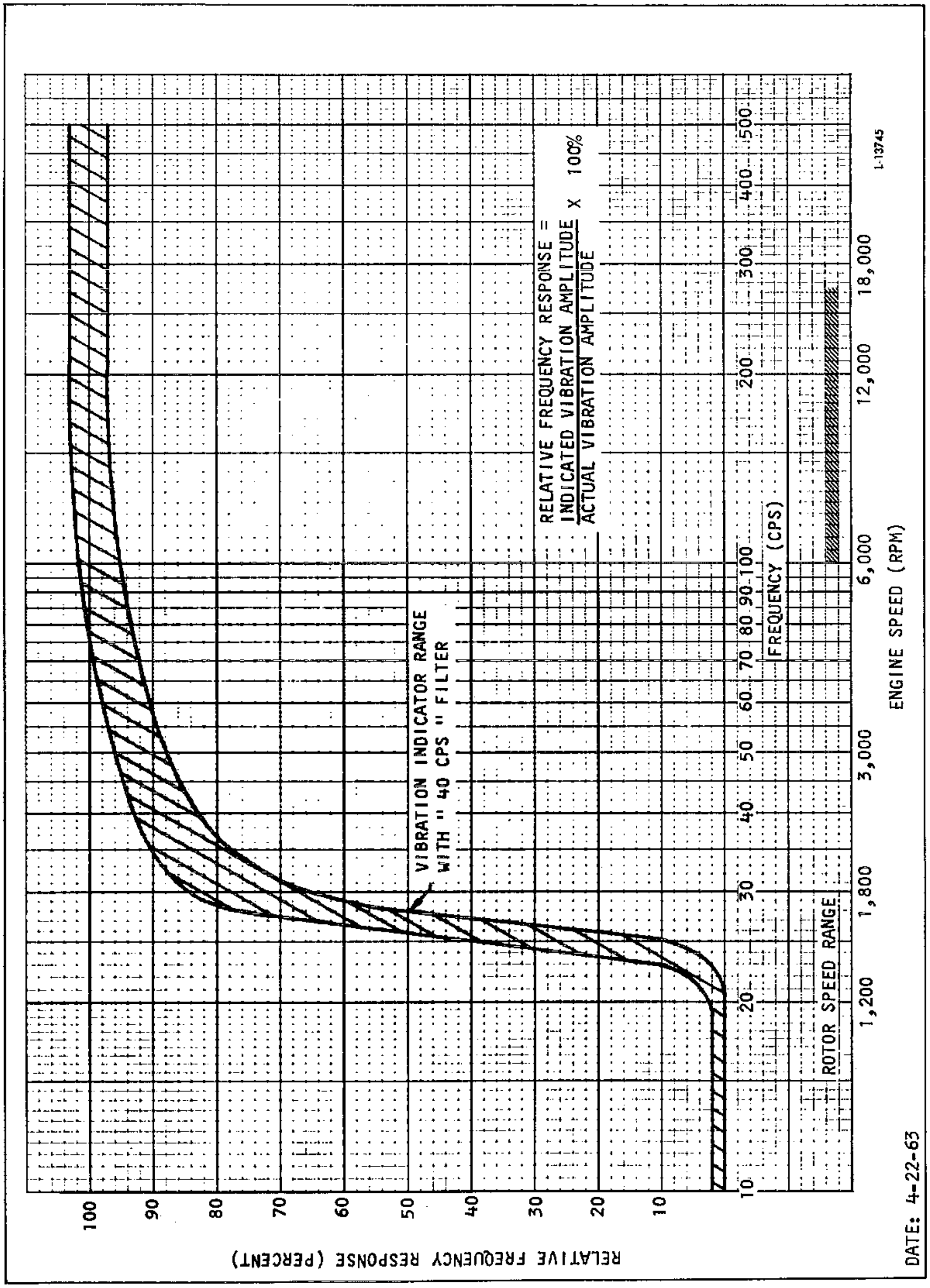


Figure 2-51H-3. Vibration Indicator and Filter Characteristics

2-292. In figures 2-51J, 2-51K and 2-51K-1 through 2-51K-7, temperature (T_{t5}) is indicated in left-hand margin and time intervals at the bottom. Enter graph from left with observed temperature and from bottom with time for which temperature existed. Code letter of the block in which temperature and time lines intersect determines which of the procedures outlined in key must be followed.

TABLE 2-3D. OVERTEMPERATURE LIMITS (ENGINE STARTING - JT12A-6 AND -6A)

	Condition	Action Required
A	If T_{t5} exceeds 525°C (977°F) but does not exceed 595°C (1103°F) for more than 5 seconds and does not exceed 630°C (1166°F).	Determine and correct cause of overtemperature.
B	(1) If T_{t5} exceeds 630°C (1166°F) for 5 seconds or less and does not exceed 700°C (1292°F). (2) If T_{t5} exceeds 595°C (1103°F) for more than 5 seconds and does not exceed 630°C (1166°F)	Perform visual inspection of all hot section parts. (1) Inspect exhaust duct for foreign particles. (2) Inspect rear of turbine for apparent damage. (3) Inspect burner section and turbine vanes.
C	(1) If T_{t5} exceeds 700°C (1292°F) for 5 seconds or less and does not exceed 800°C (1472°F). (2) If T_{t5} exceeds 630°C (1166°F) for more than 5 seconds and does not exceed 800°C (1472°F).	Perform teardown inspection of all hot section parts. (1) Fluorescent penetrant inspect turbine blades. (2) Inspect turbine vanes for bow, bend, and twist. (3) Inspect turbine blades for stretch. (4) Inspect turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)
D	If T_{t5} exceeds 800°C (1472°F) for any length of time.	Perform complete overhaul inspection of all hot section parts. (1) Scrap turbine blades and vanes. (2) Inspect turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)

TABLE 2-3D-1. OVERTEMPERATURE LIMITS (ENGINE OPERATION - JT12A-6 AND -6A)

	Condition	Action Required
A	If T_{t5} exceeds 677°C (1250°F) but does not exceed 690°C (1274°F) for more than 5 seconds and does not exceed 720°C (1328°F).	Determine and correct cause of overtemperature.
B	(1) If T_{t5} exceeds 720°C (1328°F) for 5 seconds or less but does not exceed 730°C (1346°F). (2) If T_{t5} exceeds 690°C (1274°F) for more than 5 seconds but less than 2 minutes and does not exceed 720°C (1328°F).	Perform visual inspection of all hot section parts. (1) Inspect exhaust duct for foreign particles. (2) Inspect rear of turbine for apparent damage. (3) Inspect burner section and turbine vanes.
C	(1) If T_{t5} exceeds 690°C (1274°F) for more than 2 minutes and does not exceed 800°C (1472°F). (2) If T_{t5} exceeds 720°C (1328°F) for more then 5 seconds but less than 5 minutes and does not exceed 800°C (1472°F). (3) If T_{t5} exceeds 730°C (1346°F) for 5 seconds or less but does not exceed 800°C (1472°F).	Perform teardown inspection of all hot section parts. (1) Fluorescent penetrant inspect all turbine blades and vanes. (2) Inspect turbine vanes for bow, bend, and twist. (3) Inspect all turbine blades for stretch. (See Section VI, Inspection, in this manual.) (4) Inspect turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)
D	If T_{t5} exceeds 800°C (1472°F) for any length of time.	Perform complete overhaul inspection of all hot section parts. (1) Scrap turbine blades and vanes. (2) Inspect turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)

TABLE 2-3E. OVERTEMPERATURE LIMITS
(ENGINE STARTING - JT12A-8)

	Condition	Action Required
A	If T_{t5} exceeds 525°C (977°F) but does not exceed 595°C (1103°F) for more than 5 seconds and does not exceed 630°C (1166°F).	Determine and correct cause of overtemperature.
B	(1) If T_{t5} exceeds 630°C (1166°F) for 5 seconds or less and does not exceed 700°C (1292°F). (2) If T_{t5} exceeds 595°C (1103°F) for more than 5 seconds and does not exceed 630°C (1166°F).	Perform visual inspection of all hot sections parts. (1) Inspect exhaust duct for foreign particles. (2) Inspect rear of turbine for apparent damage. (3) Inspect burner section and turbine vanes.
C	(1) If T_{t5} exceeds 700°C (1292°F) for 5 seconds or less and does not exceed 800°C (1472°F). (2) If T_{t5} exceeds 630°C (1166°F) for more than 5 seconds and does not exceed 800°C (1472°F).	Perform teardown inspection of all hot section parts. (1) Fluorescent penetrant inspect all turbine blades and vanes. (2) Inspect turbine vanes for bow, bend, and twist. (3) Inspect all turbine blades for stretch. (4) Inspect all turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)
D	If T_{t5} exceeds 800°C (1472°F) for any length of time.	Perform complete overhaul inspection of all hot section parts. (1) Scrap all turbine blades. (2) Fluorescent penetrant inspect all turbine vanes. (3) Inspect all turbine vanes for bow, bend, and twist. (4) Inspect all turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)

TABLE 2-3E-1. OVERTEMPERATURE LIMITS
(ENGINE OPERATION - JT12A-8)

	Condition	Action Required
A	If T_{t5} exceeds 720°C (1328°F) but does not exceed 730°C (1346°F) for more than 5 seconds and does not exceed 760°C (1400°F).	Determine and correct cause of over temperature.
B	(1) If T_{t5} exceeds 760°C (1400°F) for 5 seconds or less but does not exceed 770°C (1420°F). (2) If T_{t5} exceeds 730°C (1346°F) for more than 5 seconds but less than 2 minutes and does not exceed 760°C (1400°F).	Perform visual inspection of all hot section parts. (1) Inspect exhaust duct for foreign particles. (2) Inspect rear of turbine for apparent damage. (3) Inspect burner section and turbine vanes.
C	(1) If T_{t5} exceeds 730°C (1346°F) for more than 2 minutes and does not exceed 800°C (1472°F). (2) If T_{t5} exceeds 760°C (1400°F) for more than 5 seconds but less than 5 minutes and does not exceed 800°C (1472°F). (3) If T_{t5} exceeds 770°C (1420°F) for 5 seconds or less but does not exceed 800°C (1472°F).	Perform teardown inspection of all hot section parts. (1) Fluorescent penetrant inspect all turbine blades and vanes. (2) Inspect all turbine vanes for bow, bend, and twist. (3) Inspect all turbine blades for stretch. (4) Inspect all turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)
D	If T_{t5} exceeds 800°C (1472°F) for any length of time.	Perform complete overhaul inspection of all hot section parts. (1) Scrap all turbine blades. (2) Fluorescent penetrant inspect all turbine vanes. (3) Inspect all turbine vanes for bow, bend, and twist. (4) Inspect all turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)

Tables 2-3E-2 and 2-3E-3. Deleted.

All data from page 2-58H-1 deleted.

TABLE 2-3E-4. OVERTEMPERATURE LIMITS (ENGINE STARTING - JFTD12A-4A)

	Condition	Action Required
A	If T_{t5} exceeds 525°C (977°F) but does not exceed 595°C (1103°F) for more than five seconds and does not exceed 630°C (1166°F).	Determine and correct cause of overtemperature.
B	(1) If T_{t5} exceeds 630°C (1166°F) for five seconds or less and does not exceed 700°C (1292°F). (2) If T_{t5} exceeds 595°C (1103°F) for more than five seconds and does not exceed 630°C (1166°F).	Perform visual inspection of all hot section parts. (1) Inspect exhaust duct for foreign particles. (2) Inspect rear of turbine for apparent damage. (3) Inspect burner section and turbine vanes.
C	(1) If T_{t5} exceeds 700°C (1292°F) for five seconds or less and does not exceed 800°C (1472°F). (2) If T_{t5} exceeds 630°C (1166°F) for more than five seconds and does not exceed 800°C (1472°F).	Perform teardown inspection of all hot section parts. (1) Fluorescent penetrant inspect turbine and free turbine blades and vanes. (2) Inspect turbine vanes for bow, bend, and twist. (3) Inspect free turbine vanes for bow. (4) Inspect turbine and free turbine blades for stretch. (5) Inspect turbine and free turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)
D	If T_{t5} exceeds 800°C (1472°F) for any length of time.	Perform complete overhaul inspection of all hot section parts. (1) Scrap turbine blades (not free turbine). (2) Fluorescent penetrant inspect turbine vanes and free turbine blades and vanes. (3) Inspect turbine vanes for bow, bend, and twist. (4) Inspect free turbine vanes for bow. (5) Inspect free turbine blades for stretch. (6) Inspect turbine and free turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)

TABLE 2-3E-5. OVERTEMPERATURE LIMITS (ENGINE OPERATION - JFTD12A-4A)

	Condition	Action Required
A	If T_{t5} exceeds 688°C (1271°F) but does not exceed 730°C (1346°F) for more than five seconds, and does not exceed 760°C (1400°F).	Determine and correct cause of overtemperature.
B	(1) If T_{t5} exceeds 760°C (1400°F) for five seconds or less but does not exceed 770°C (1420°F). (2) If T_{t5} exceeds 730°C (1346°F) for more than five seconds but less than two minutes and does not exceed 760°C (1400°F).	Perform visual inspection of all hot section parts. (1) Inspect exhaust duct for foreign particles. (2) Inspect rear of turbine for apparent damage. (3) Inspect combustion section, turbine vanes, and front of turbine section for excessive distortion or damage.
C	(1) If T_{t5} exceeds 730°C (1346°F) for more than two minutes and does not exceed 800°C (1472°F). (2) If T_{t5} exceeds 760°C (1400°F) for more than five seconds but less than five minutes and does not exceed 800°C (1472°F). (3) If T_{t5} exceeds 770°C (1420°F) for five seconds or less but does not exceed 800°C (1472°F).	Perform teardown inspection of all hot section parts. (1) Fluorescent penetrant inspect turbine and free turbine blades and vanes. (2) Inspect turbine vanes for bow, bend, and twist. (3) Inspect all free turbine vanes for bow. (4) Inspect turbine and free turbine blades for stretch. (5) Inspect turbine and free turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)
D	If T_{t5} exceeds 800°C (1472°F) for any length of time.	Perform complete overhaul inspection of all hot section parts. (1) Scrap turbine blades (not free turbine). (2) Fluorescent penetrant inspect turbine vanes and free turbine blades and vanes. (3) Inspect turbine vanes for bow, bend, and twist. (4) Inspect free turbine vanes for bow. (5) Inspect free turbine blades for stretch. (6) Inspect turbine and free turbine disks for growth and hardness.

TABLE 2-3E-6. OVERTEMPERATURE LIMITS - ENGINE OPERATING (JFTD12A-5A)

	Condition	Action Required
A	If T_{t5} exceeds 720°C (1328°F) but does not exceed 730°C (1346°F) for more than five seconds, and does not exceed 760°C (1400°F).	Determine and correct cause of overtemperature.
B	(1) If T_{t5} exceeds 760°C (1400°F) for five seconds or less but does not exceed 770°C (1420°F). (2) If T_{t5} exceeds 730°C (1346°F) for more than five seconds but less than two minutes and does not exceed 760°C (1400°F).	Perform visual inspection of all hot section parts. (1) Inspect exhaust duct for foreign particles. (2) Inspect rear of turbine for apparent damage. (3) Inspect combustion section, turbine vanes, and front of free turbine section for excessive distortion or damage.
C	(1) If T_{t5} exceeds 730°C (1346°F) for more than two minutes and does not exceed 800°C (1472°F). (2) If T_{t5} exceeds 760°C (1400°F) for more than five seconds but less than five minutes and does not exceed 800°C (1472°F). (3) If T_{t5} exceeds 770°C (1420°F) for five seconds or less but does not exceed 800°C (1472°F).	Perform teardown inspection of all hot section parts. (1) Fluorescent penetrant inspect turbine and free turbine blades and vanes. (2) Inspect turbine vanes for bow, bend, and twist. (3) Inspect all free turbine vanes for bow. (4) Inspect turbine and free turbine blades for stretch. (5) Inspect turbine and free turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)
D	If T_{t5} exceeds 800°C (1472°F) for any length of time.	Perform complete overhaul inspection of all hot section parts. (1) Scrap turbine blades (not free turbine). (2) Fluorescent penetrant inspect turbine vanes and free turbine blades and vanes. (3) Inspect turbine vanes for bow, bend, and twist. (4) Inspect free turbine vanes for bow. (5) Inspect free turbine blades for stretch. (6) Inspect turbine and free turbine disks for growth and hardness. (Hardness shall be at least Rockwell A66.)

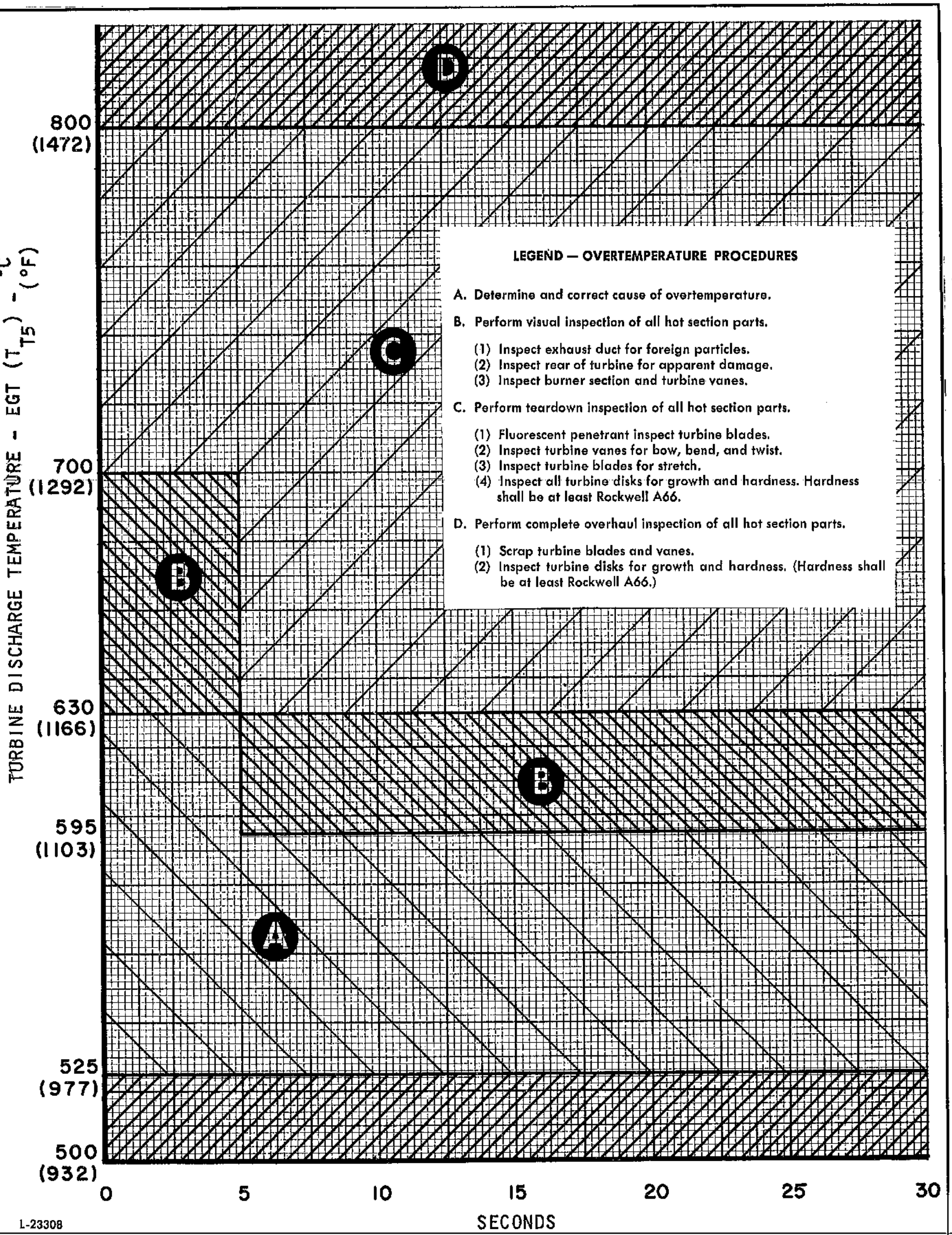


Figure 2-51J. Engine Starting Overtemperature Limits (JT12A-6, -6A)

Figure 2-51J-1. Deleted

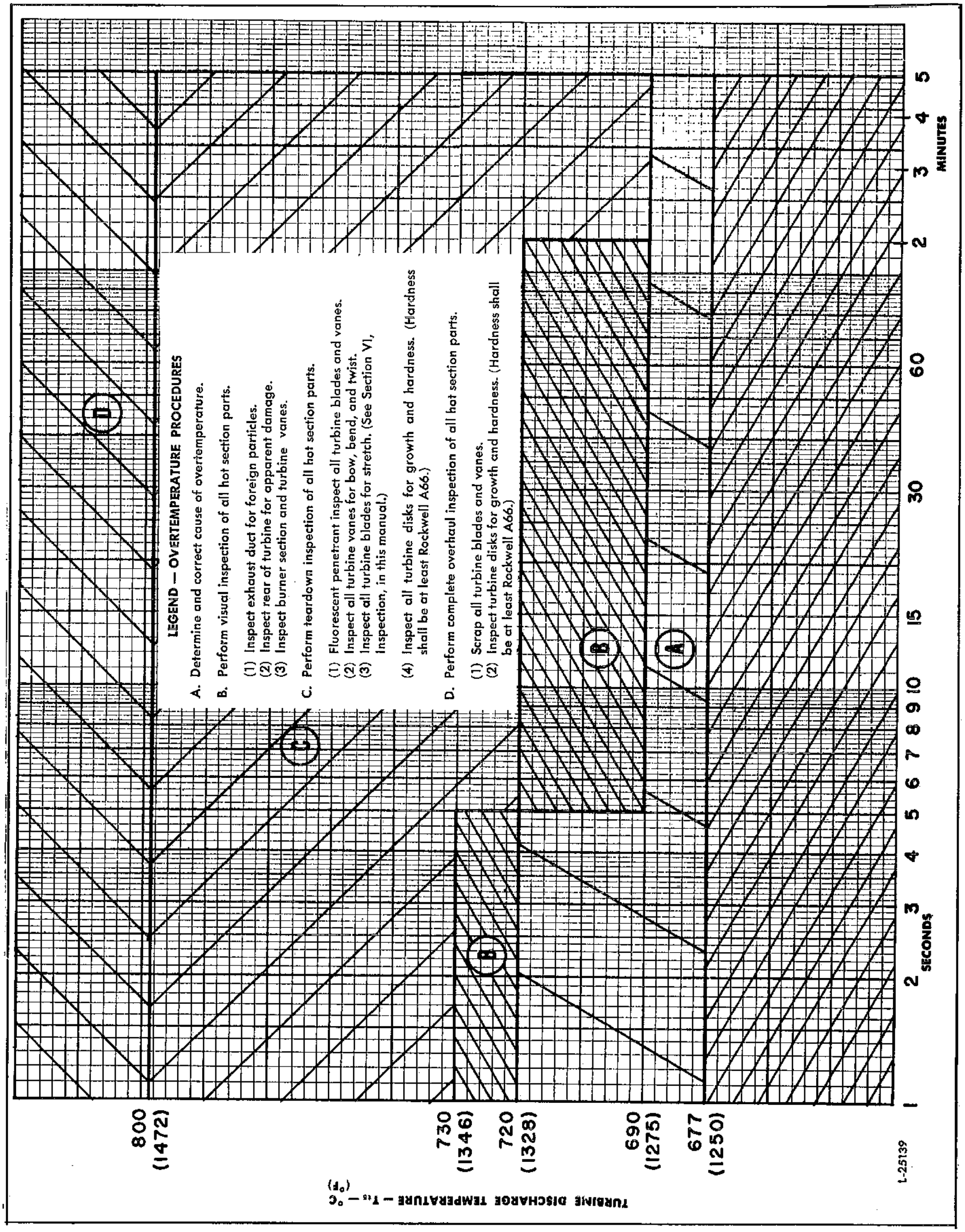


Figure 2-51K. Engine Operation Overtemperature Limits (JT12A-6 and -6A)

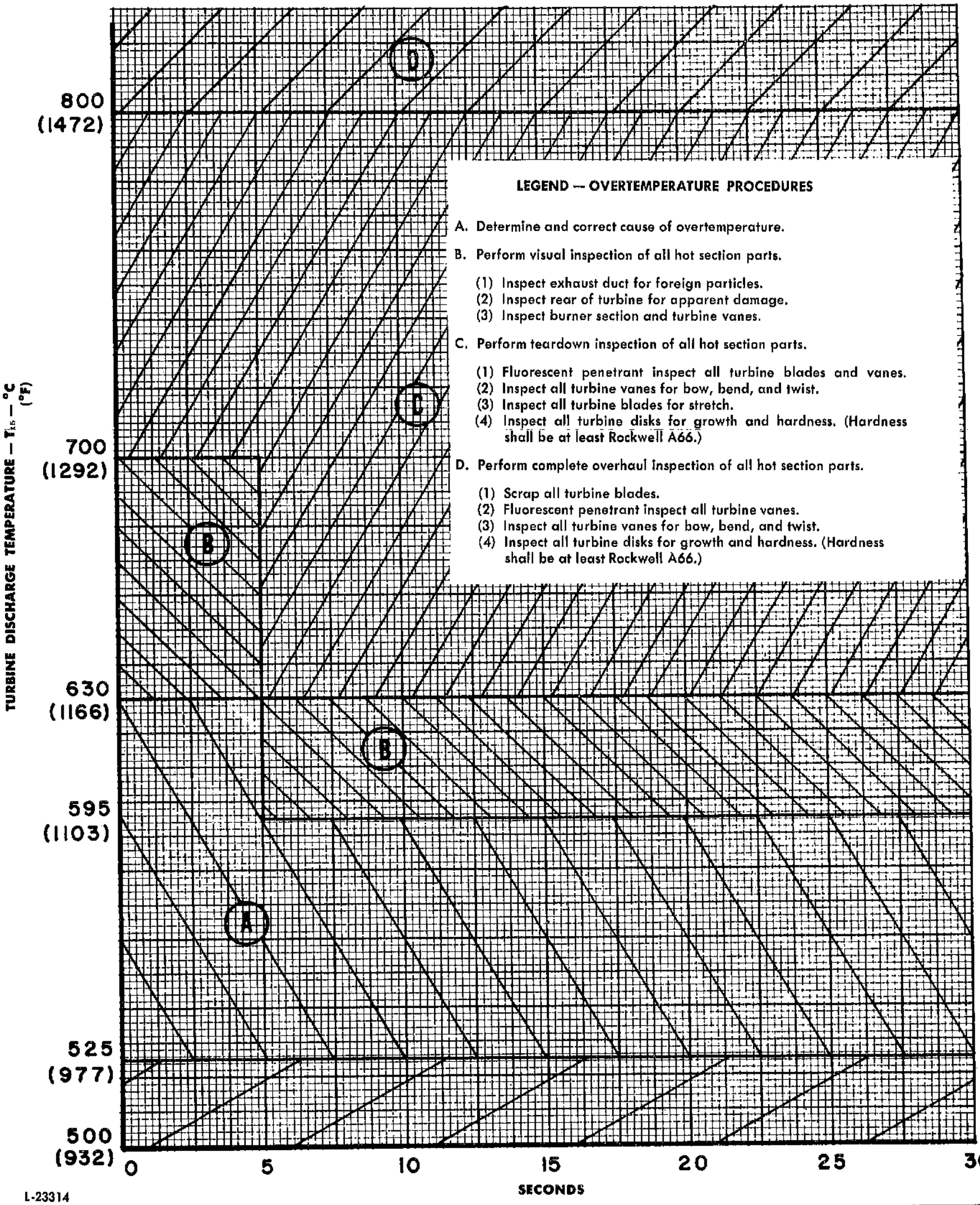


Figure 2-51K-1. Engine Starting Overtemperature Limits (JT12A-8N and -8L)

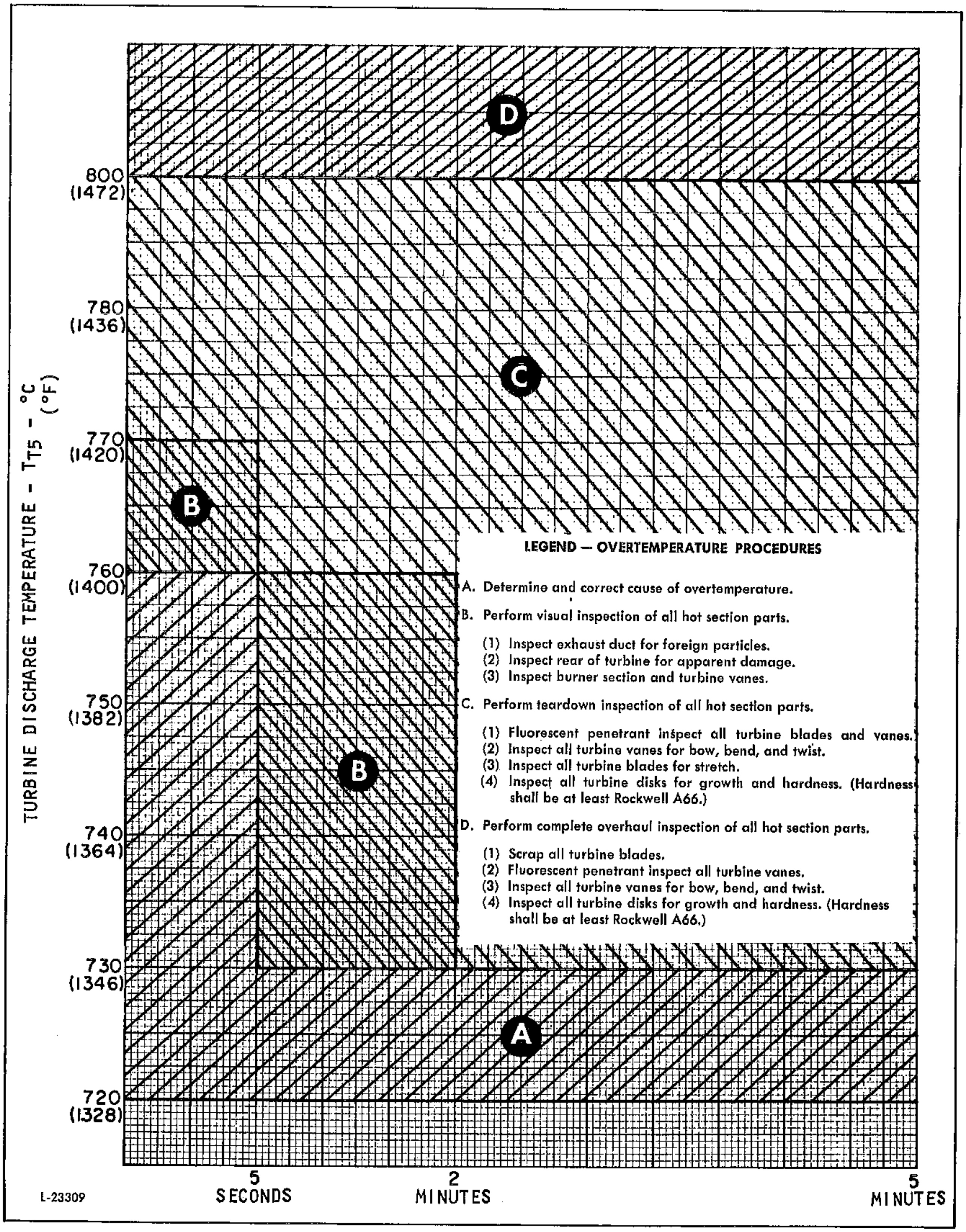


Figure 2-51K-2. Engine Operation Overtemperature Limits (JT12A-8N and -8L)

Figure 2-51K-3 and Figure 2-51K-4. Deleted.
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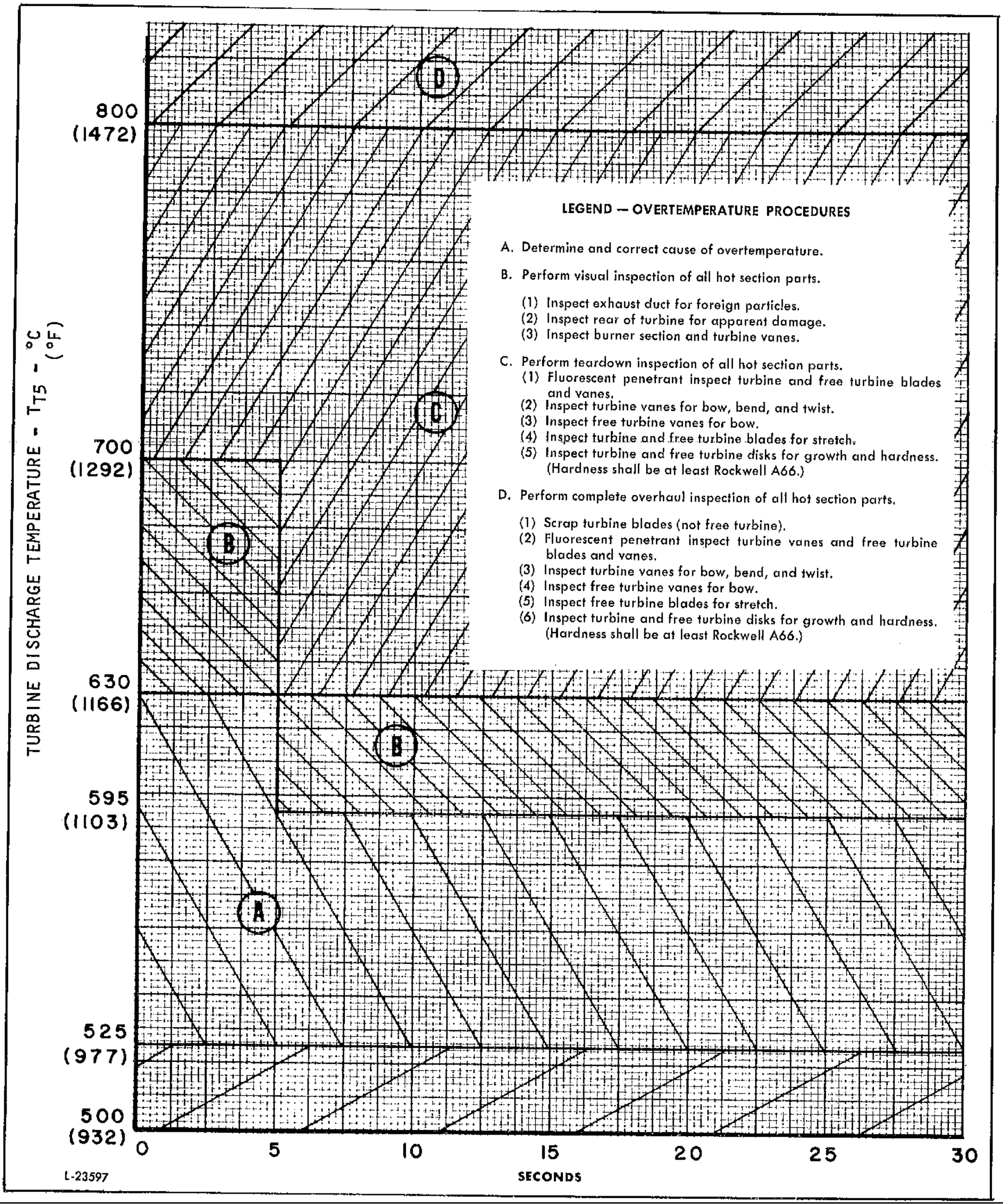


Figure 2-51K-5. Engine Starting Overtemperature Limits (JFTD12A-4A and -5A)

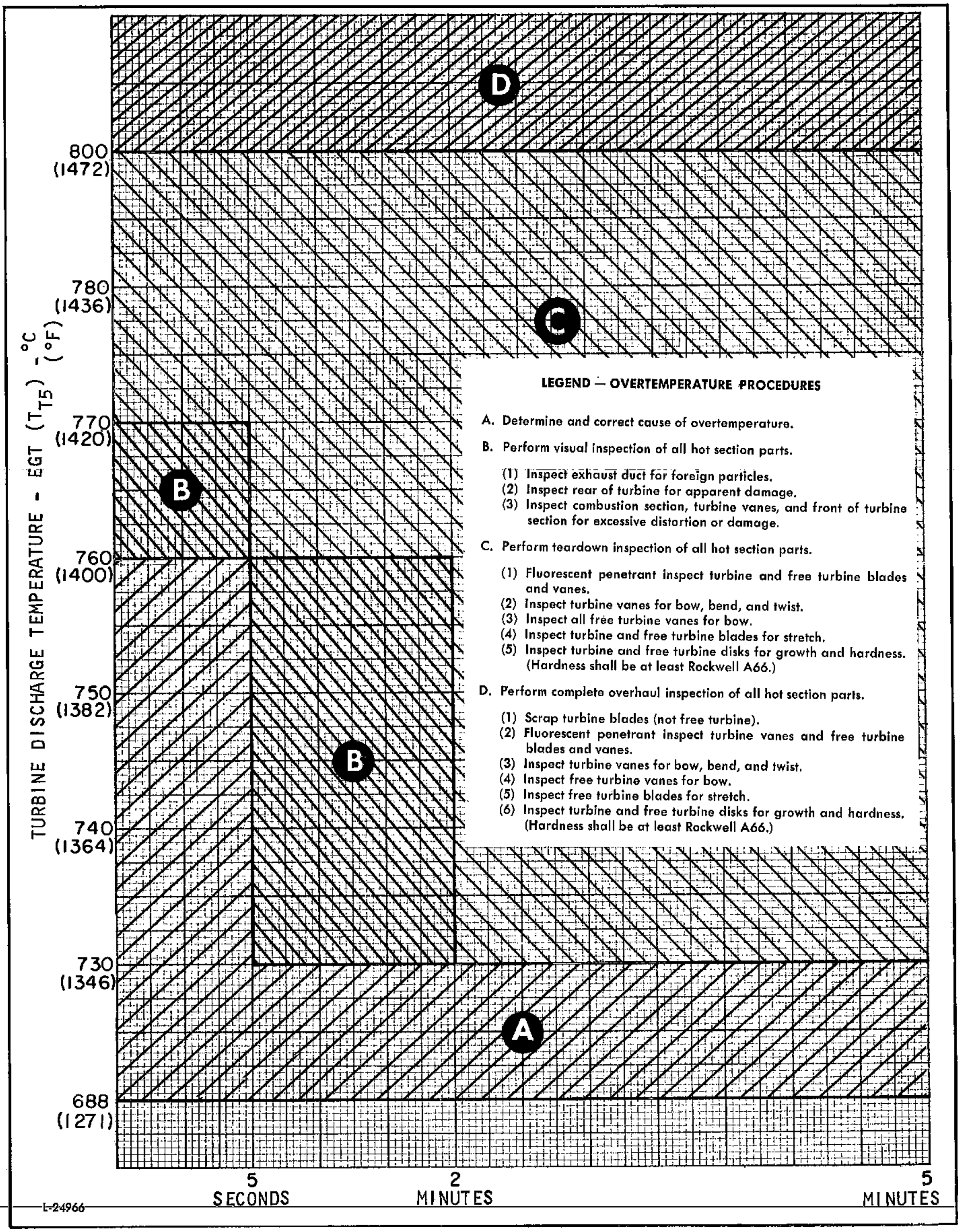


Figure 2-51K-6. Engine Operation Overtemperature Limits (JFTD12A-4A)

2–293. ENGINE OPERATION (TURBOJET ENGINES).

2–294. ENGINE STARTING.

2–295. The following procedure is to be used for engines equipped with electric, pneumatic, or combustion starters. Because combustion starters have a very limited burning time, it is essential to perform the sequence of the starting procedure as quickly as possible when this type of starter is used.

a. Engine Anti-Icing Switch – OFF

b. Power Lever – OFF

c. Engine Master Switch – ON

d. Engine Fuel Shut-off Switch – OPEN

e. Fuel Boost Pump Switch – ON

f. Engine Starter Switch – ON (check for oil pressure rise)

g. Ignition Switch – ON when tachometer indicates five to seven percent minimum.

CAUTION

The ignition switch shall not be turned ON prior to engaging the starter as an accumulation of fuel in the engine might result in an internal fire or explosion.

Note

The operating cycle for continuous use of high-energy ignition is two minutes ON and three minutes OFF for the first starting attempt, then two minutes ON and 23 minutes OFF for the second attempt, to allow the ignition system components to cool. In some cases, the restrictions imposed on starter operation will govern the use of the ignition.

h. Power Lever – IDLE when tachometer indicates ten percent.

i. Engine Starter Switch – OFF when engine attains IDLE rpm.

j. Ignition Switch – OFF

2–296. SATISFACTORY START.

2–297. If all of the following conditions are met, the engine has started satisfactorily.

a. "Light-up" takes place within 20 seconds after the power lever has been placed in IDLE position. A "light-up" will be evidenced by a rise in the turbine discharge temperature.

Note

The 20 second time interval is an arbitrary value. The actual time to light is dependent upon the amount of torque supplied by the starter.

b. Engine will accelerate to approximately 43 percent rpm.

c. Turbine discharge temperature does not exceed the maximum starting temperature during transition period to IDLE rpm.

d. Oil pressure is at least 35 psi (relative to internal engine scavenge compartment).

e. Turbine discharge temperature will drop below the IDLE temperature limit after IDLE rpm is obtained.

CAUTION

If the power lever is inadvertently retarded to the OFF position, do not advance the power lever in an attempt to regain the "light". The normal starting sequence must be repeated. Introducing unburned fuel into the engine creates a fire hazard.

2–298. UNSATISFACTORY START. An unsatisfactory start has occurred, if one or more of the following conditions takes place.

a. *Hot Start.* The turbine discharge temperature exceeds the starting temperature limit. If a greater than normal fuel flow is observed when the power lever is first placed in the IDLE position, a "hot start" may be anticipated and the operator should be prepared to abort the start before the turbine discharge temperature limit is exceeded. A hot start may also be caused by a "false or hung start."

b. *False Start or Hung Start.* After "light-up" has occurred, the rpm does not increase to that of IDLE but remains at some lower rpm. The turbine discharge temperature may continue to rise and the operator should be prepared to abort the start before temperature limits are exceeded.

c. *No Start.* The engine does not "light-up" within 20 seconds after the power lever is placed in the IDLE position. If the turbine discharge temperature gage does not indicate a temperature rise, or if there is no increase in rpm, a "light-up" has not been obtained.

d. Following any unsatisfactory start clear the engine as specified in paragraph 2-299., CLEAR ENGINE PROCEDURE.

2–299. CLEAR ENGINE PROCEDURE. Clear the engine of trapped fuel or vapors in accordance with the following instructions.

a. Power lever – OFF

b. Ignition switch – OFF

c. Engine fuel shut-off switch – OPEN

d. Fuel boost pump switch – ON

e. Engine starter switch – ON

f. Maintain starter operation for 10 to 20 seconds or for burning time of cartridge starter.

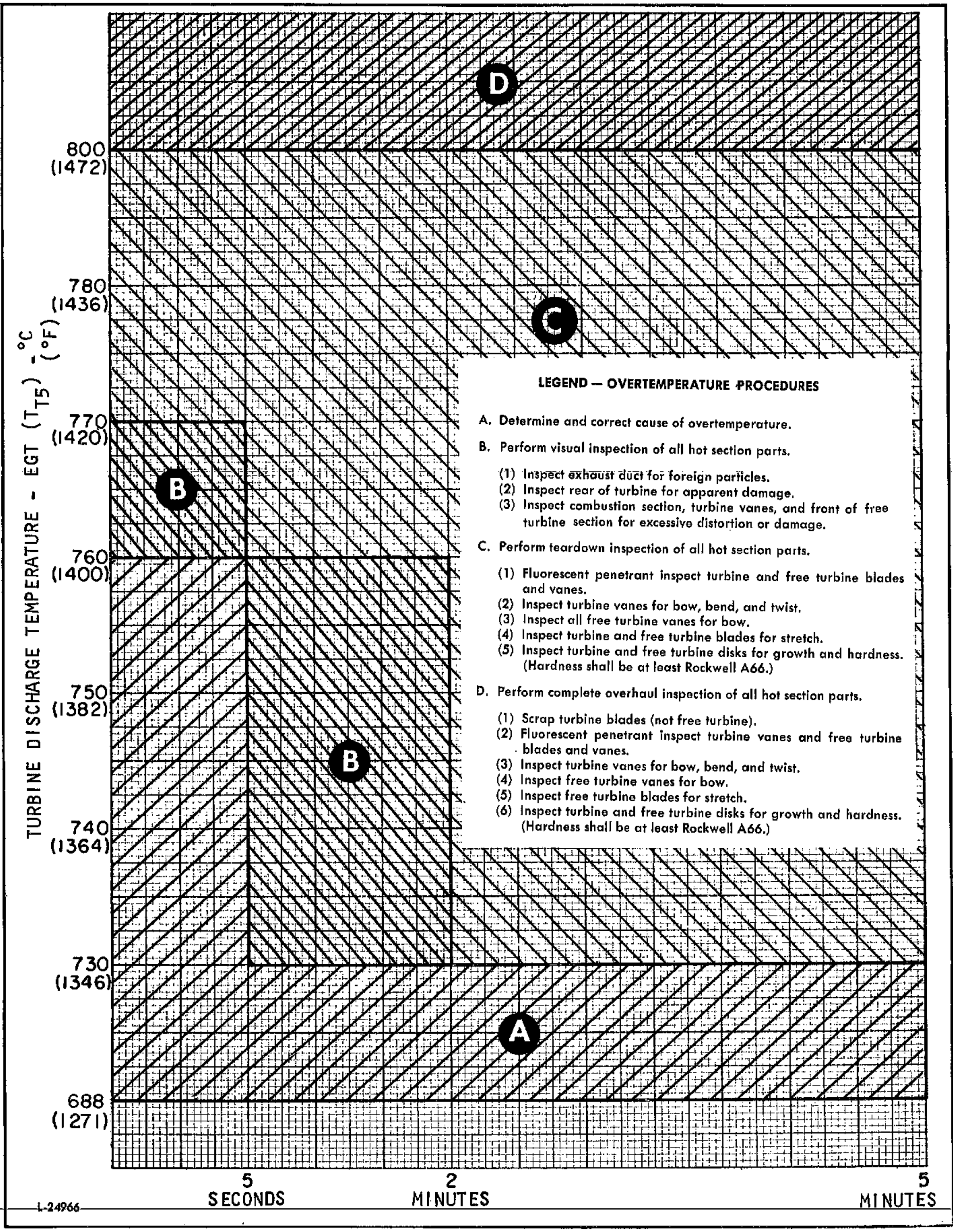


Figure 2-51K-7. Engine Operation Overtemperature Limits (JFTD12A-5A)

g. Engine starter switch - OFF.

h. Fuel boost pump switch - OFF.

i. Allow fuel drainage period of at least two minutes before attempting another start.

2-300. ENGINE SHUTDOWN PROCEDURE.

a. Operate engine at IDLE for two to five minutes (depending on intensity of prior running) to ensure adequate interval cooling.

b. Increase to 75 percent rpm for 30 seconds to provide for proper scavenging of residual oil; then retard power lever to OFF.

c. Fuel boost pump switch - OFF (after compressor stops rotating).

d. Engine fuel shutoff switch - CLOSED.

e. Engine master switch - OFF.

f. Ascertain that compressor decelerates freely.

NOTE

During engine run-down, under conditions of low pump rpm and high discharge pressures, fuel pump may produce noise. This is proven characteristic of pump and should not be sole reason for removing pump from service.

2-300A. BLEED SYSTEM LEAKAGE.

2-300B. Bleed strap leakage can be considered excessive, and necessitating corrective action, when there is appreciable change in engine parameter. Increase in engine rpm or EGT, or both, for a given EPR is considered to be such indication.

2-301. ENGINE TEST AFTER REPAIR (TURBOJET ENGINES).

2-302. GENERAL.

2-203. Extent of repair and replacement of engine parts will vary with different engines. Test requirements which are necessary to prove satisfactory performance after repair will also vary. To eliminate unnecessary ground testing and to conserve fuel, this test section is subdivided into three ground test procedures which will be referred to as Test Nos. 1, 2, and 3. Test No. 1 is for engines requiring engine ground run-up. Test No. 2 will apply to engines which require trim and power setting. Test No. 3 will cover engines requiring ground check, run-up, and power setting prior to an actual operating condition time run of engines. Before attempting to test

engines, refer to applicable sections of Table 2-3F to determine test requirement for a given engine. Comply with only most comprehensive test specified for repaired engine.

2-304. DETERMINING TURBINE DISCHARGE PRESSURE (P_{t5}) FOR CHECKING OR SETTING ENGINE THRUST (TURBOJET ENGINES).

2-305. Use following procedure to determine expected thrust output for normally functioning engine under static conditions. Thrust lines appearing on engine power curves (Figures 2-51L, 2-51L-1, 2-51M, 2-51M-1, 2-51N, 2-51N-1, and 2-51N-2) are used to determine engine thrust in terms of turbine discharge pressure (P_{t5}) for prevailing ambient conditions.

NOTE

Part Power P_{t5} settings must be within -0 to +0.5 inch Hg of values determined from figure 2-51M or 2-51M-1. Take-Off Maximum Continuous, and Maximum Climb settings must be at P_{t5} (or EPR) values determined from applicable curves (figures 2-51L, 2-51L-1, 2-51N, 2-51N-1, and 2-51N-2).

a. Obtain ambient (outside) air temperature as close to engine inlet as possible.

b. Enter engine thrust curve with ambient temperature and proceed vertically downward to intersect thrust line. (When using TAKE-OFF curve, proceed downward to intersect barometric pressure horizontal line which corresponds with field true barometer.)

c. From the intersection of ambient temperature and thrust (or barometric pressure horizontal line on TAKE-OFF curve) proceed horizontally to left to intersect line corresponding to prevailing field barometric pressure. From this intersection proceed downward to read desired turbine discharge pressure (P_{t5}).

d. Record P_{t5} value determined above.

2-306. ADJUSTED DATA PLATE SPEED. (TURBOJET ENGINES)

2-307. GENERAL.

2-307A. Each engine produces its Take-Off rated thrust (or more) at an EPR shown on thrust setting curves. Trimming of engine, however, is done at lower thrust setting which is termed PART POWER setting. The Part Power condition is at thrust level sufficiently low to allow trimming over wide range of ambient temperatures thus eliminating possibility of engine trimmed on cold day failing to produce Take-Off thrust on hot day. Properly trimmed engine fuel control provides sufficient power lever travel margin above part power position to enable engine to reach Take-Off thrust. Although engine thrust level and fuel control trim are determined by EPR, fuel control itself senses engine rpm. Relationship of rpm to thrust under any given ambient air condition, can change as service life increases (EPR to thrust relationship remains constant) to extent that retrimming becomes necessary. When engine power lever reaches its maximum position before Take-Off rated thrust is obtained, trim check should be made. Trim check also must be made when new fuel control is installed.

TABLE 2-3F. REPAIR REFERENCES

Units Repaired or Replaced	Test Required
Accessory Section	No. 1 (with vibration pickups installed)
Control - Engine Fuel	No. 2 and compressor bleed valve check
Exhaust Case	No. 1 and trim check
Ignition Exciters and/or Sparkigniters	Perform a satisfactory start
Liners - Combustion Chamber	No. 1
Manifold Assembly - Fuel	No. 2
Nozzle Assembly - 1st Stage Turbine	No. 3
Nozzles - Fuel	No. 2
Main Oil Pump	No. 1
*Major Cases	No. 3
*Main Bearings and Accessory Drive	No. 3
Pump - Fuel	No. 2
Strainer - Main Oil	No. 1
*Turbine Disk and Blade Assembly	No. 3
*Turbine Rotor Shaft	No. 3
Valve - Compressor Bleed	No. 1
Valve - Fuel Pressurizing and Dump	No. 1
Electrical Harness	No. 1

*These units would be replaced by facilities with the required capability and in accordance with instruction in the JT12A Overhaul Manual.

2-308. Speed at which engine originally produced PART POWER EPR is stamped on engine data plate in rpm and in percent of 15,909 rpm for engines with 0.264:1 tachometer drive or in percent of 16,030 rpm for engines with 0.262:1 tachometer drive. This speed is for 15°C (59°F) day. Since engine speed for any given thrust varies with changes in compressor inlet temperature (T_{t2}), speed which produces Part Power thrust will vary with ambient conditions. Thus, for purposes of field engine trim setting, data plate speed must be adjusted for ambient conditions.

2-309. COMPUTATION.

2-310. To adjust data plate speed for ambient temperature, proceed as follows:

a. Determine ambient temperature as close to engine inlet as possible.

b. Enter Temperature - rpm curve (Figure 2-51P) at this temperature and proceed vertically to curve. From this intersection, proceed horizontally to left and read percent of data plate speed which is to be expected at this temperature. (This percentage is known as the SPEED BIAS.)

c. Multiply data plate speed by percentage determined from figure 2-51P (Speed Bias). Product is Part Power speed to be expected at existing ambient temperature, and is known as ADJUSTED DATA PLATE SPEED.

2-311. MAXIMUM ALLOWABLE TRIM SPEED (TURBOJET ENGINES).

2-312. GENERAL.

2-313. As service time is accumulated on engine, it will generally be noted that desired turbine discharge pressure (P_{t5}) cannot be obtained when operating at the Adjusted Data Plate Speed. This is primarily due to contamination of engine air passages. When this condition occurs, engine must be trimmed to bring turbine discharge pressure (P_{t5}) up to desired value. This trimming will result in increase in compressor speed. Compressor speed must not be raised more than 300 rpm above Adjusted Data Plate Speed. This limit will be referred to in subsequent procedures as MAXIMUM ALLOWABLE INCREASE. Sum of Adjusted Data Plate Speed and Maximum Allowable Increase will be referred to as MAXIMUM ALLOWABLE TRIM SPEED.

2-314. COMPUTATION.

NOTE

This computation may be made using rpm or percent. For engines with a 0.262:1 tachometer drive ratio, 300 rpm equals 1.871 percent. For engines with a 0.264:1 tachometer drive ratio, 300 rpm equals 1.886 percent.

a. Determine Adjusted Data Plate Speed by multiplying Data Plate Speed by the Speed Bias Factor (figure 2-51P).

b. Determine Maximum Allowable Trim Speed by adding Maximum Allowable Increase (300 rpm) to the Adjusted Data Plate Speed.

c. Trim engine to desired Part Power turbine discharge pressure for ambient conditions (figures 2-51M and 2-51M-1.)

d. Compare observed Part Power Speed to Maximum Allowable Trim Speed.

e. If Part Power Observed Speed is less than Maximum Allowable Trim Speed, engine may be continued in service. If observed speed is greater than allowable speed, send engine to overhaul for cleaning.

2-315. Above procedure is set forth in Table 2-3G. Sample computations, using rpm and using percent, are also included in table.

2-316. Trim setting worksheet will prove helpful in trimming engines and checking thrust deterioration by providing orderly arrangement of pertinent data. Worksheet format may vary with different installations or when airframe manufacturer's trim curves are being used. Sample worksheet (Figure 2-51Q) is provided herein as guide.

2-317. TEST NO. 1 (ENGINE GROUND RUN-UP) (TURBOJET ENGINES).

a. Inspect test area for cleanliness.

b. Determine TAKE-OFF P_{t5} from figure 2-51L or 2-51L-1.

c. Perform satisfactory start and allow instrument readings to stabilize.

NOTE

During inlet icing conditions with anti-icing system in operation accurate power check readings cannot be made.

d. Accelerate engine and establish that compressor bleed is open at 12,600 rpm and closed at 13,000 rpm. Decelerate engine and establish that bleeds are closed at 13,000 rpm and open at 12,600 rpm.

e. Advance power lever to the TAKE-OFF position. When engine stabilizes (allow at least five minutes), record P_{t5} gage reading at end of run.

CAUTION

Make certain that operating limits in engine check chart are not exceeded and that observed N rpm is not above maximum allowable.

TABLE 2-3G. DETERMINING PART POWER TRIM SPEED ACCEPTABILITY

NOTE

The following conditions are assumed for the purpose of making the sample computations herein:
1. Data Plate Speed = 15375 rpm or 95.91 percent (96.64 percent)*
2. Ambient Air Temperature = -10°C (+14°F)
3. Speed Bias Factor = 99.5 percent
4. Observed Speed = 15400 rpm or 96.07 percent (96.80 percent)*

Procedure	Method	Sample Computation: Using RPM	Sample Computation: Using Percent*
Determine Adjusted Data Plate Speed	Multiply Data Plate Speed by Speed Bias Factor	15375 x 0.995 = 15298	95.91 x 0.995 = 95.43 (96.64 x 0.995 = 96.16)
Determine Maximum Allowable Trim Speed	Add Adjusted Data Plate Speed and Maximum Allowable Increase	15298 + 300 = 15598	95.43 + 1.871 = 97.30 (96.16 + 1.886 = 98.05)
Compare Observed Speed to Maximum Allowable Speed	Subtract Observed Speed from Maximum Allowable Trim Speed	15598 - 15400 = 198	97.30 - 96.80 = 0.50 (98.05 - 96.80 = 1.25)
		NOTE Since Observed Speed is less than Maximum Allowable Trim Speed, engine may be continued in service.	

*Computations are based on engines having a 0.262:1 Tachometer Drive Ratio and a 100 percent rotor speed of 16030 rpm. The figures in parentheses are for engines having a 0.264:1 Tachometer Drive and a 100 percent rotor speed of 15909 rpm.

f. If P_{t5} gage reading does not agree with predetermined P_{t5}, check engine trim in accordance with Test No. 2.

NOTE

Check for P_{t5} leaks before running Test No. 2.

g. Retard power lever to MAXIMUM CONTINUOUS (figures 2-51N, 2-51N-1, or 2-51N-2) and allow instrumentation to stabilize.

h. Turn anti-icing air switch ON. A properly operating anti-icing system will cause an immediate but small drop of pressure on P_{t5} gage and a rise in temperature on anti-icing air temperature gage.

i. Turn anti-icing air switch OFF. Retard power lever to IDLE and allow to cool.

j. Inspect engine for any evidence of fuel, oil, or air leaks.

k. Shut down, per paragraph 2-300.

2-318. TEST NO. 2 - ENGINE TRIM - TURBOJET ENGINES.

a. Inspect and clean test area.

b. Position part power trim stop on fuel control to limit power lever travel.

NOTE

Hamilton Standard controls of a later design must have part power stop installed as shown in Figure 2-51Q-1.

c. Determine and record TAKE-OFF and PART POWER turbine discharge pressure (P_{t5}) from figure 2-51L, 2-51L-1, 2-51M, and 2-51M-1.

d. Determine and record Adjusted Data Plate Speed (figure 2-51P).

e. Start engine and allow instruments to stabilize for at least one and one-half minutes.

All data from page 2-58M-2 deleted.

NOTE

Accurate power check readings cannot be obtained when inlet icing conditions occur or when anti-icing system is in operation.

f. Advance power lever to part power stop and allow instruments to stabilize for at least five minutes.

CAUTION

PART POWER lever position is considerably less than full power lever travel. Do not apply excessive force to power lever.

g. After stabilization observe P_{t5} gage reading. If engine is properly trimmed, P_{t5} will be same. Part Power P_{t5} value determined from Figure 2-51M or 2-51M-1.

(1) If gage reading is too high, turn fuel control MAX trimmer in decrease direction until gage reading is below desired value and then turn MAX trimmer in increase direction until desired gage reading is obtained.

(2) If gage reading is too low, turn fuel control MAX trimmer in increase direction.

WARNING

If remote trimming is not being used, return engine to IDLE before approaching engine to make adjustment.

CAUTION

Adjusting fuel control MAX trim screw to either extreme position can result in binding of governor lever which will cause power lever binding. If this condition is encountered trim screw shall be turned one-half to two and one-half turns in direction opposite from extreme to free power lever. Full trim screw travel should not be required to trim engine to allowable limits.

h. With power lever in PART POWER trim position, and engine stabilized within P_{t5} limits for at least five minutes, observe and record engine rpm (N). This rpm must not exceed Adjusted Data Plate Speed by more than 300 rpm (1.886 percent).

NOTE

If N rpm exceeds Adjusted Data Plate Speed by more than 300 rpm (1.886 percent for engines with 0.264:1 tachometer drive ratios or 1.871 percent for those with 0.262:1 tachometer drive ratio) before, or at, determined PART POWER P_{t5} value (and investigation discloses no P_{t5} indicating system leakage or instrument errors) return engine to over-haul for cleaning.

i. When engine has been properly trimmed at PART POWER lever position, return power lever to IDLE and allow instrument readings to stabilize for at least five minutes.

j. If N rpm is within limits of Figure 2-51R or 2-51S engine is properly trimmed.

(1) If IDLE rpm is too high, turn fuel control IDLE trimmer in decrease direction until rpm is slightly below desired rpm and then turn IDLE trimmer in increase direction until desired IDLE rpm is obtained.

(2) If IDLE rpm is too low, turn fuel control IDLE trimmer in increase direction to bring rpm within limits.

(3) On engines using Hamilton Standard control, if IDLE trimmer is adjusted, recheck PART POWER setting.

k. Remove PART POWER trim stop and place it in stored position on fuel control.

NOTE

PART POWER stop must remain with same fuel control. Do not readjust set screw adjustment on PART POWER stop as this is bench calibration setting. ALL final IDLE and PART POWER (MAX trimmer) adjustments should be made in increase direction.

l. Advance power lever until P_{t5} gage reaches value determined for TAKE-OFF rated power from figure 2-51L or 2-51L-1.

CAUTION

There is no power lever stop at TAKE-OFF. During operation up to, and at, TAKE-OFF setting, turbine discharge temperature (T_{t5}) and engine speed (N) must be carefully monitored to ensure that maximum limits are not exceeded. If T_{t5} gage reading approaches maximum limit before desired P_{t5} value is reached, and it is evident that further advancement of power lever will cause overtemperature condition, retard power lever to IDLE immediately, allowing engine to cool. Shut down per paragraph 2-300, and check accuracy of instrumentation.

2-319. TEST NO. 3 (TURBOJET ENGINES).

a. Inspect test area for cleanliness.

b. Perform satisfactory start.

c. Run engine in accordance with Test No. 2 (Engine Trim) and shut down.

d. During remaining portion of test, following readings shall be recorded at each power lever position:

(1) Time of day.

(2) Temperature at the test area.

(3) True barometer.

(4) Fuel inlet pressure.

(5) Observed fuel flow (pounds per hour).

(6) Observed N rpm.

(7) Main oil temperature.

(8) Main oil pressure.

(9) Turbine discharge pressure (P_{t5}).

(10) Turbine discharge temperature (T_{t5}).

(11) Compressor inlet temperature (T_{t2}).

(12) Vibration amplitude.

e. Perform satisfactory start.

f. Run engine for 15 minutes at MAXIMUM CONTINUOUS. During last five minutes of this run operate anti-icing system and check for proper operation as indicated by rise on anti-icing air temperature gage and slight immediate drop on P_{t5} gage.

g. Run 20 minutes consisting of two ten-minute cycles of five minutes at IDLE and five minutes at MAXIMUM CONTINUOUS. Each acceleration and deceleration must be accomplished by rapid (one second) movement of power lever.

h. Run five minutes at TAKE-OFF.

i. Retard power lever to IDLE and allow engine to cool.

j. Inspect engine for any evidence of fuel, oil, or air leaks.

k. Shut down, per paragraph 2-300.

2-320. EXHAUST GAS TEMPERATURE SPREAD CHECK (TURBOJET ENGINES).

a. Connect lead from individual exhaust gas temperature indicator to engine T_{t5} thermocouples harness individual thermocouple receptacle.

b. Perform a satisfactory engine start.

c. Determine desired TAKE-OFF P_{t5} from figure 2-51L or 2-51L-1 and advance power lever to obtain this value on P_{t5} gage.

NOTE

Do not exceed operating limits in engine check chart or maximum allowable observed N rpm.

d. Allow instrument readings to stabilize and record temperature of each thermocouple.

e. Retard power lever to IDLE and allow engine to cool.

f. Shut down, per paragraph 2-300.

g. Temperature recorded by any one thermocouple or harness average must fall below line on figures 2-51H-2-1, 2-51H-2-1A or 2-51H-2-2. Readings from individual reading thermocouples shall be averaged arithmetically and shall agree within -11°C (-20°F) to +22°C (+40°F) of reading taken with averaging harness. If limits have been exceeded, and accuracy of indicating thermocouples and gages has been verified, fuel nozzle flow restriction should be suspected and Fuel Nozzle Visual Flow Check should be made.

2-320A. OIL TANK SERVICING (TANKS WITHOUT REMOTE FILLER).

CAUTION

Prior to all engine shutdowns, run engine at IDLE for two to five minutes (depending on intensity of prior running), increase to 75 percent rpm for 30 seconds, then retard power lever to OFF. This procedure ensures adequate internal cooling and proper scavenging of residual oil.

NOTE

When checking oil level with dipstick, do not withdraw dipstick for approximately 10 seconds after bottoming of dipstick. This allows oil to flow back into dipstick scabbard.

a. Within one hour of engine shutdown, check oil level at tank. If oil level is within one quart of FULL, do not service oil tank.

NOTE

Oil level should be at FULL mark for engines incorporating P/N 504810 gage or 505416 gage.

Since approximately one quart of oil usually remains in gearbox after shutdown, it is not recommended that tank be filled to FULL mark unless gearbox has been drained prior to servicing (new engine installation, engine repairs, etc.). Once engine is serviced following shutdown, it will not be necessary to recheck oil level until termination of next flight provided oil strainer has not been removed.

b. If oil level is below one quart from FULL mark, add lubricating oil, conforming to Service Bulletin No. 238, to bring level up to within one quart of FULL mark.

c. If engine was not serviced within one hour of shutdown, start engine and run through shutdown procedure (two minutes at IDLE and 30 seconds at 75 percent rpm). Shut down engine and check oil level. If necessary, add oil to bring level to within one quart of FULL mark.

CAUTION

Motoring-over engine tends to load bearing compartments with oil. If engine is motored-over at any time prior to servicing oil tank, engine must be started and shutdown procedure followed before servicing tank.

2-321. OIL TANK SERVICING (REMOTE FILLER TANK).

CAUTION

Prior to all engine shutdowns, run engine at IDLE for two to five minutes (depending on intensity of prior running), increase to 75 percent rpm for 30 seconds, then retard power lever to OFF. This procedure ensures adequate internal cooling and proper scavenging of residual oil.

NOTE

It is recommended that oil changes be made in accordance with Service Bulletin No. 238.

a. Within one hour of engine shutdown, connect suitable oil servicing unit to remote oil filler and overflow connectors.

NOTE

All engine shutdowns must be preceded by running two minutes at IDLE followed by 30 seconds at 75 percent rpm. Oil tank may be serviced with engine operating at IDLE provided two minutes at IDLE and 30 seconds at 75 percent rpm are run prior to servicing. Two minutes at IDLE and 30 seconds at 75 percent rpm must also be run prior to servicing tank whenever more than one hour has elapsed since last shutdown, or when engine has been motored-over subsequent to last shutdown. (Motoring-over engine tends to load bearing compartments with oil which must be scavenged before servicing tank.)

b. Fill tank, at rate of one-half gallon per minute maximum flow and ten psi maximum pressure, until oil starts to flow from overflow line.

c. Disconnect lubricating unit and cap remote filler and overflow connectors.

2-321A. OIL TANK SERVICING (FREE TURBINE ENGINES).

CAUTION

Prior to all engine shutdowns, run engine at IDLE for two to five minutes (depending on intensity of prior running), increase to 65 percent rpm for 30 seconds, then retard power lever to OFF. This procedure ensures adequate internal cooling and proper scavenging of residual oil. If prior five minutes of operation was below 85 percent, and last two minutes was at flight idle, normal shutdown may be made.

NOTE

When checking oil level with dipstick, do not withdraw dipstick for approximately 10 seconds after bottoming of dipstick. This allows oil to flow back into dipstick scabbard.

a. Check oil level at tank filler neck within 15 minutes after engine shutdown. If oil level is within one quart of FULL mark, servicing is optional. It is recommended, however, that oil be added if level is over 1/2 quart below FULL mark if extensive running is anticipated before recheck.

NOTE

If oil quantity check is not made within 15 minutes of shutdown, perform scavenge run at 65 percent.

b. Service oil tank with lubricating oil conforming to Service Bulletin No. 238 if oil level is below one quart mark.

NOTE

If tubing and scavenge sections are dry, approximately one quart of oil will be required to "wet" system. Wet system by first filling tank, then operating engine for two to five minutes at IDLE, shutting down, and immediately refilling tank.

c. Allow engine to stand for ten minutes and recheck oil level.

d. If amount of oil required to fill tank appears excessive (more than one quart for a dry system), or if oil level drops more than one-half inch during ten minute waiting period, perform following.

(1) Drain component drive gearbox.

(2) Check for, and remedy any cause of drainage from tank to gearbox.

(3) Repeat entire oil servicing procedure.

2-321B. ENGINE AND FREE TURBINE GAS GENERATOR ACCELERATION LIMITS. Advance power lever from IDLE to TAKE-OFF. Engine speed must reach point 200 rpm less than TAKE-OFF speed in ten seconds or less.

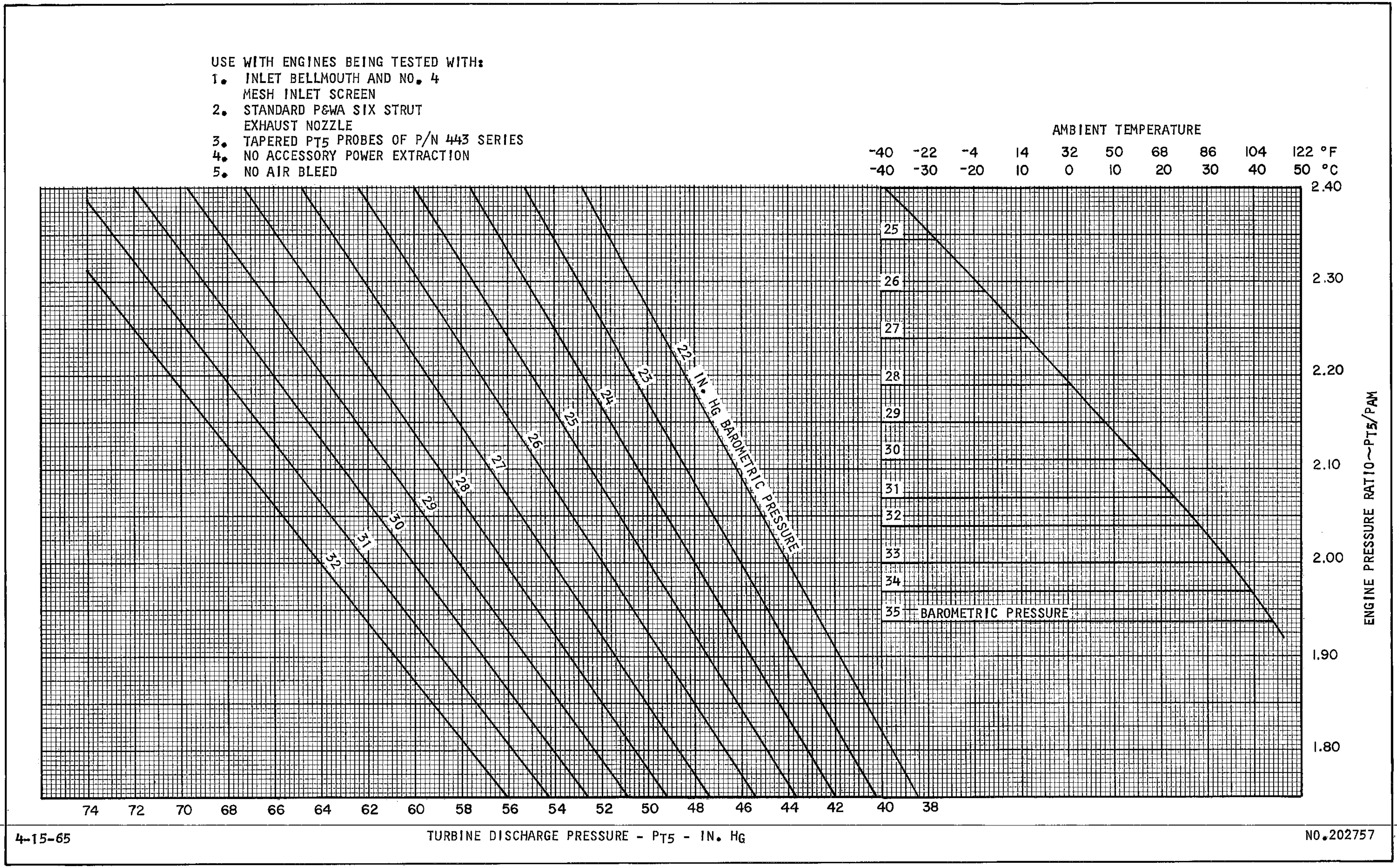


Figure 2-51L. Take-Off Thrust Setting Curve (JT12A-6 and -6A)

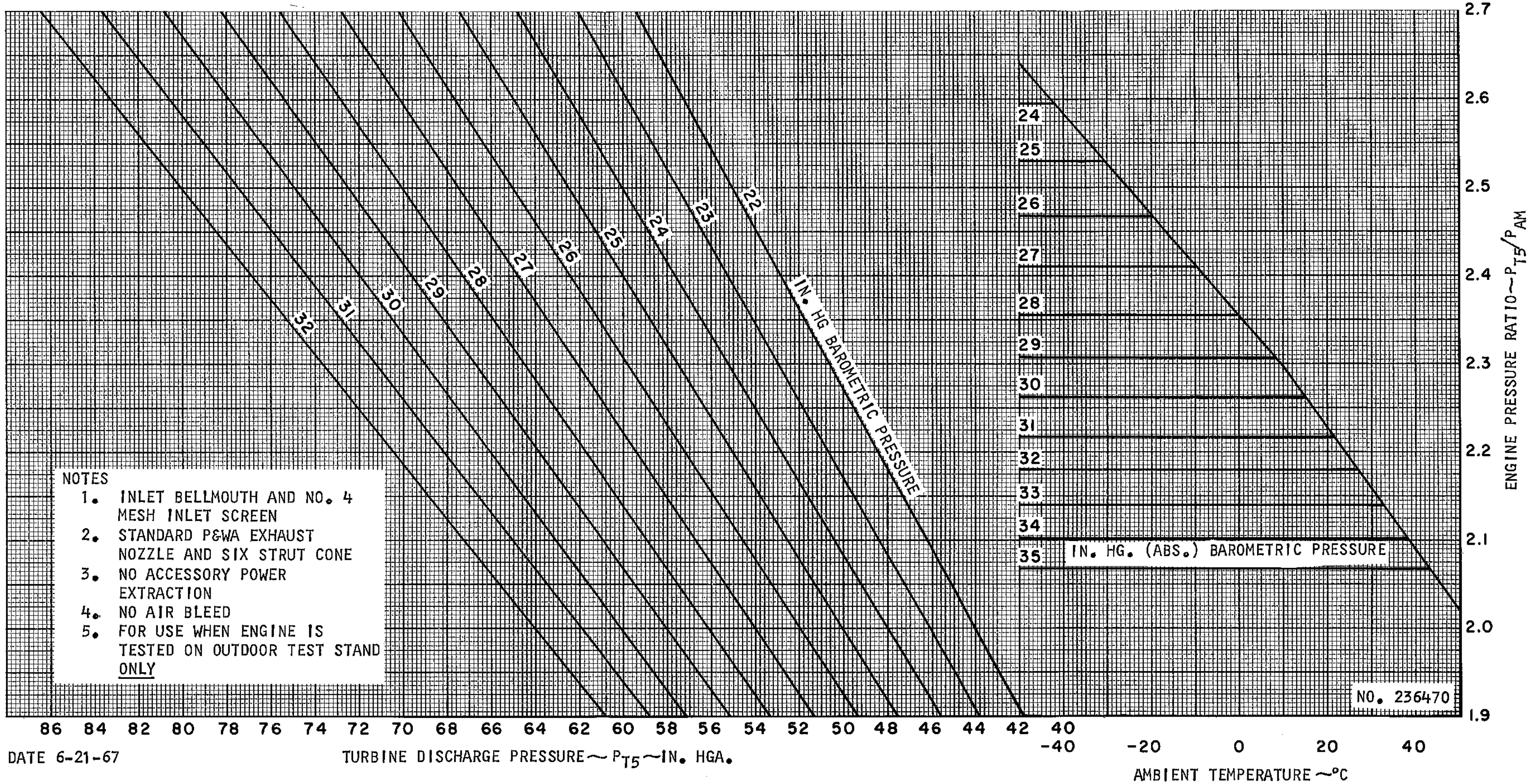


Figure 2-51L-1. Take-Off Thrust Setting Curve (JT12A-8)

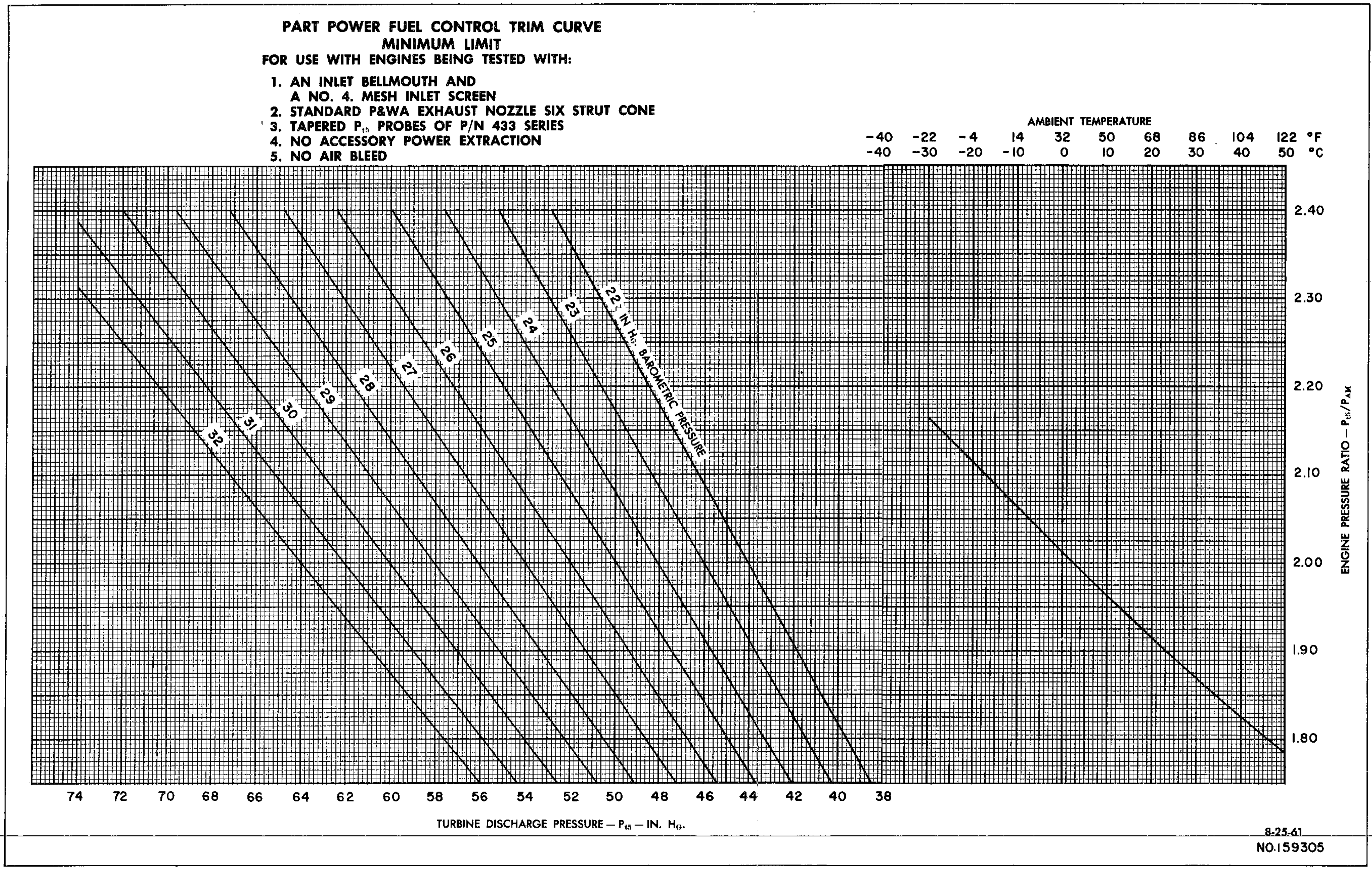


Figure 2—51M. Turbojet Engine Part Power Thrust Setting Curve (JT12A-6 and JT12A-6A)

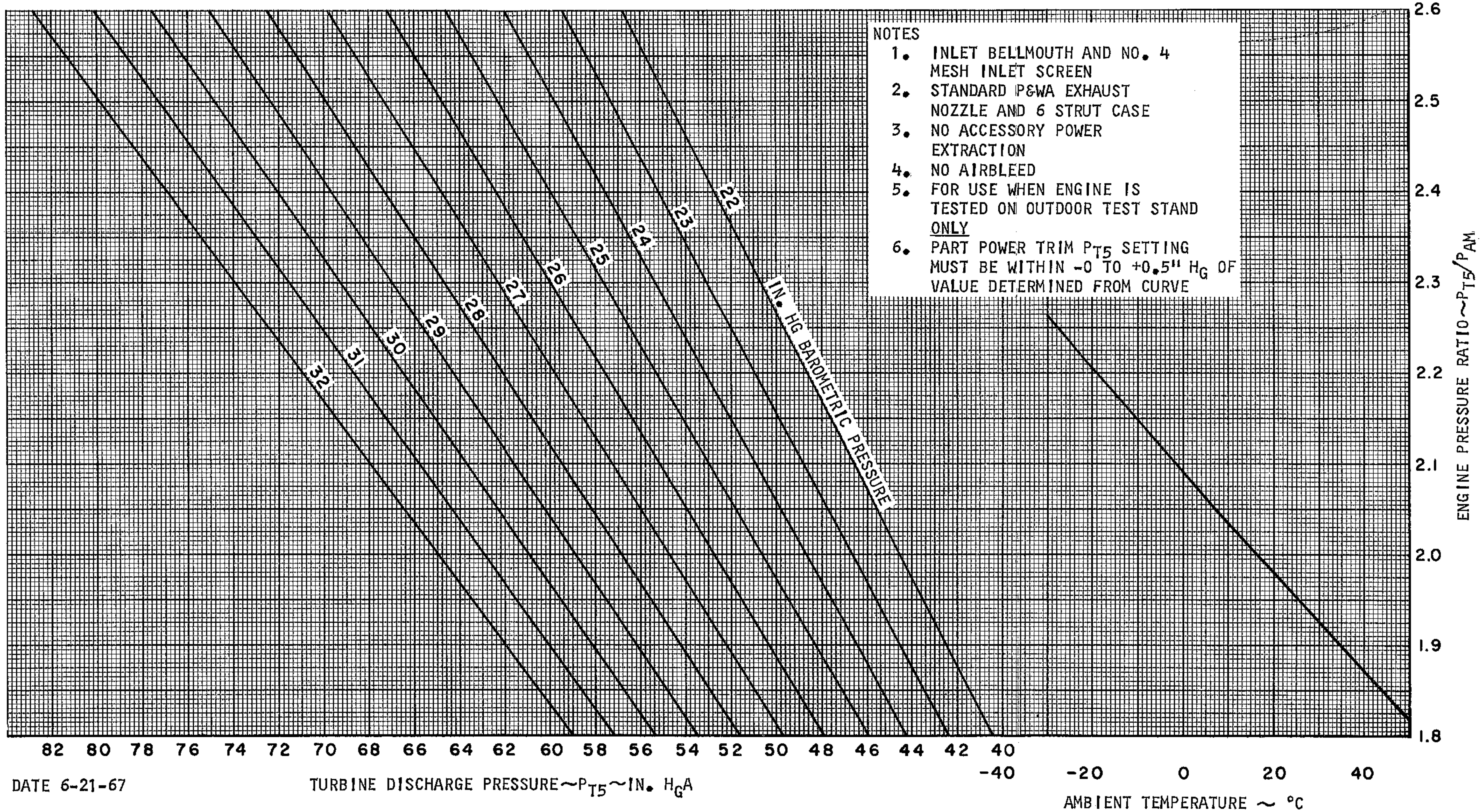


Figure 2-51M-1. Part Power Fuel Control Trim Curve (JT12A-8)

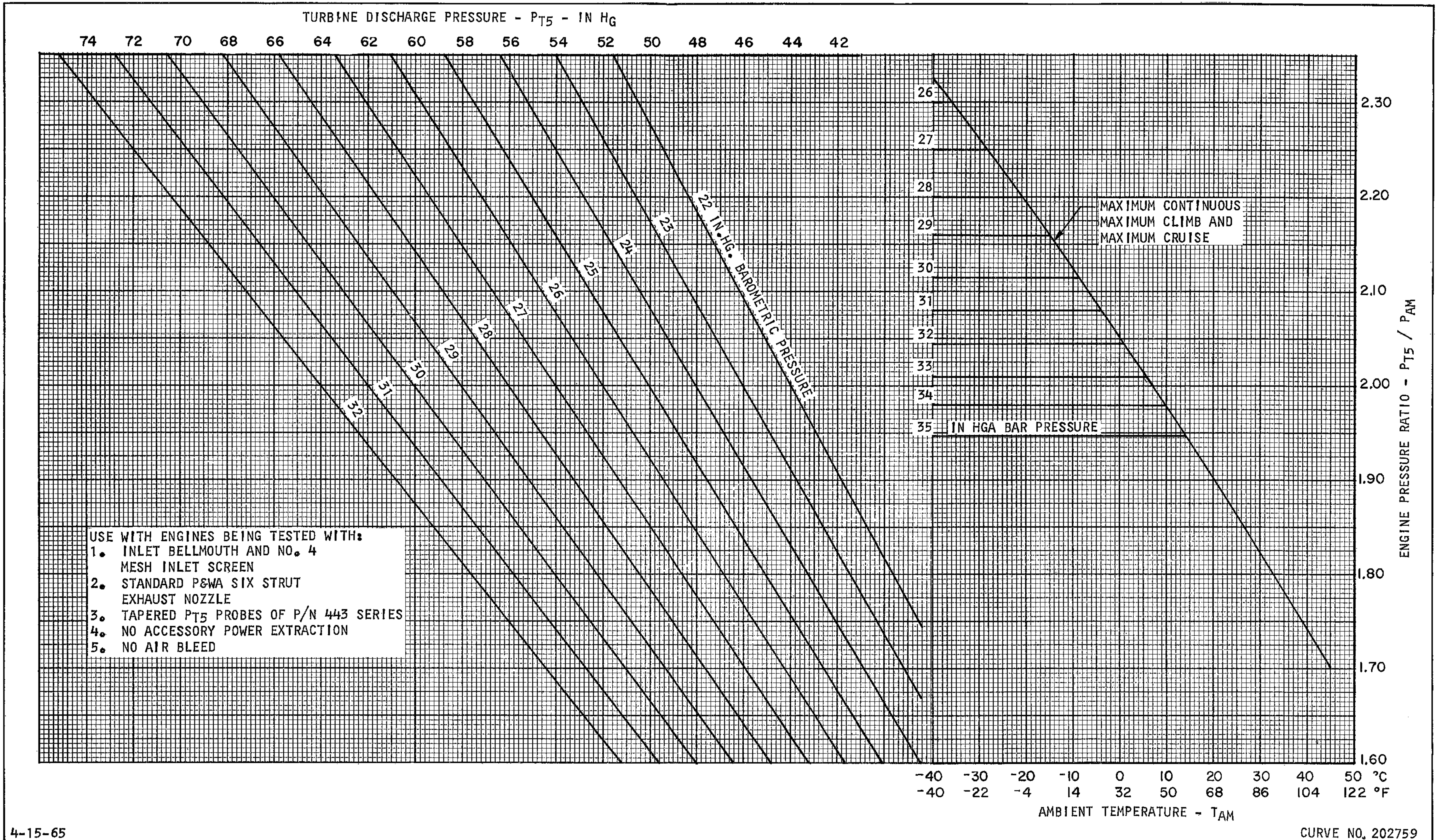


Figure 2-51N. Turbojet Engine Maximum Continuous and Maximum Climb Thrust Setting Curve (JT12A-6A)

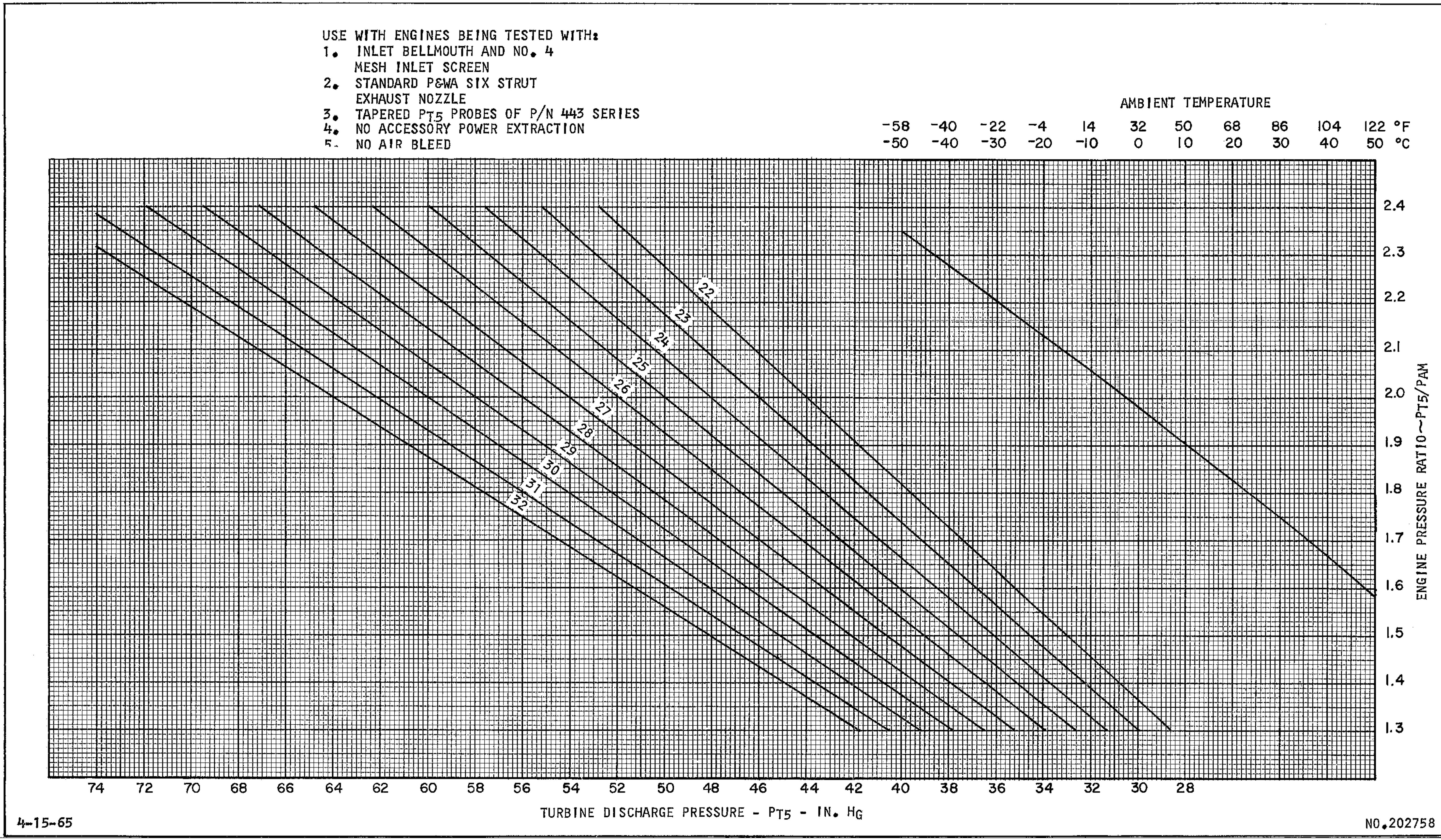


Figure 2-51N-1. Turbojet Engine Maximum Continuous and Maximum Climb Thrust Setting Curve (JT12A-6)

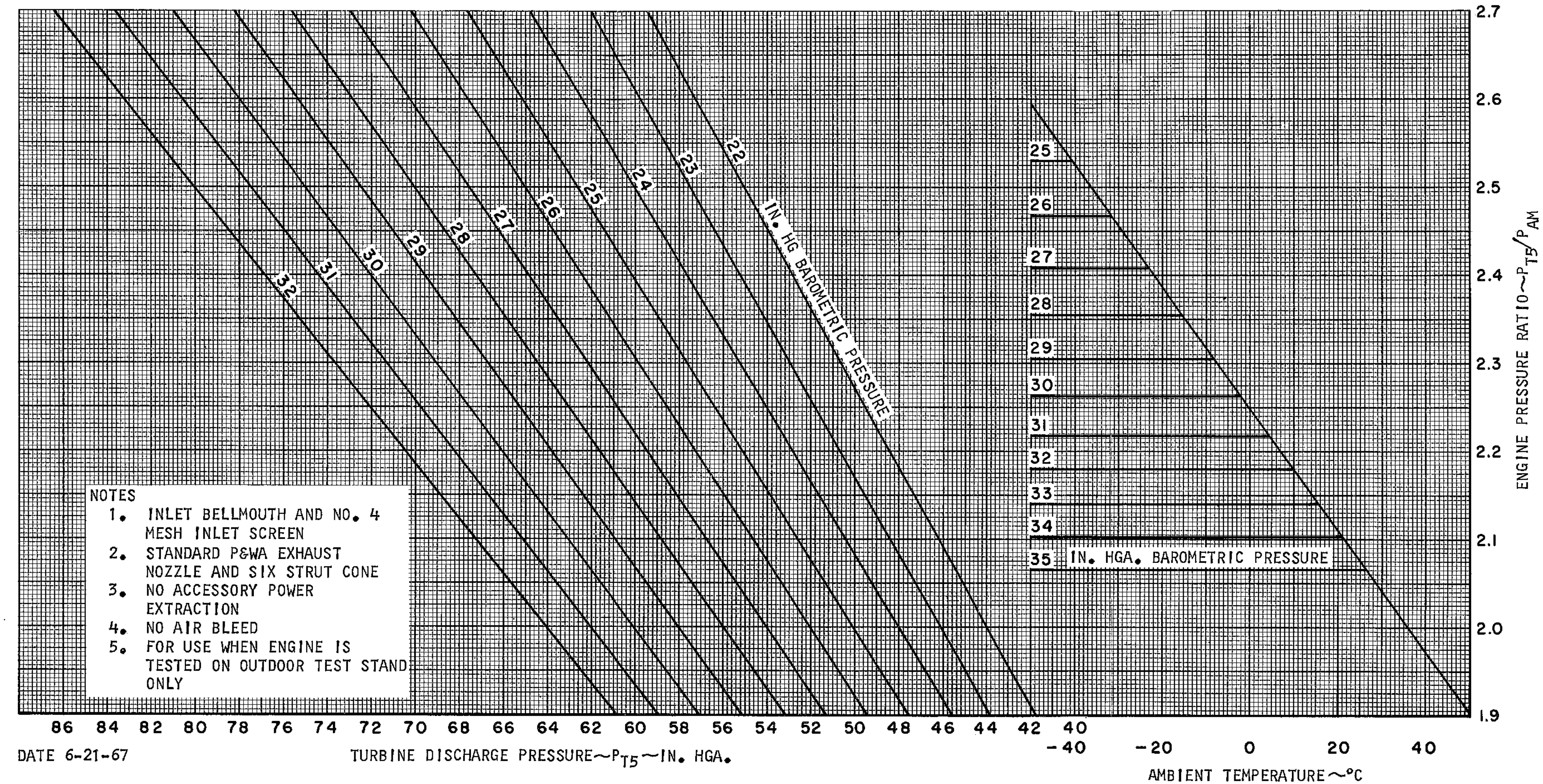


Figure 2-51N-2. Maximum Continuous and Maximum Climb Thrust Setting Curve (JT12A-8)

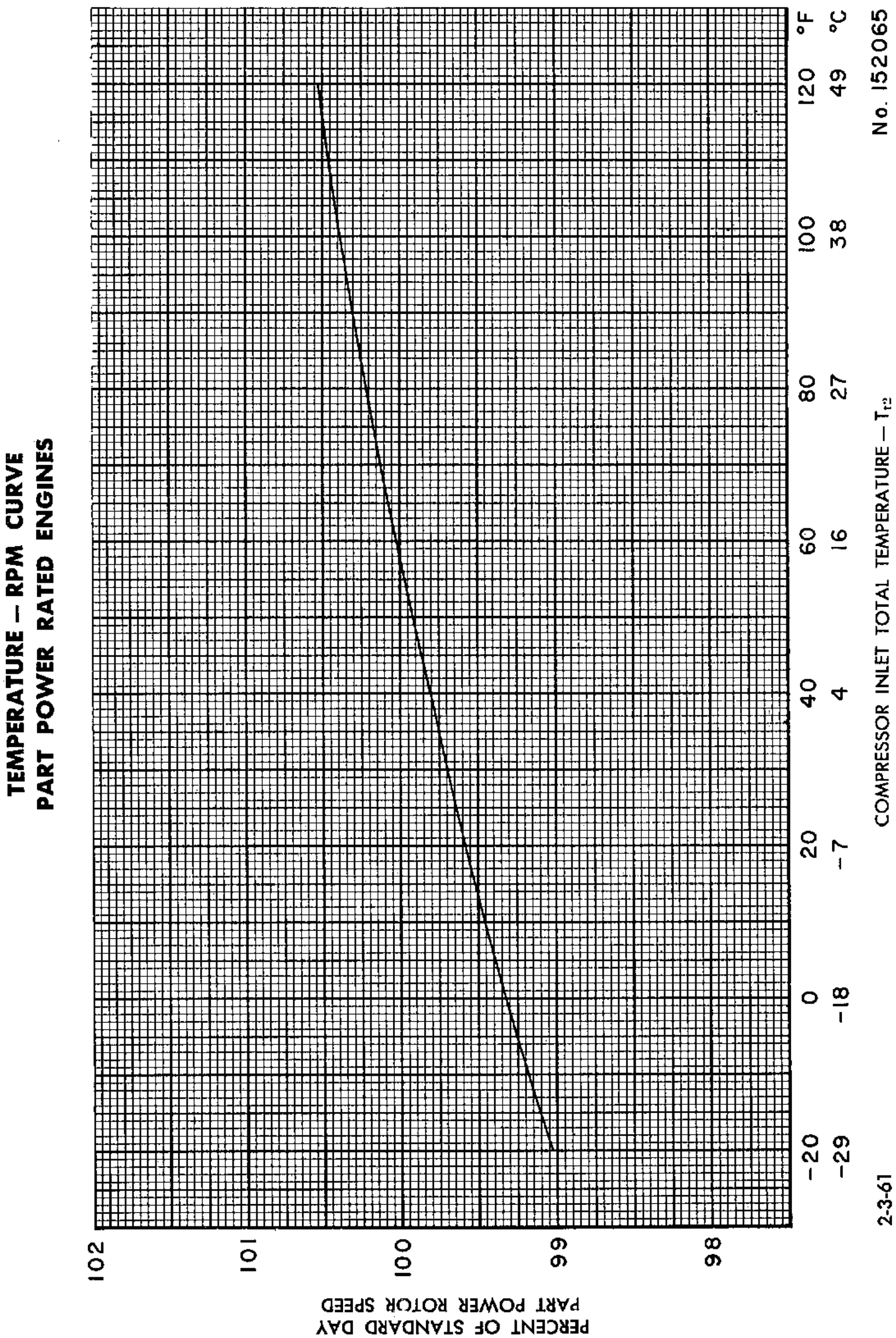


Figure 2—51P. Temperature — RPM Curve

ENGINE NO. __________ ENGINE TYPE __________ DATE __________

FUEL CONTROL SERIAL NO. __________ PART NO. __________

1. AMBIENT AIR TEMPERATURE ______ °C (______ °F)
2. TRUE BAROMETER __________ "Hg. 3. EXHAUST NOZZLE AREA __________ sq. ft.
   (Check barometer and temperature readings frequently)

4. DATA PLATE SPEED .... ______ rpm ______ percent
5. SPEED BIAS FACTOR (From Temperature-RPM Curve) .... ______ ______
   (Will vary with changes in ambient temperature)
6. ADJUSTED DATA PLATE SPEED (Line 4 x line 5) .... ______ rpm ______ percent
7. MAXIMUM ALLOWABLE INCREASE .... ______ rpm ______ percent
8. MAXIMUM ALLOWABLE TRIM SPEED (Line 6 + Line 7) .... ______ rpm ______ percent
   (Will vary with changes in ambient temperature)

9. SPECIFIED TURBINE DISCHARGE PRESSURE (P_{t5})
   (Determined from Part Power Thrust Setting Curve) ______ to ______ "Hg. E.P.R. ______
   (Will vary with ambient air temp. and true barometer)

10. PART POWER OBSERVED SPEED .... ______ rpm ______ percent
    Part Power P_{t5} ______ "Hg. E.P.R. ______

11. FUEL CONTROL MAXIMUM TRIMMER ADJUSTED .... ______ turns C.W. ______ turns C.C.W.

13. PART POWER OBSERVED SPEED (after adjustment) .... ______ rpm ______ percent
    Part Power P_{t5} ______ "Hg. E.P.R. ______

Note

If the speed recorded on lines 10 or 12 is equal to, or below the Maximum Allowable Trim Speed (line 8), and P_{t5} is within the specified limits (line 9), continue the engine in service. If the observed speed is greater than the Maximum Allowable Trim Speed, send the engine to Overhaul for cleaning.

14. OBSERVED IDLE SPEED (before adjustment) ______ percent
    Idle Speed Limits (From Idle Trim Setting Curve) ______ to ______ percent
    Fuel Control Idle Trimmer adjusted .... ______ turns C.W. ______ turns C.C.W.

15. OBSERVED IDLE SPEED (after adjustment) ______ percent

16. PART POWER OBSERVED SPEED (after IDLE adjustment) ______ rpm ______ percent
    Part Power P_{t5} ______ "Hg. E.P.R. ______

Note

If Part Power Observed speed after Idle adjustment, is greater than the Maximum Allowable Trim Speed (line 8) repeat the Part Power trimming procedure (lines 10 through 16).

Figure 2—51Q. Engine Trim Worksheet (Sample)

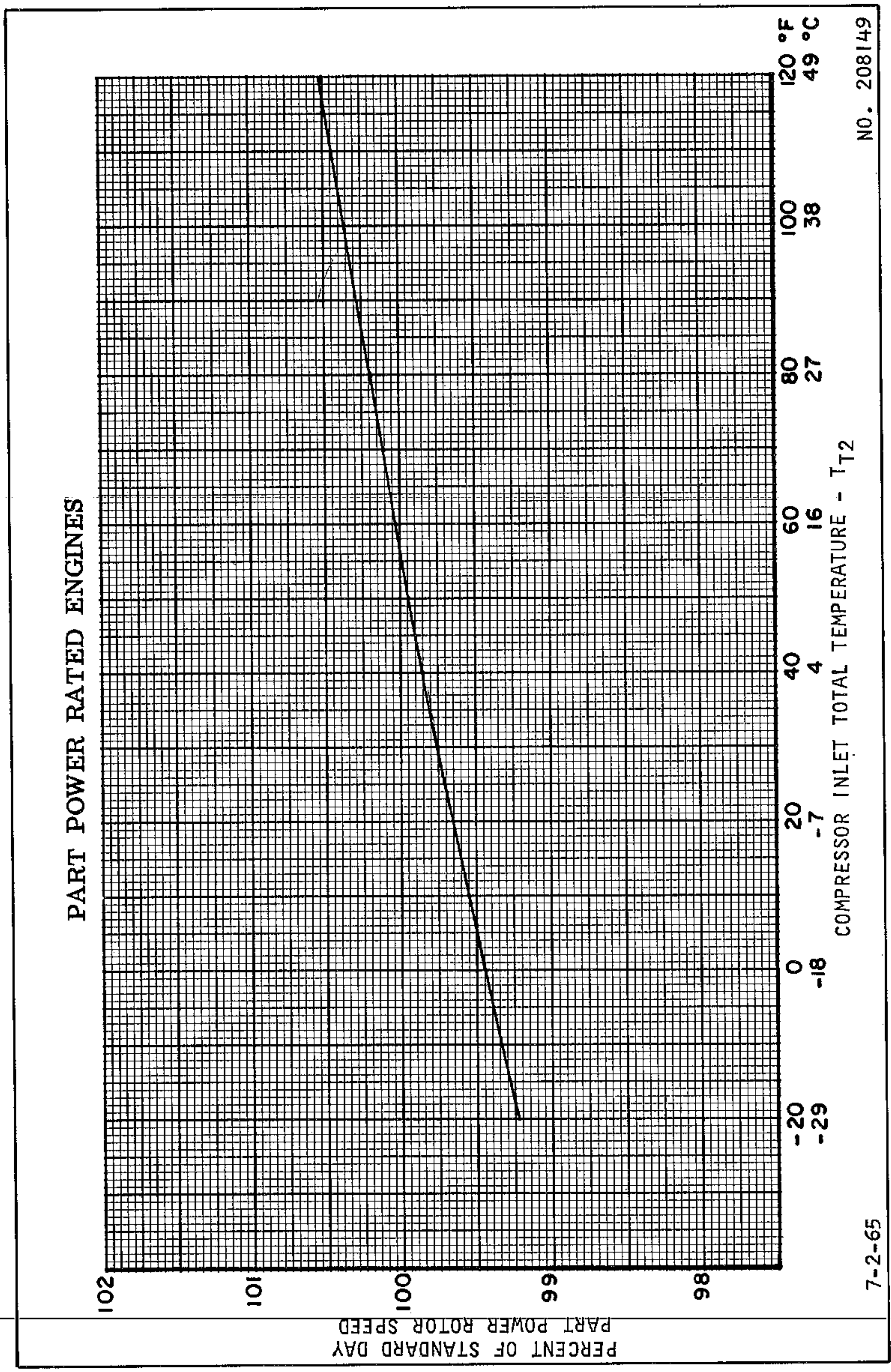


Figure 2-51P. Temperature - RPM Curve

ENGINE NO. ____________ ENGINE TYPE ____________ DATE ____________

FUEL CONTROL SERIAL NO. ______________ PART NO. ______________

1. AMBIENT AIR TEMPERATURE ______ °C (______°F)
2. TRUE BAROMETER ______________ "Hg. 3. EXHAUST NOZZLE AREA ____________________ sq. ft.
   (Check barometer and temperature readings frequently)

4. DATA PLATE SPEED .... ____________ rpm ____________ percent
5. SPEED BIAS FACTOR (From Temperature-RPM Curve) .... ____________ ____________
   (Will vary with changes in ambient temperature)
6. ADJUSTED DATA PLATE SPEED (Line 4 x line 5) .... ____________ rpm ____________ percent
7. MAXIMUM ALLOWABLE INCREASE .... ____________ rpm ____________ percent
8. MAXIMUM ALLOWABLE TRIM SPEED (Line 6 + Line 7) .... ____________ rpm ____________ percent
   (Will vary with changes in ambient temperature)

9. SPECIFIED TURBINE DISCHARGE PRESSURE (P_{t5})
   (Determined from Part Power Thrust Setting Curve) ____________ to ____________ "Hg. E.P.R. ____________
   (Will vary with ambient air temp. and true barometer)

10. PART POWER OBSERVED SPEED .... ____________ rpm ____________ percent
    Part Power P_{t5} ____________ "Hg. E.P.R. ____________

11. FUEL CONTROL MAXIMUM TRIMMER ADJUSTED .... ________ turns C.W. ________ turns C.C.W.

13. PART POWER OBSERVED SPEED (after adjustment) .... ____________ rpm ____________ percent
    Part Power P_{t5} ____________ "Hg. E.P.R. ____________

Note

If the speed recorded on lines 10 or 12 is equal to, or below the Maximum Allowable Trim Speed (line 8), and P_{t5} is within the specified limits (line 9), continue the engine in service. If the observed speed is greater than the Maximum Allowable Trim Speed, send the engine to Overhaul for cleaning.

14. OBSERVED IDLE SPEED (before adjustment) ____________ percent
    Idle Speed Limits (From Idle Trim Setting Curve) ____________ to ____________ percent
    Fuel Control Idle Trimmer adjusted .... ________ turns C.W. ________ turns C.C.W.

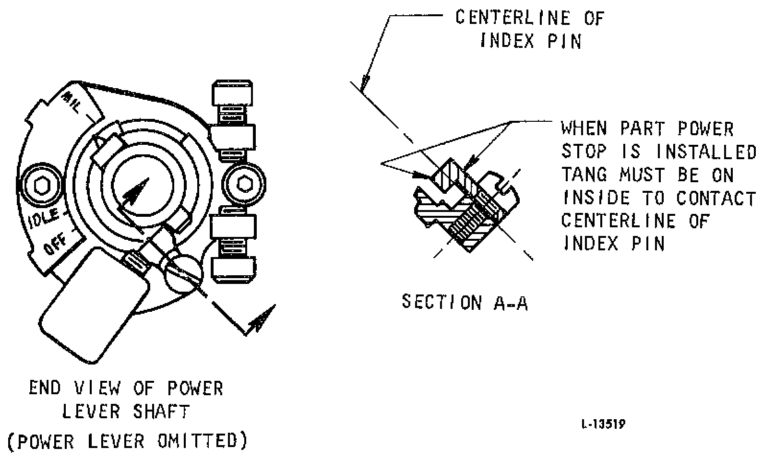
15. OBSERVED IDLE SPEED (after adjustment) ____________ percent

16. PART POWER OBSERVED SPEED (after IDLE adjustment) ____________ rpm ____________ percent
    Part Power P_{t5} ____________ "Hg. E.P.R. ____________

Note

If Part Power Observed speed after Idle adjustment, is greater than the Maximum Allowable Trim Speed (line 8) repeat the Part Power trimming procedure (lines 10 through 16).

Figure 2—51Q. Engine Trim Worksheet (Sample)



Applicable for the Following Controls Only:

557450L21 and subsequent	580777L20 and subsequent
561561L20 and subsequent	581555L20 and subsequent
573400L20 and subsequent	581888L20 and subsequent
580666L20 and subsequent	581999L20 and subsequent

Figure 2-51Q-1. Part Power Stop Position (Hamilton Standard Fuel Control)

2-321C. ENGINE TEST AFTER REPAIR (JFTD12A-4A AND -5A ENGINES).

2-321D. GENERAL. The extent of repair and replacement of engine parts will vary with different engines. The test requirements which are necessary to prove satisfactory performance after repair will also vary. To eliminate unnecessary ground testing and to conserve fuel, this test section is sub-divided into three ground test procedures which will be referred to as Test Nos. 1, 2, and 3. Test No. 1 is for engines requiring engine ground run-up. Test No. 2 will apply to engines which require trim and power setting. Test No. 3 will cover engines requiring ground check, run-up, and power setting prior to an actual operating condition time run of the engines. The performance check as outlined in Test No. 4 may be run on engine in conjunction with any of these tests. Before attempting to test the engines, refer to the applicable sections of Table 2-3H to determine the test requirement for a given engine. Comply with only the most comprehensive test specified for a repaired engine.

2-321E. DETERMINING TURBINE DISCHARGE PRESSURE (P_{t5}) FOR CHECKING OR SETTING ENGINE POWER (JFTD12A-4A AND -5A ENGINES). Use the following procedure to determine expected power output for a normally functioning engine under static conditions. The power lines appearing on the engine power curves (Figures 2-51T, 2-51T-1, 2-51U, 2-51U-1, 2-51V, and 2-51V-1) are used to determine engine power in terms of turbine discharge pressure (P_{t5}) for the prevailing ambient conditions.

NOTE

Reduced Power P_{t5} settings must be within -0 inch Hg to +0.5 inch Hg of the values determined from figure 2-51V. Take-Off and Maximum Continuous settings must be at the P_{t5} (or EPR) values determined from the applicable curves. (See figures 2-51T, 2-51T-1, 2-51U, and 2-51U-1.)

a. Obtain ambient (outside) air temperature as close to engine inlet as possible.

b. Enter engine power curve with ambient temperature and proceed vertically downward to intersect power line. (When using Take-Off curve, proceed downward to intersect barometric pressure horizontal line which corresponds with field true barometer.)

c. From intersection of ambient temperature and power (or barometric pressure horizontal line on Take-Off curve) proceed horizontally to left to intersect line corresponding to prevailing field barometric pressure. From this intersection proceed downward to read desired turbine discharge pressure (P_{t5}).

d. Record P_{t5} value determined above.

2-321F. ADJUSTED DATA PLATE CHECK SPEED (JFTD12A-4A AND -5A ENGINES).

2-321G. GENERAL.

a. Each engine produces its Take-Off rated power (or more) at an EPR shown on power setting curves. Trimming of the engine, however, is done at a lower power setting which is termed the REDUCED POWER setting. The Reduced Power condition is at a power level sufficiently low to allow trimming over a wide range of ambient temperatures, thus eliminating the possibility of an engine trimmed on a cold day failing to produce Take-Off power on a hot day. A properly trimmed engine fuel control provides sufficient power lever travel margin above the reduced power position to enable the engine to reach Take-Off power. Although the engine power level and the fuel control trim are determined by EPR, the fuel control itself senses engine rpm. The relationship of rpm to power under any given ambient air condition can change as service life increases (EPR to power relationship remains constant) to the extent that retrimming becomes necessary. When the engine power lever reaches its maximum position before Take-Off rated power is obtained, a trim check and Data Plate Check Speed deterioration check should be made. A trim check also must be made when a new fuel control is installed.

TABLE 2-3H. REPAIR REFERENCES

Units Repaired or Replaced	Test Required
Accessory Section	No. 1 (with vibration pick-ups installed)
Control - Engine Fuel	No. 2 and compressor bleed valve check
Exhaust Case	No. 1 and trim check
Ignition Exciters and/or Igniter Plugs	Perform satisfactory start
Liners - Combustion Chamber	No. 1
Manifold Assembly - Fuel	No. 2
*Major Cases	No. 3
*Main Bearings and Accessory Drive	No. 3
Nozzle Assembly - First Stage Turbine	No. 3
Nozzles - Fuel	No. 2
Main Oil Pump	No. 1
Pump - Fuel	No. 2
Strainer - Main Oil	No. 1
*Turbine Disk and Blade Assembly	No. 3
*Turbine Rotor Shaft	No. 3
Valve Compressor Bleed	No. 1
Valve - Fuel Pressurizing and Dump	No. 1
Electrical Harness	No. 1

*These units would be replaced by facilities with the required capability and in accordance with instructions in the JT12A Overhaul Manual.

b. The speed at which the engine reached a pressure ratio, EPR (P_{t5}/P_{t2}) of 1.650, is stamped on the engine data plate in rpm and percent of 16030 rpm. This check speed is for a 15°C (59°F) day. Since engine speed for any given EPR varies with changes in compressor inlet temperature (T_{t2}), the Data Plate Check Speed must be adjusted for ambient conditions when checking for deterioration.

2-321H. COMPUTATION. To adjust Data Plate Check Speed for ambient temperature, proceed as follows:

a. Determine ambient temperature as close to engine inlet as possible.

b. Enter Ambient Temperature - Data Plate Check Speed Curve (Figure 2-51W) at this temperature and proceed vertically to curve. From this intersection, proceed horizontally to left and read percent of Data Plate Check Speed which is to be expected at this temperature. (This percentage is known as the SPEED BIAS.)

c. Multiply Data Place Check Speed by percentage determined from figure 2-51W. The product is the speed to be expected at existing ambient temperature, and is known as ADJUSTED DATA PLATE CHECK SPEED.

2-321J. MAXIMUM ALLOWABLE CHECK SPEED (JFTD12A-4A AND -5A ENGINES).

2-321K. GENERAL. As service time is accumulated on the engine, it will generally be noted that the desired turbine discharge pressure (P_{t5}) cannot be obtained when operating at Reduced Power Stop position of the fuel control. This is primarily due to contamination of the engine air passages. When this condition occurs, the engine must be trimmed to bring turbine discharge pressure (P_{t5}) up to the desired value. This trimming will result in an increase in compressor speed. The compressor speed increase must not be more than 300 rpm above the Adjusted Data Plate Check Speed when the engine deterioration check run is made. This limit will be referred to in subsequent procedures as the MAXIMUM ALLOWABLE INCREASE. The sum of the Adjusted Data Plate Check Speed and Maximum Allowable Increase will be referred to as MAXIMUM ALLOWABLE DETERIORATION SPEED.

2-321L. COMPUTATION.

NOTE

This computation may be made using rpm or percent. With tachometer drive ratio of 0.262:1, 300 rpm equals 1.871 percent.

a. Determine Adjusted Data Plate Check Speed by multiplying Data Plate Check Speed by the Speed Bias Factor (figure 2-51W).

b. Determine Maximum Allowable Deterioration Speed by adding the Maximum Allowable Increase (300 rpm) to the Adjusted Data Plate Check Speed.

c. Set EPR to the deterioration check value of 1.650. Aircraft installation effects such as airbleed, accessory loads, etc. must be the absolute minimum as they will affect engine speed. Compare the Indicated Speed to the Maximum Allowable Deterioration Speed. For those instances where P_{t2} is not measured, P_{t5}/P_{amb} can be used for this check. The adjustments to P_{t5}/P_{t2} necessary for this appear below.

d. The EPR (P_{t5}/P_{t2} = 1.650) does not include any correction for aircraft inlet duct loss (P_{t2}/P_{amb}). In order to determine the Data Plate Check Speed EPR for each engine installed in airframe or test stand, these corrections will have to be made to EPR (P_{t5}/P_{t2}) to get the correct P_{t5}/P_{amb}. For engines running with a Pratt & Whitney inlet bellmouth and coarse mesh screen the P_{t5}/P_{amb} may be set at 1.640.

e. If indicated speed is less than Maximum Allowable Deterioration Speed, the engine may be continued in service. If the indicated speed is greater than the allowable speed, send the engine to overhaul for cleaning.

NOTE

The above procedure is set forth in Table 2-3J. Sample computations, using rpm and using percent, are also included in the table. A trim setting worksheet will prove helpful in trimming engines and checking power deterioration by providing an orderly arrangement of pertinent data. Worksheet format may vary with different installations or when airframe manufacturer's trim curves are being used. A sample worksheet (Table 2-3K) is provided herein as a guide.

2-321M. TEST NO. 1 ENGINE GROUND RUN-UP (JFTD12A-4A AND -5A ENGINES).

a. Inspect the test area for cleanliness.

b. Determine the Take-Off P_{t5} from figure 2-51T or 2-51T-1.

c. Perform a satisfactory start and allow instrument readings to stabilize for at least five minutes.

NOTE

During inlet icing conditions with the anti-icing system in operation accurate power check readings cannot be made.

d. Accelerate the engine and establish that the automatic modulated bleed starts to close between 11,000 and 11,300 rpm and is fully closed at 13,000 rpm. Decelerate the engine and establish that the bleed starts to open between 13,000 and 12,700 rpm, and is fully open at 11,000 rpm.

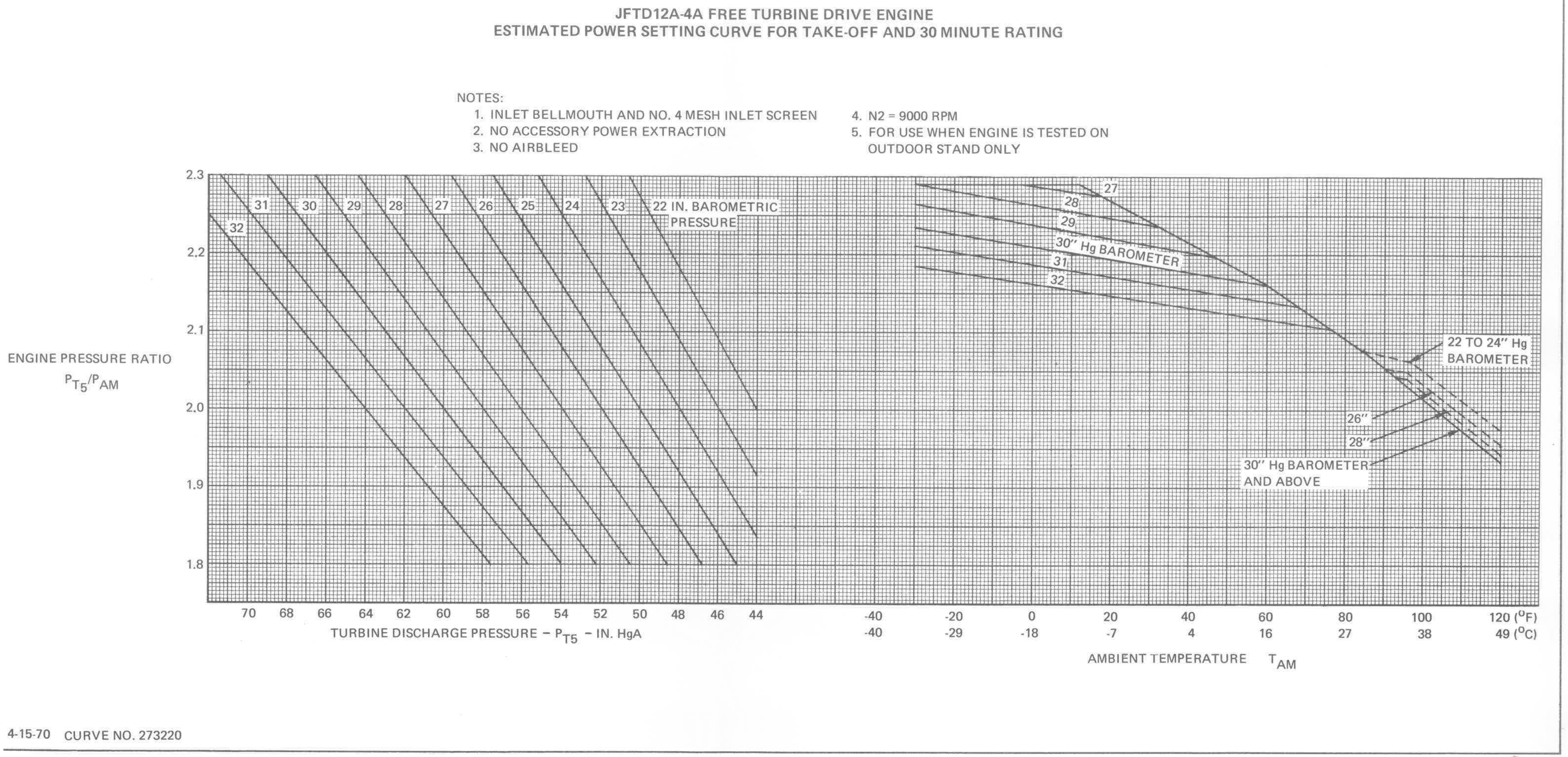
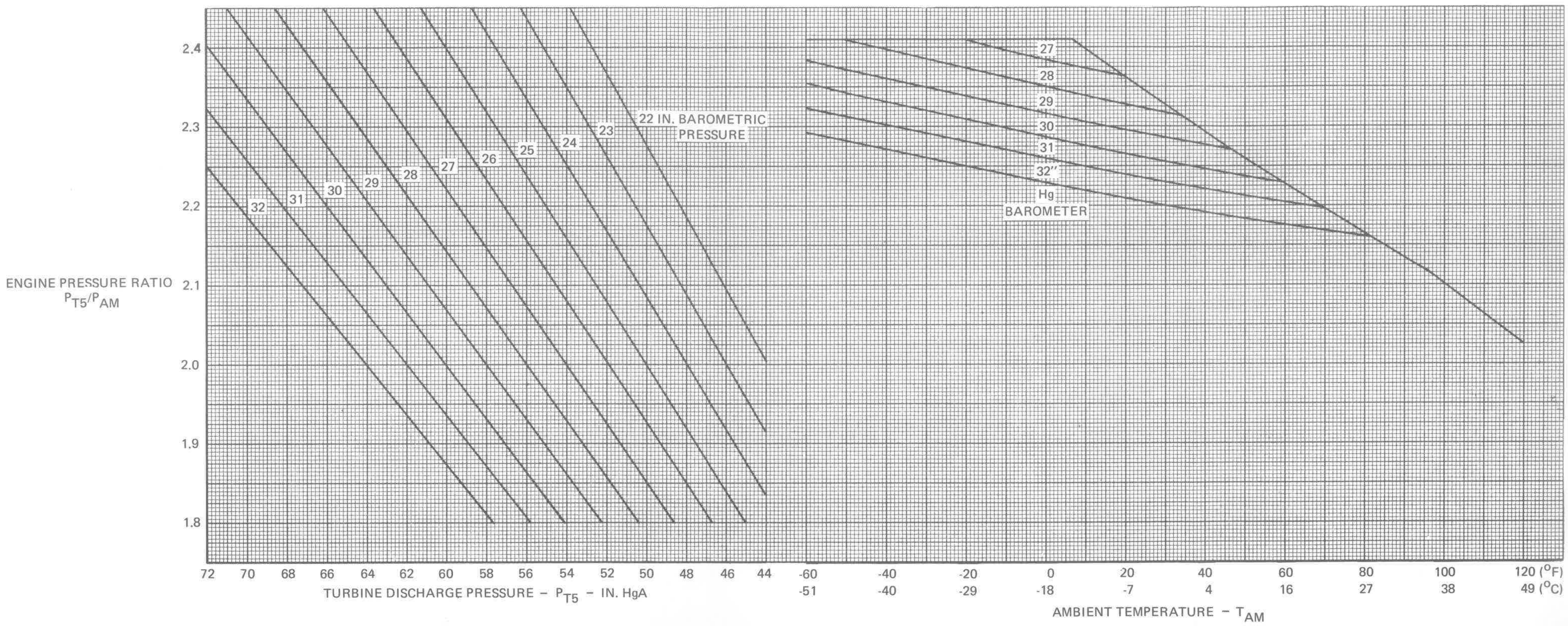


Figure 2-51T. Power Setting Curve for Take-Off Rating (JFTD12A-4A)

JFTD12A-5A FREE TURBINE DRIVE ENGINE
ESTIMATED POWER SETTING CURVE FOR TAKE-OFF & 30 MINUTE RATING

NOTES:

1. INLET BELLMOUTH AND NO. 4 MESH INLET SCREEN
2. NO ACCESSORY POWER EXTRACTION
3. NO AIRBLEED
4. N2 = 9000 RPM
5. FOR USE WHEN ENGINE IS TESTED ON OUTDOOR STAND ONLY



4-15-70

CURVE NO. 273822

Figure 2-51T-1. Power Setting Curve for Take-Off Rating (JFTD12A-5A)

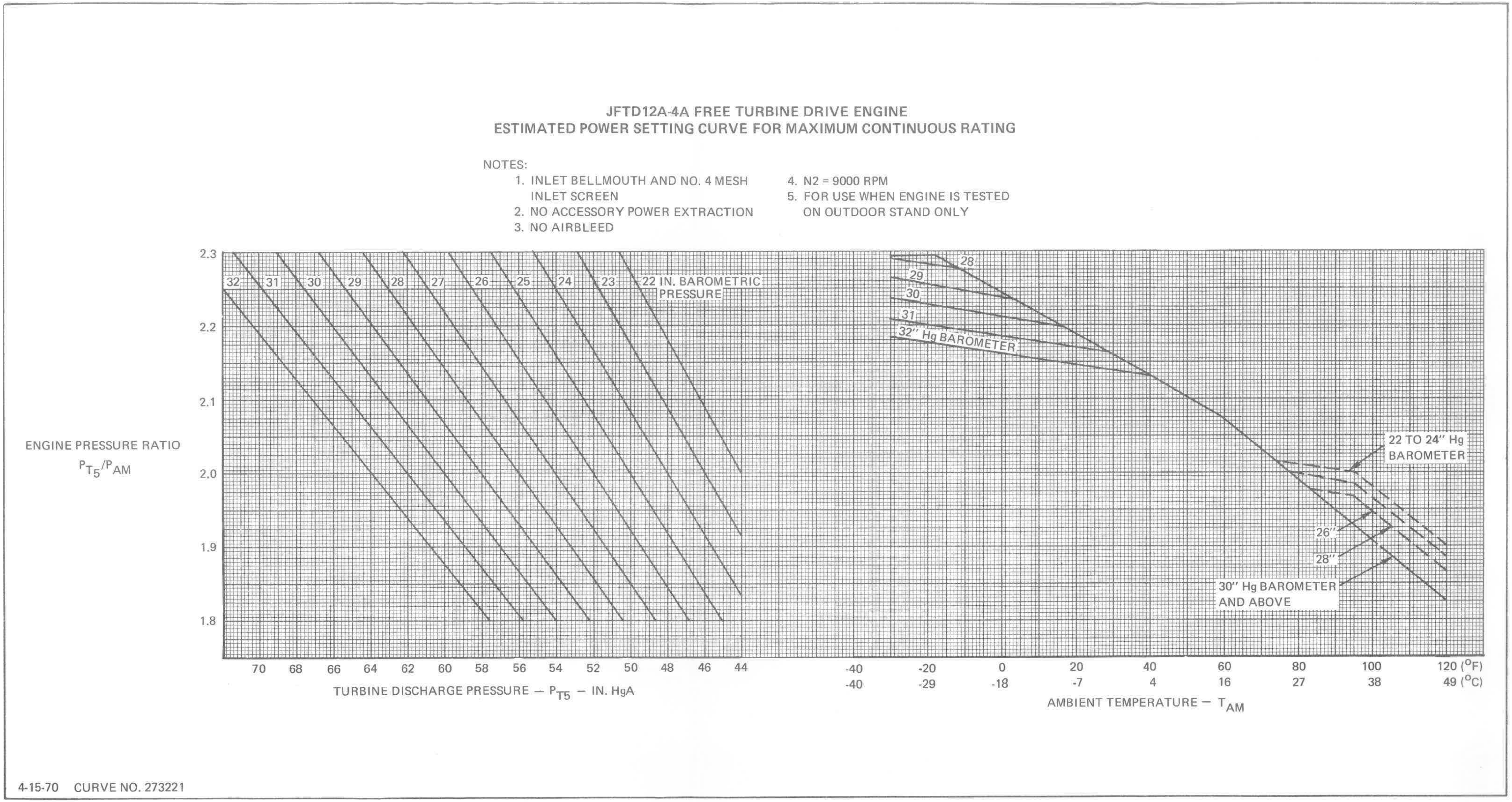


Figure 2-51U. Power Setting Curve for Maximum Continuous Rating (JFTD12A-4A)

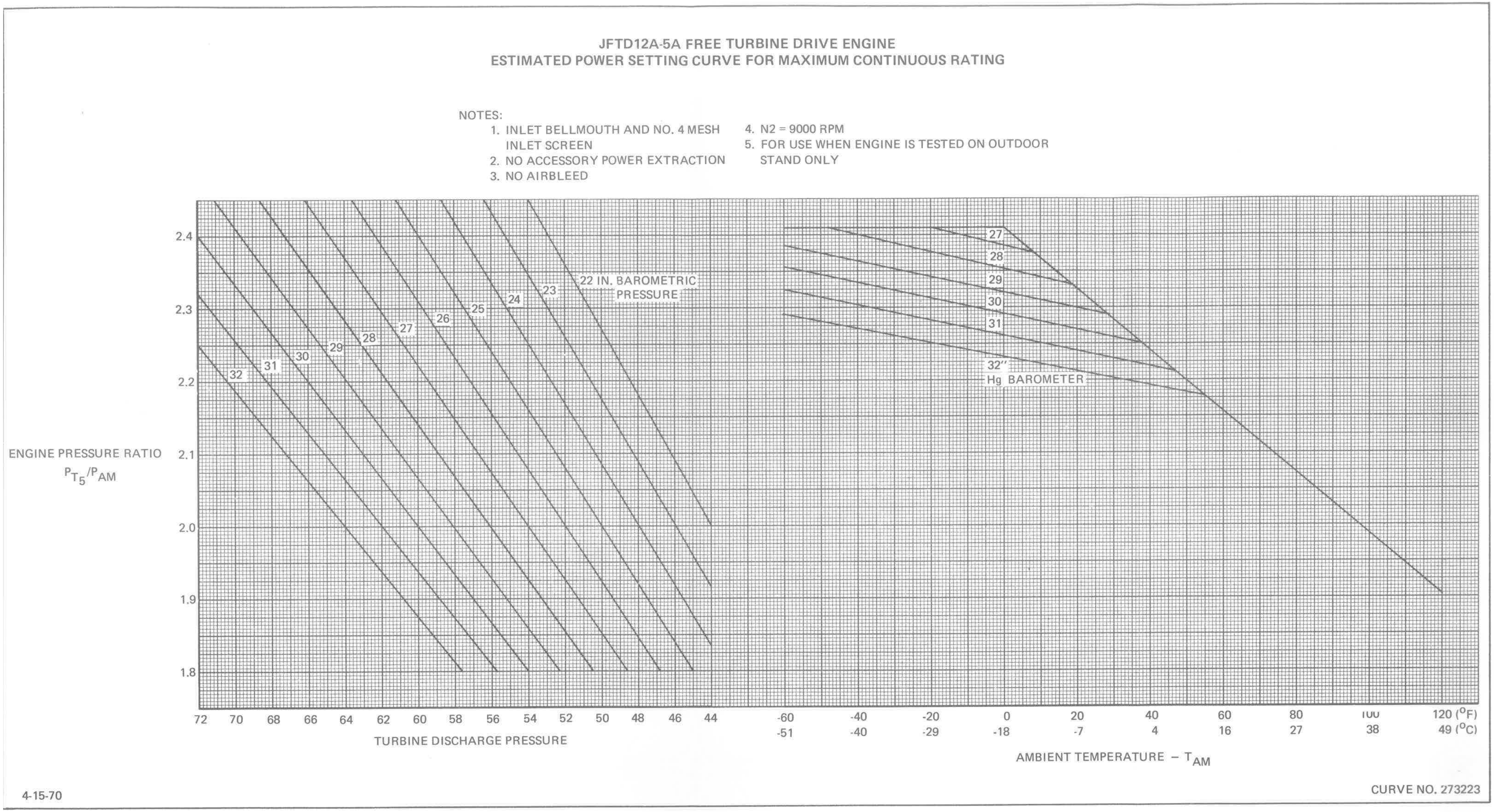


Figure 2-51U-1. Power Setting Curve for Maximum Continuous Rating (JFTD12A-5A)

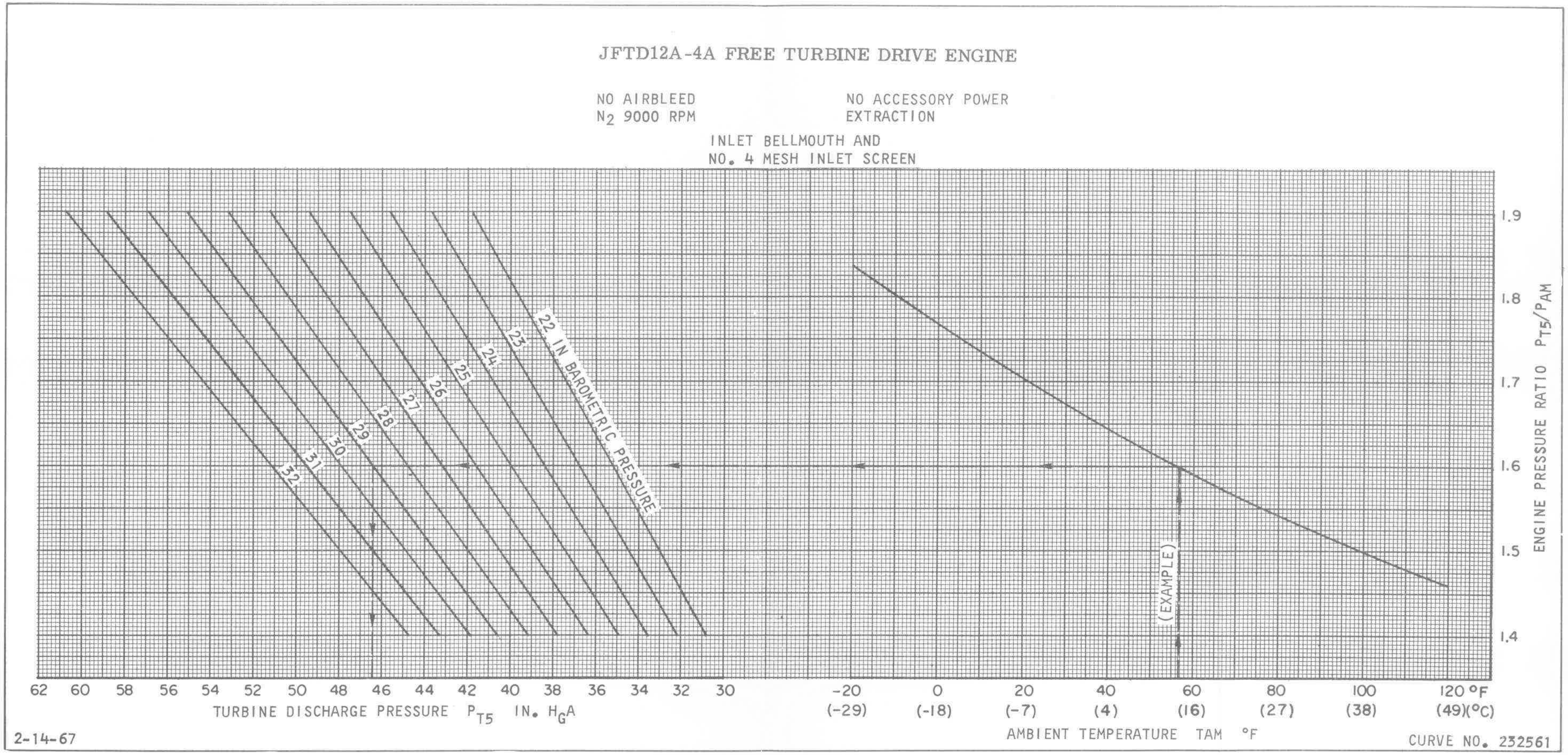
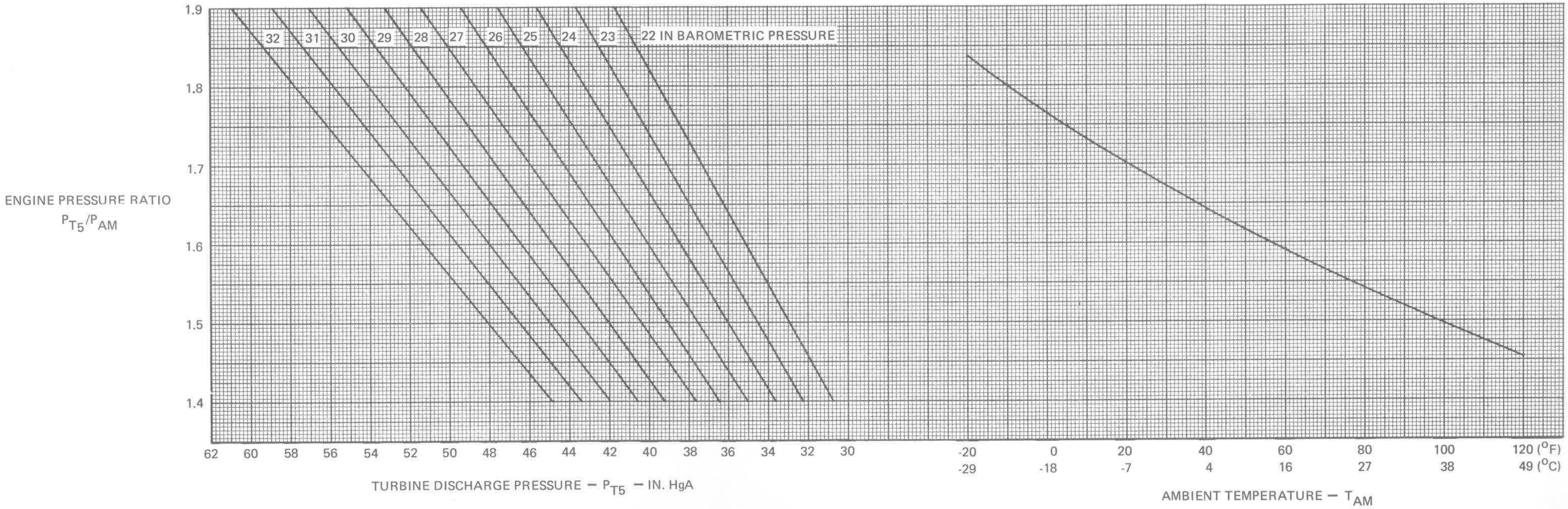


Figure 2-51V. Reduced Power Trim Curve (JFTD12A-4A)

JFTD12A-5A FREE TURBINE DRIVE ENGINE
ESTIMATED REDUCED POWER TRIM CURVE

NOTES:
1. INLET BELLMOUTH WITH NO. 4 MESH INLET SCREEN
2. NO ACCESSORY POWER EXTRACTION
3. NO AIRBLEED
4. N2 = 9000 RPM
5. FOR USE WHEN ENGINE IS TESTED ON OUTDOOR STAND ONLY
6. REDUCED POWER TRIM SETTING MUST BE WITHIN -0 TO +0.5" Hg OF VALUE DETERMINED FROM CURVE



4-15-70 CURVE NO. 273224

Figure 2-51V-1. Reduced Power Trim Curve (JFTD12A-5A)

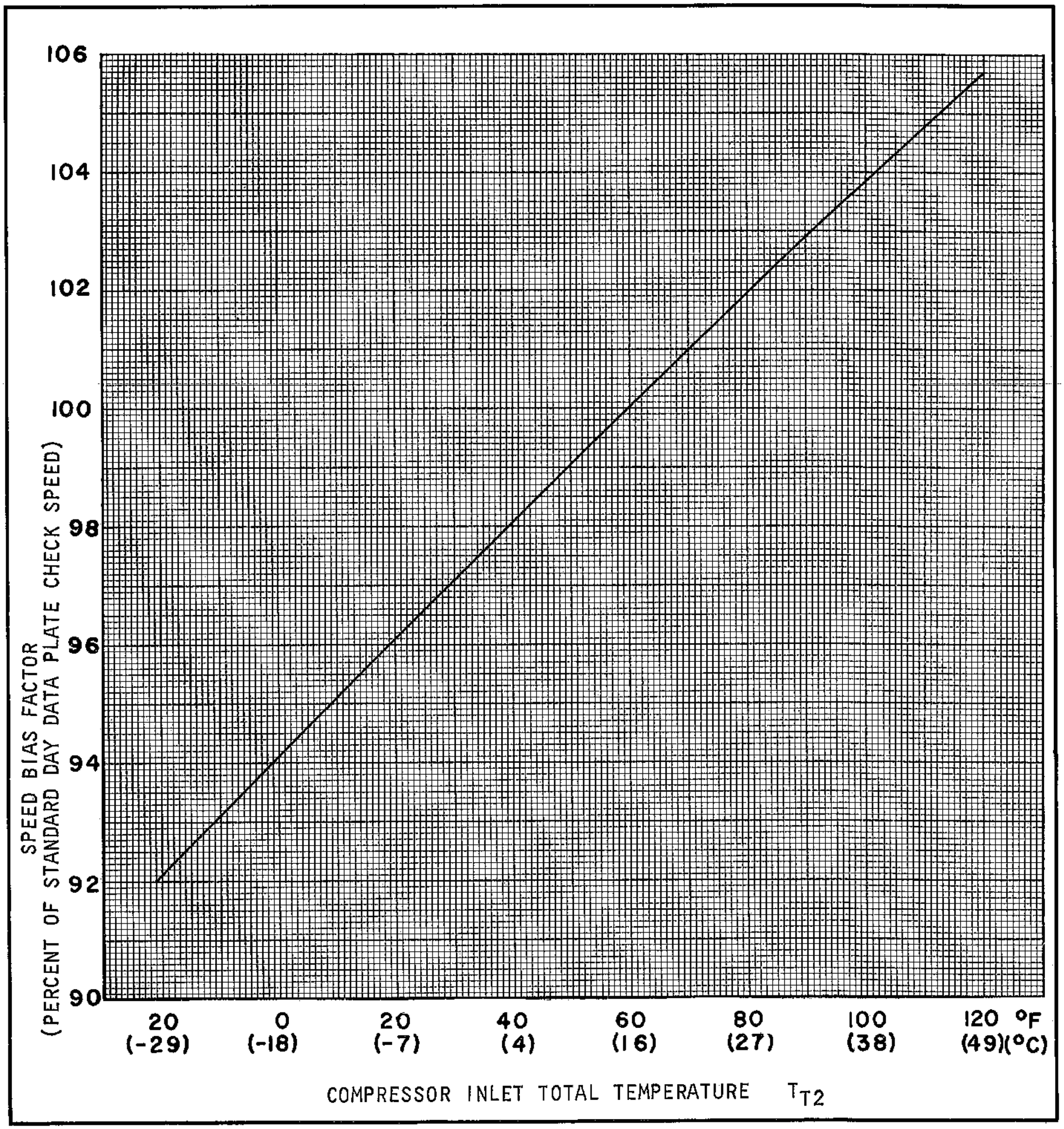


Figure 2-51W. Ambient Temperature - Data Plate Check Speed Correction Curve (JFTD12A-4A)

TABLE 2-3J. DETERMINING ENGINE PERFORMANCE ACCEPTABILITY (FREE TURBINE ENGINES)

NOTE

The following conditions for JFTD12A-4A engines are assumed for the purpose of making the sample computations herein:
1. Data Plate Check Speed = 13875 rpm or 86.56 percent
2. Ambient Air Temperature = 10°C (14°F)
3. Speed Bias Factor = 95.6 percent
4. Indicated Speed = 13400 rpm or 83.59 percent

Procedure	Method	Sample Computation*	
		Using RPM	Using Percent*
Determine Adjusted Data Plate Check Speed	Multiply Data Plate Check Speed by Speed Bias Factor	13875 × .956 = 13265	86.56 × .956 = 82.75
Determine Maximum Allowable Check Speed	Add Adjusted Data Plate Check Speed and Maximum Allowable Increase	13265 + 300 = 13565	82.75 + 1.871 = 84.621
Compare Indicated Speed to Maximum Allowable Speed	Subtract Indicated Speed from Maximum Allowable Check Speed	13565 - 13400 = 165	84.621 - 83.59 = 1.031
		NOTE Since Indicated Speed is less than Maximum Allowable Check Speed, the engine may be continued in service.	

*Computations are based on engines having 0.262:1 Tachometer Drive Ratio and 100 percent rotor speed of 16030 rpm.

e. Advance power lever to Take-Off position. When engine stabilizes, record P_{t5} gage reading at end of run.

CAUTION

Make certain that operating limits in engine check chart are not exceeded and that observed N_1 rpm is not above maximum allowable.

f. If P_{t5} gage reading does not agree with predetermined P_{t5}, check engine trim in accordance with Test No. 2.

NOTE

Check for P_{t5} leaks before running Test No. 2.

g. Retard the power lever to MAXIMUM CONTINUOUS (figure 2-51U) and allow instrumentation to stabilize.

h. Turn anti-icing air switch ON. A properly operating anti-icing system will cause an immediate but small drop of pressure on P_{t5} gage and rise in temperature on anti-icing air temperature gage.

i. Turn anti-icing air switch OFF. Retard power lever to IDLE and allow to cool.

j. Inspect engine for any evidence of fuel, oil, or air leaks.

k. Shut down, per paragraph 2-300.

2-321N. TEST NO. 2 - ENGINE TRIM (JFTD12A-4A ENGINES).

a. Inspect and clean test area.

b. Install reduced power trim stop on fuel control to limit power lever travel and position pitch and trim levers in maximum (full forward) positions.

NOTE

Hamilton Standard controls of later design must have reduced power stop installed as shown in figure 2-51Q-1.

c. Determine and record Take-Off and Reduced Power turbine discharge pressure (P_{t5}) from figures 2-51T and 2-51V.

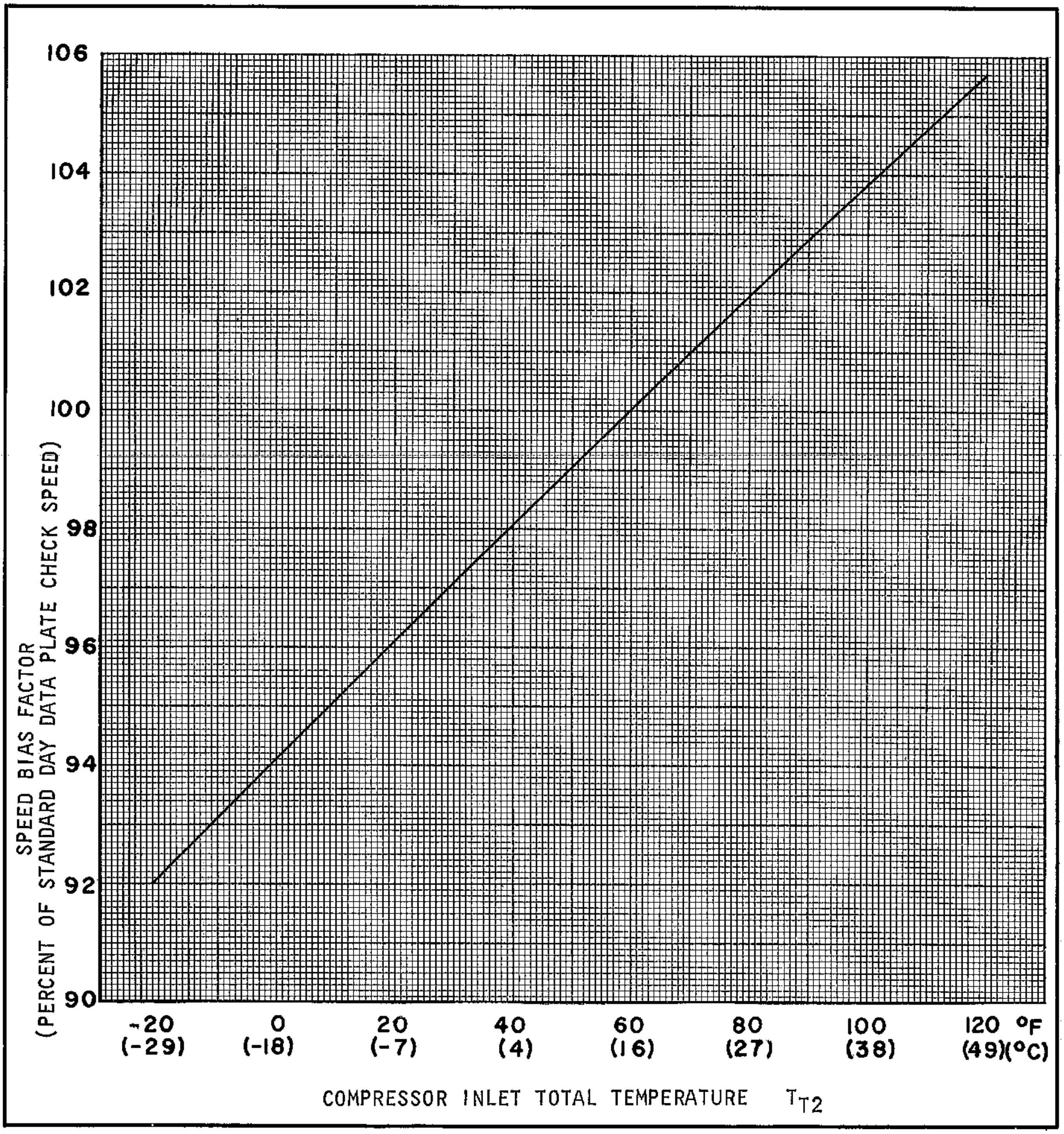


Figure 2-51W. Ambient Temperature - Data Plate Check Speed Correction Curve (JFTD12A-4A and -5A)

TABLE 2-3J. DETERMINING ENGINE PERFORMANCE ACCEPTABILITY (FREE TURBINE ENGINES)

NOTE

The following conditions for JFTD12A-4A engines are assumed for the purpose of making the sample computations herein:

1. Data Plate Check Speed = 13875 rpm or 86.56 percent
2. Ambient Air Temperature = 10°C (14°F)
3. Speed Bias Factor = 95.6 percent
4. Indicated Speed = 13400 rpm or 83.59 percent

Procedure	Method	Sample Computation*	
		Using RPM	Using Percent*
Determine Adjusted Data Plate Check Speed	Multiply Data Plate Check Speed by Speed Bias Factor	13875 × .956 = 13265	86.56 × .956 = 82.75
Determine Maximum Allowable Check Speed	Add Adjusted Data Plate Check Speed and Maximum Allowable Increase	13265 + 300 = 13565	82.75 + 1.871 = 84.621
Compare Indicated Speed to Maximum Allowable Speed	Subtract Indicated Speed from Maximum Allowable Check Speed	13565 - 13400 = 165	84.621 - 83.59 = 1.031
		NOTE Since Indicated Speed is less than Maximum Allowable Check Speed, the engine may be continued in service.	

*Computations are based on engines having 0.262:1 Tachometer Drive Ratio and 100 percent rotor speed of 16030 rpm.

e. Advance power lever to Take-Off position. When engine stabilizes, record P_{t5} gage reading at end of run.

CAUTION

Make certain that operating limits in engine check chart are not exceeded and that observed N_1 rpm is not above maximum allowable.

f. If P_{t5} gage reading does not agree with predetermined P_{t5}, check engine trim in accordance with Test No. 2.

NOTE

Check for P_{t5} leaks before running Test No. 2.

g. Retard the power lever to MAXIMUM CONTINUOUS (figure 2-51U) and allow instrumentation to stabilize.

h. Turn anti-icing air switch ON. A properly operating anti-icing system will cause an immediate but small drop of pressure on P_{t5} gage and rise in temperature on anti-icing air temperature gage.

i. Turn anti-icing air switch OFF. Retard power lever to IDLE and allow to cool.

j. Inspect engine for any evidence of fuel, oil, or air leaks.

k. Shut down, per paragraph 2-300.

2-321N. TEST NO. 2 - ENGINE TRIM (JFTD12A-4A ENGINES).

a. Inspect and clean test area.

b. Install reduced power trim stop on fuel control to limit power lever travel and position pitch and trim levers in maximum (full forward) positions.

NOTE

Hamilton Standard controls of later design must have reduced power stop installed as shown in figure 2-51Q-1.

c. Determine and record Take-Off and Reduced Power turbine discharge pressure (P_{t5}) from figures 2-51T and 2-51V.

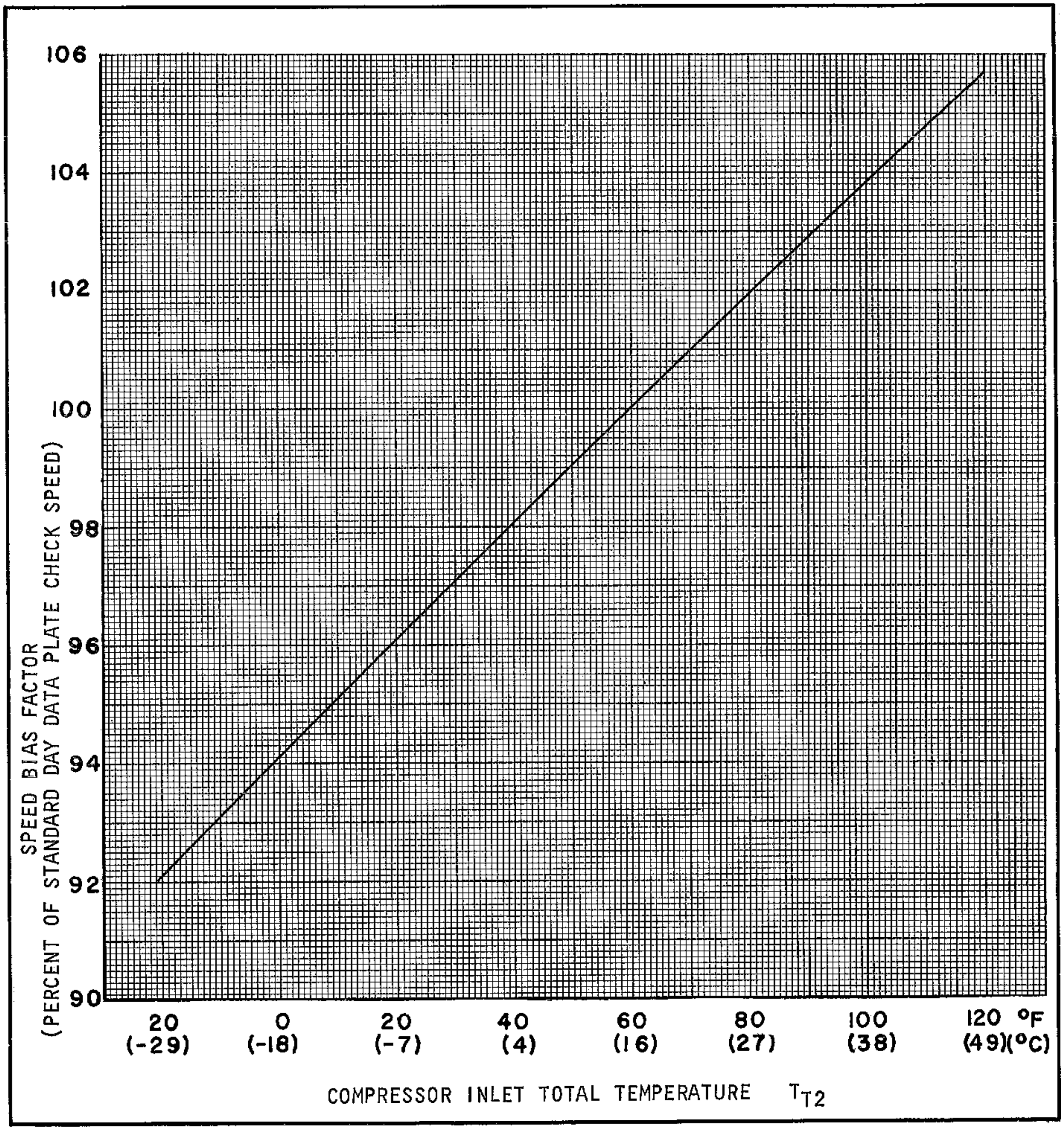


Figure 2-51W. Ambient Temperature - Data Plate Check Speed Correction Curve (JFTD12A-4A)

TABLE 2-3J. DETERMINING ENGINE PERFORMANCE ACCEPTABILITY (FREE TURBINE ENGINES)

NOTE

The following conditions for JFTD12A-4A and -5A engines are assumed for the purpose of making the sample computations herein:
1. Data Plate Check Speed = 13875 rpm or 86.56 percent
2. Ambient Air Temperature = 10°C (14°F)
3. Speed Bias Factor = 95.6 percent
4. Indicated Speed = 13400 rpm or 83.59 percent

Procedure	Method	Sample Computation*	
		Using RPM	Using Percent*
Determine Adjusted Data Plate Check Speed	Multiply Data Plate Check Speed by Speed Bias Factor	13875 × .956 = 13265	86.56 × .956 = 82.75
Determine Maximum Allowable Check Speed	Add Adjusted Data Plate Check Speed and Maximum Allowable Increase	13265 + 300 = 13565	82.75 + 1.871 = 84.621
Compare Indicated Speed to Maximum Allowable Speed	Subtract Indicated Speed from Maximum Allowable Check Speed	13565 - 13400 = 165	84.621 - 83.59 = 1.031
		NOTE Since Indicated Speed is less than Maximum Allowable Check Speed, the engine may be continued in service.	

*Computations are based on engines having 0.262:1 Tachometer Drive Ratio and 100 percent rotor speed of 16030 rpm.

e. Advance power lever to Take-Off position. When engine stabilizes (allow at least five minutes), record P_{t5} gage reading at end of run.

CAUTION

Make certain that operating limits in engine check chart are not exceeded and that observed N_1 rpm is not above maximum allowable.

f. If P_{t5} gage reading does not agree with predetermined P_{t5}, check engine trim in accordance with Test No. 2.

NOTE

Check for P_{t5} leaks before running Test No. 2.

g. Retard the power lever to MAXIMUM CONTINUOUS (figure 2-51U) and allow instrumentation to stabilize for at least five minutes.

h. Turn anti-icing air switch ON. A properly operating anti-icing system will cause an immediate but small drop of pressure on P_{t5} gage and rise in temperature on anti-icing air temperature gage.

i. Turn anti-icing air switch OFF. Retard power lever to IDLE and allow to cool.

j. Inspect engine for any evidence of fuel, oil, or air leaks.

k. Shut down, per paragraph 2-300.

2-321N. TEST NO. 2 - ENGINE TRIM (JFTD12A-4A and -5A ENGINES).

a. Inspect and clean test area.

b. Install reduced power trim stop on fuel control to limit power lever travel and position pitch and trim levers in maximum (full forward) positions.

NOTE

Hamilton Standard controls of later design must have reduced power stop installed as shown in figure 2-51Q-1.

c. Determine and record Take-Off and Reduced Power turbine discharge pressure (P_{t5}) from figures 2-51T or 2-51T-1 and 2-51V or 2-51V-1.

NOTE

Reduce trim P_{t5} setting must be within -0 to + 0.5 in. Hg. value determined from curve.

TABLE 2-3K. ENGINE TRIM SHEET (SAMPLE) FOR FREE TURBINE ENGINES

ENGINE NO. ________________ ENGINE TYPE ____________ DATE ______________________

FUEL CONTROL SERIAL NO. ________________________ PART NO. ______________________

1. AMBIENT AIR TEMPERATURE _________ °C (________ °F)

2. TRUE BAROMETER ________________ "Hg. 3. EXHAUST NOZZLE AREA ____________ sq. ft.
(Check barometer and temperature readings frequently.)

4. DATA PLATE CHECK SPEED . . . . ____________ rpm ____________ percent

5. SPEED BIAS FACTOR (From Temperature-RPM Curve) . . ____________ ____________
(Will vary with changes in ambient temperature)

6. ADJUSTED DATA PLATE CHECK SPEED (Line 4 x Line 5) ____________ rpm ____________ percent

7. MAXIMUM ALLOWABLE INCREASE . . . . ____________ rpm ____________ percent

8. MAXIMUM ALLOWABLE TRIM SPEED (Line 6 + Line 7) . . ____________ rpm ____________ percent
(Will vary with changes in ambient temperature)

9. SPECIFIED TURBINE DISCHARGE PRESSURE (P_{t5})

(Determined from Reduced Power Setting Curve) ____________ to ________ "Hg EPR ____________
(Will vary with ambient air temperature and true barometer)

10. FUEL CONTROL MAXIMUM TRIMMER ADJUSTED . . . . . _______ turns C.W. ______ turns C.C.W.

11. INDICATED IDLE SPEED (before adjustment) __________ percent

Idle Speed Limits (Front Idle Trim Setting Curve) ____________ to ________ percent

Fuel Control Idle Trimmer Adjusted . . . . ________ turns C.W. ________ turns C.C.W.

12. INDICATED IDLE SPEED (after adjustment) ____________ percent

13. PERFORMANCE CHECK SPECIFIED TURBINE DISCHARGE PRESSURE (P_{t5})
(Determined from performance check value $P_{t5}/P_{t2} = 1.650$) _______________ "Hg. EPR ______________

14. INDICATED ROTOR (N_1) SPEED
(At performance check specified turbine discharge pressure) ______________ rpm ____________ percent

NOTE

If Indicated Rotor Speed (Item No. 14) is greater than the Maximum Allowable Deterioration Speed (Item No. 8) recheck Item Nos. 4, 5, 6, 7, 8, 13, and 14.

d. Start the engine and allow instruments to stabilize for at least one and one-half minutes.

NOTE

Accurate power check readings cannot be obtained when inlet icing conditions occur or when the anti-icing system is in operation.

e. Advance the power lever to the reduced power stop and allow instruments to stabilize for at least one and one-half minutes.

CAUTION

REDUCED POWER lever position is considerably less than full power lever travel. Do not apply excessive force to the power lever.

f. After stabilization observe the P_{t5} gage reading. If the engine is properly trimmed, P_{t5} will be the same as the Reduced Power P_{t5} value determined from figure 2-51V.

(1) If the gage reading is too high, turn the fuel control MAX trimmer in the decrease direction until gage reading is below desired value and then turn MAX trimmer in increase direction until desired gage reading is obtained.

(2) If the gage reading is too low, turn the fuel control MAX trimmer in the increase direction.

WARNING

If remote trimming is not being used, return the engine to IDLE before approaching the engine to make an adjustment.

CAUTION

Adjusting the fuel control MAX trim screw to either extreme position can result in binding of the governor lever which will cause power lever binding. If this condition is encountered the trim screw shall be turned one-half to two and one-half turns in a direction opposite from the extreme to free the power lever. Full trim screw travel should not be required to trim the engine to allowable limits.

g. When the engine has been properly trimmed at the REDUCED POWER lever position, return the power lever to IDLE and allow the instrument readings to stabilize for at least one and one-half minutes.

h. If N_1 rpm is within the limits of Figure 2-51X the engine is properly trimmed.

(1) If IDLE rpm is too high, turn fuel control IDLE trimmer in the decrease direction until rpm is slightly below desired rpm and then turn IDLE trimmer in increase direction until desired IDLE rpm is obtained.

(2) If IDLE rpm is too low, turn the fuel control IDLE trimmer in the increase direction to bring rpm within limits.

(3) If IDLE trimmer is adjusted, recheck the Reduced Power setting.

i. Remove the Reduced Power trim stop and place it in the stowed position on the fuel control.

NOTE

The REDUCED POWER stop must remain with the same fuel control. Do not readjust the set-screw adjustment on the REDUCED POWER stop as this is a bench calibration setting.

j. Advance the power lever until the P_{t5} gage reaches the value determined for Take-Off rated power from figure 2-51T.

CAUTION

There is no power lever stop at TAKE-OFF During operation up to, and at, the TAKE-OFF setting, turbine discharge temperature (T_{t5}) and engine speed (N_1) must be carefully monitored to ensure that maximum limits are not exceeded. The the T_{t5} gage reading approaches the maximum limit before the desired P_{t5} value is reached, and it is evident that further advancement of the power lever will cause an over-temperature condition, retard the power lever to IDLE immediately. Allow the engine to cool, shut down, and check accuracy of instrumentation.

k. If turbine discharge temperature (T_{t5}) and engine speed (N_1) during operation at TAKE-OFF power are over limits or unusually high, run the Performance Check as outlined in Test No. 4.

2-321P. TEST NO. 3 (JFTD12A-4A ENGINES).

a. Inspect the test area for cleanliness.

b. Perform a satisfactory start.

c. Run the engine per Test No. 2 (Engine Trim) and shut down.

d. During the remaining portion of the test, the following readings shall be recorded at each power lever position.

(1) Time of day.

(2) Temperature at the test area.

(3) True barometer.

TABLE 2-3K. ENGINE TRIM SHEET (SAMPLE) FOR FREE TURBINE ENGINES

ENGINE NO. ________________ ENGINE TYPE ____________ DATE ____________________

FUEL CONTROL SERIAL NO. _________________________ PART NO. _______________________

1. AMBIENT AIR TEMPERATURE _________°C (________°F)

2. TRUE BAROMETER ________________"Hg. 3. EXHAUST NOZZLE AREA ____________ sq. ft.
(Check barometer and temperature readings frequently.)

4. DATA PLATE CHECK SPEED . . . . ____________ rpm ____________ percent

5. SPEED BIAS FACTOR (From Temperature-RPM Curve) . . ____________ ____________
(Will vary with changes in ambient temperature)

6. ADJUSTED DATA PLATE CHECK SPEED (Line 4 x Line 5) ____________ rpm ____________ percent

7. MAXIMUM ALLOWABLE INCREASE . . . . ____________ rpm ____________ percent

8. MAXIMUM ALLOWABLE TRIM SPEED (Line 6 + Line 7) . . ____________ rpm ____________ percent
(Will vary with changes in ambient temperature)

9. SPECIFIED TURBINE DISCHARGE PRESSURE (P_{t5})

(Determined from Reduced Power Setting Curve) ____________ to ________ "Hg EPR ____________
(Will vary with ambient air temperature and true barometer)

10. FUEL CONTROL MAXIMUM TRIMMER ADJUSTED . . . . . ______ turns C.W. ______ turns C.C.W.

11. INDICATED IDLE SPEED (before adjustment) __________ percent

Idle Speed Limits (Front Idle Trim Setting Curve) ____________ to ________ percent

Fuel Control Idle Trimmer Adjusted . . . . ________ turns C.W. ________ turns C.C.W.

12. INDICATED IDLE SPEED (after adjustment) ____________ percent

13. PERFORMANCE CHECK SPECIFIED TURBINE DISCHARGE PRESSURE (P_{t5})
(Determined from performance check value P_{t5}/P_{t2} =1.650) _______________"Hg. EPR ____________

14. INDICATED ROTOR (N_1) SPEED
(At performance check specified turbine discharge pressure) ______________ rpm ____________ percent

NOTE

If Indicated Rotor Speed (Item No. 14) is greater than the Maximum Allowable Deterioration Speed (Item No. 8) recheck Item Nos. 4, 5, 6, 7, 8, 13, and 14.

d. Start the engine and allow instruments to stabilize for at least five minutes.

NOTE

Accurate power check readings cannot be obtained when inlet icing conditions occur or when the anti-icing system is in operation.

e. Advance the power lever to the reduced power stop and allow instruments to stabilize for at least five minutes.

CAUTION

REDUCED POWER lever position is considerably less than full power lever travel. Do not apply excessive force to the power lever.

f. After stabilization observe the P_{t5} gage reading. If the engine is properly trimmed, P_{t5} will be within -0 to + 0.5 in. Hg. of the Reduced Power P_{t5} value determined from figure 2-51V or 2-51V-1.

(1) If the gage reading is too high, turn the fuel control MAX trimmer in the decrease direction until gage reading is below desired value and then turn MAX trimmer in increase direction until desired gage reading is obtained.

(2) If the gage reading is too low, turn the fuel control MAX trimmer in the increase direction.

WARNING

If remote trimming is not being used, return the engine to IDLE before approaching the engine to make an adjustment.

CAUTION

Adjusting the fuel control MAX trim screw to either extreme position can result in binding of the governor lever which will cause power lever binding. If this condition is encountered the trim screw shall be turned one-half to two and one-half turns in a direction opposite from the extreme to free the power lever. Full trim screw travel should not be required to trim the engine to allowable limits.

g. When the engine has been properly trimmed at the REDUCED POWER lever position, return the power lever to IDLE and allow the instrument readings to stabilize for at least five minutes.

h. If N_1 rpm is within the limits of Figure 2-51X or 2-51Y the engine is properly trimmed.

(1) If IDLE rpm is too high, turn fuel control IDLE trimmer in the decrease direction until rpm is slightly below desired rpm and then turn IDLE trimmer in increase direction until desired IDLE rpm is obtained.

(2) If IDLE rpm is too low, turn the fuel control IDLE trimmer in the increase direction to bring rpm within limits.

(3) If IDLE trimmer is adjusted, recheck the Reduced Power setting.

i. Remove the Reduced Power trim stop and place it in the stowed position on the fuel control.

NOTE

The REDUCED POWER stop must remain with the same fuel control. Do not readjust the set-screw adjustment on the REDUCED POWER stop as this is a bench calibration setting.

j. Advance the power lever until the P_{t5} gage reaches the value determined for Take-Off rated power from figure 2-51T or 2-51T-1.

CAUTION

There is no power lever stop at TAKE-OFF. During operation up to, and at, the TAKE-OFF setting, turbine discharge temperature (T_{t5}) and engine speed (N_1) must be carefully monitored to ensure that maximum limits are not exceeded. The T_{t5} gage reading approaches the maximum limit before the desired P_{t5} value is reached, and it is evident that further advancement of the power lever will cause an over-temperature condition, retard the power lever to IDLE immediately. Allow the engine to cool, shut down, and check accuracy of instrumentation.

k. If turbine discharge temperature (T_{t5}) and engine speed (N_1) during operation at TAKE-OFF power are over limits or unusually high, run the Performance Check as outlined in Test No. 4.

2-321P. TEST NO. 3 (JFTD12A-4A ENGINES).

a. Inspect the test area for cleanliness.

b. Perform a satisfactory start.

c. Run the engine per Test No. 2 (Engine Trim) and shut down.

d. During the remaining portion of the test, the following readings shall be recorded at each power lever position.

(1) Time of day.

(2) Temperature at the test area.

(3) True barometer.

d. Start the engine and allow instruments to stabilize for at least one and one-half minutes.

NOTE

Accurate power check readings cannot be obtained when inlet icing conditions occur or when the anti-icing system is in operation.

e. Advance the power lever to the reduced power stop and allow instruments to stabilize for at least one and one-half minutes.

CAUTION

REDUCED POWER lever position is considerably less than full power lever travel. Do not apply excessive force to the power lever.

f. After stabilization observe the P_{t5} gage reading. If the engine is properly trimmed, P_{t5} will be the same as the Reduced Power P_{t5} value determined from figure 2-51V.

(1) If the gage reading is too high, turn the fuel control MAX trimmer in the decrease direction until gage reading is below desired value and then turn MAX trimmer in increase direction until desired gage reading is obtained.

(2) If the gage reading is too low, turn the fuel control MAX trimmer in the increase direction.

WARNING

If remote trimming is not being used, return the engine to IDLE before approaching the engine to make an adjustment.

CAUTION

Adjusting the fuel control MAX trim screw to either extreme position can result in binding of the governor lever which will cause power lever binding. If this condition is encountered the trim screw shall be turned one-half to two and one-half turns in a direction opposite from the extreme to free the power lever. Full trim screw travel should not be required to trim the engine to allowable limits.

g. When the engine has been properly trimmed at the REDUCED POWER lever position, return the power lever to IDLE and allow the instrument readings to stabilize for at least one and one-half minutes.

h. If N_1 rpm is within the limits of Figure 2-51X the engine is properly trimmed.

(1) If IDLE rpm is too high, turn fuel control IDLE trimmer in the decrease direction until rpm is slightly below desired rpm and then turn IDLE trimmer in increase direction until desired IDLE rpm is obtained.

(2) If IDLE rpm is too low, turn the fuel control IDLE trimmer in the increase direction to bring rpm within limits.

(3) If IDLE trimmer is adjusted, recheck the Reduced Power setting.

i. Remove the Reduced Power trim stop and place it in the stowed position on the fuel control.

NOTE

The REDUCED POWER stop must remain with the same fuel control. Do not readjust the set-screw adjustment on the REDUCED POWER stop as this is a bench calibration setting.

j. Advance the power lever until the P_{t5} gage reaches the value determined for Take-Off rated power from figure 2-51T.

CAUTION

There is no power lever stop at TAKE-OFF During operation up to, and at, the TAKE-OFF setting, turbine discharge temperature (T_{t5}) and engine speed (N_1) must be carefully monitored to ensure that maximum limits are not exceeded. The the T_{t5} gage reading approaches the maximum limit before the desired P_{t5} value is reached, and it is evident that further advancement of the power lever will cause an over-temperature condition, retard the power lever to IDLE immediately. Allow the engine to cool, shut down, and check accuracy of instrumentation.

k. If turbine discharge temperature (T_{t5}) and engine speed (N_1) during operation at TAKE-OFF power are over limits or unusually high, run the Performance Check as outlined in Test No. 4.

2-321P. TEST NO. 3 (JFTD12A-4A ENGINES).

a. Inspect the test area for cleanliness.

b. Perform a satisfactory start.

c. Run the engine per Test No. 2 (Engine Trim) and shut down.

d. During the remaining portion of the test, the following readings shall be recorded at each power lever position.

(1) Time of day.

(2) Temperature at the test area.

(3) True barometer.

TABLE 2-3K. ENGINE TRIM SHEET (SAMPLE) FOR FREE TURBINE ENGINES

ENGINE NO. ________________ ENGINE TYPE ____________ DATE ________________________

FUEL CONTROL SERIAL NO. __________________________ PART NO. ________________________

1. AMBIENT AIR TEMPERATURE _________°C (_________°F)

2. TRUE BAROMETER _________________"Hg. 3. EXHAUST NOZZLE AREA ____________sq. ft.
(Check barometer and temperature readings frequently.)

4. DATA PLATE CHECK SPEED . . . . ____________ rpm ___________ percent

5. SPEED BIAS FACTOR (From Temperature-RPM Curve) . . ____________ ____________
(Will vary with changes in ambient temperature)

6. ADJUSTED DATA PLATE CHECK SPEED (Line 4 x Line 5) ____________ rpm ____________percent

7. MAXIMUM ALLOWABLE INCREASE . . . . ____________ rpm ____________percent

8. MAXIMUM ALLOWABLE TRIM SPEED (Line 6 + Line 7) . . ____________ rpm ____________ percent
(Will vary with changes in ambient temperature)

9. SPECIFIED TURBINE DISCHARGE PRESSURE (P_{t5})

(Determined from Reduced Power Setting Curve) ____________ to ________"Hg EPR______________
(Will vary with ambient air temperature and true barometer)

10. FUEL CONTROL MAXIMUM TRIMMER ADJUSTED . . . . . _______ turns C.W. ______ turns C.C.W.

11. INDICATED IDLE SPEED (before adjustment) __________ percent

Idle Speed Limits (Front Idle Trim Setting Curve) ____________ to ________percent

Fuel Control Idle Trimmer Adjusted . . . . ________turns C.W. _______turns C.C.W.

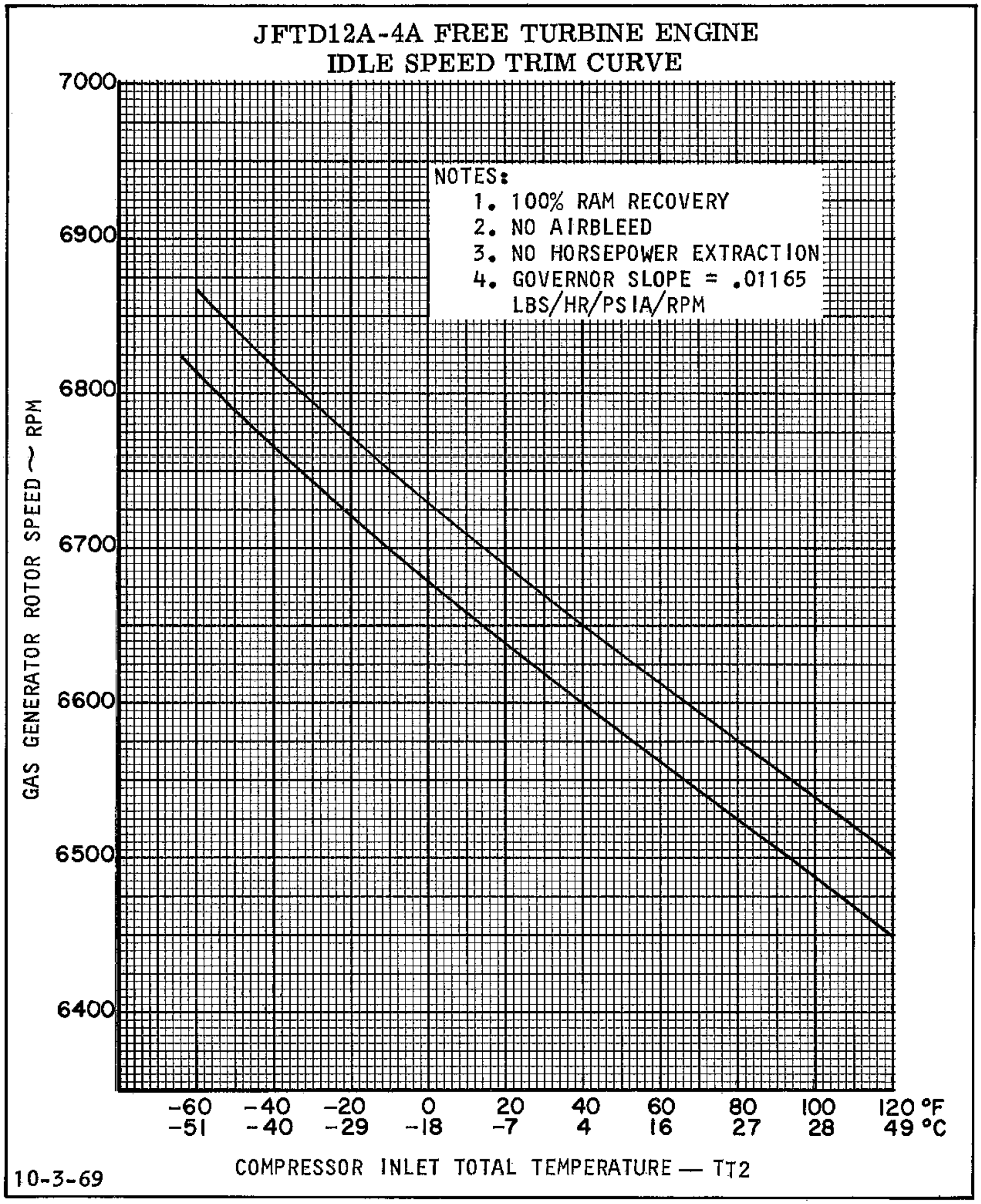
12. INDICATED IDLE SPEED (after adjustment) ____________ percent

13. PERFORMANCE CHECK SPECIFIED TURBINE DISCHARGE PRESSURE (P_{t5})
(Determined from performance check value P_{t5}/P_{t2} =1.650) _______________"Hg. EPR ______________

14. INDICATED ROTOR (N_1) SPEED
(At performance check specified turbine discharge pressure) ______________rpm ____________ percent

NOTE

If Indicated Rotor Speed (Item No. 14) is greater than the Maximum Allowable Deterioration Speed (Item No. 8) recheck Item Nos. 4, 5, 6, 7, 8, 13, and 14.



~~Figure 2-51X. Idle Speed Trim Curve (JFTD12A-4A)~~

(4) Fuel inlet pressure.

(5) Observed fuel flow (pounds per hour).

(6) Indicated N_1 rpm.

(7) Main oil temperature.

(8) Main oil pressure.

(9) Turbine discharge pressure (P_{t5}).

(10) Turbine discharge temperature (T_{t5}).

(11) Compressor inlet temperature (T_{t2}).

(12) Vibration amplitude.

e. Perform satisfactory start.

f. Run engine for 15 minutes at MAXIMUM CONTINUOUS. During last five minutes of this run operate the anti-icing system and check for proper operation as indicated by rise on anti-icing air temperature gage and slight immediate drop on P_{t5} gage.

g. Run 20 minutes consisting of two ten minute cycles of five minutes at IDLE and five minutes at MAXIMUM CONTINUOUS. Each acceleration and deceleration must be accomplished by rapid (one second) movement of power lever.

h. Run five minutes at TAKE-OFF.

i. Retard power lever to IDLE and allow engine to cool.

j. Inspect engine for any evidence of fuel, oil, or air leaks.

k. Shut down.

2-321Q. TEST NO. 4 (JFTD12A-4A and -5A ENGINES).

a. Inspect test area for cleanliness.

b. Perform satisfactory start.

c. Set engine to EPR (P_{t5}/P_{t2} = 1.650) or comparable P_{t5}/P_{amb} (paragraph 2-321L, step c.) N_2 must be 9000 rpm.

d. Allow instruments to stabilize for at least five minutes.

e. After stabilization observe and record engine speed (N_1) reading. This rpm must not exceed Adjusted Data Plate Check Speed by more than 300 rpm (1.871 percent).

NOTE

If N_1 rpm exceeds Adjusted Data Plate Check Speed by more than 300 rpm (1.871 percent) before, or at, determined P_{t5} value (and investigation discloses no P_{t5} indicating system leakage or instrument errors) return engine to overhaul for cleaning.

f. Shut down engine, per paragraph 2-300.

2-322. OIL PRESSURE ADJUSTMENT.

a. Remove adjusting screw cap on oil pressure relief valve.

b. Loosen locknut and turn adjusting screw to give oil pressure of 40 to 50 psi at MAXIMUM CONTINUOUS rating and above for JT12A engines and 45 to 55 psi at MAXIMUM CONTINUOUS/NORMAL RATED for JFTD12A engines.

WARNING

Oil pressure for engine operation at RPM's in excess of IDLE and below MAXIMUM CONTINUOUS shall fall within range specified for MAXIMUM CONTINUOUS operation.

WARNING

This adjustment must be made when engine is at IDLE. Turn adjusting screw clockwise to increase and counterclockwise to decrease oil pressure. It may be necessary to make several adjustments before desired oil pressure is obtained.

c. Tighten adjusting screw locknut.

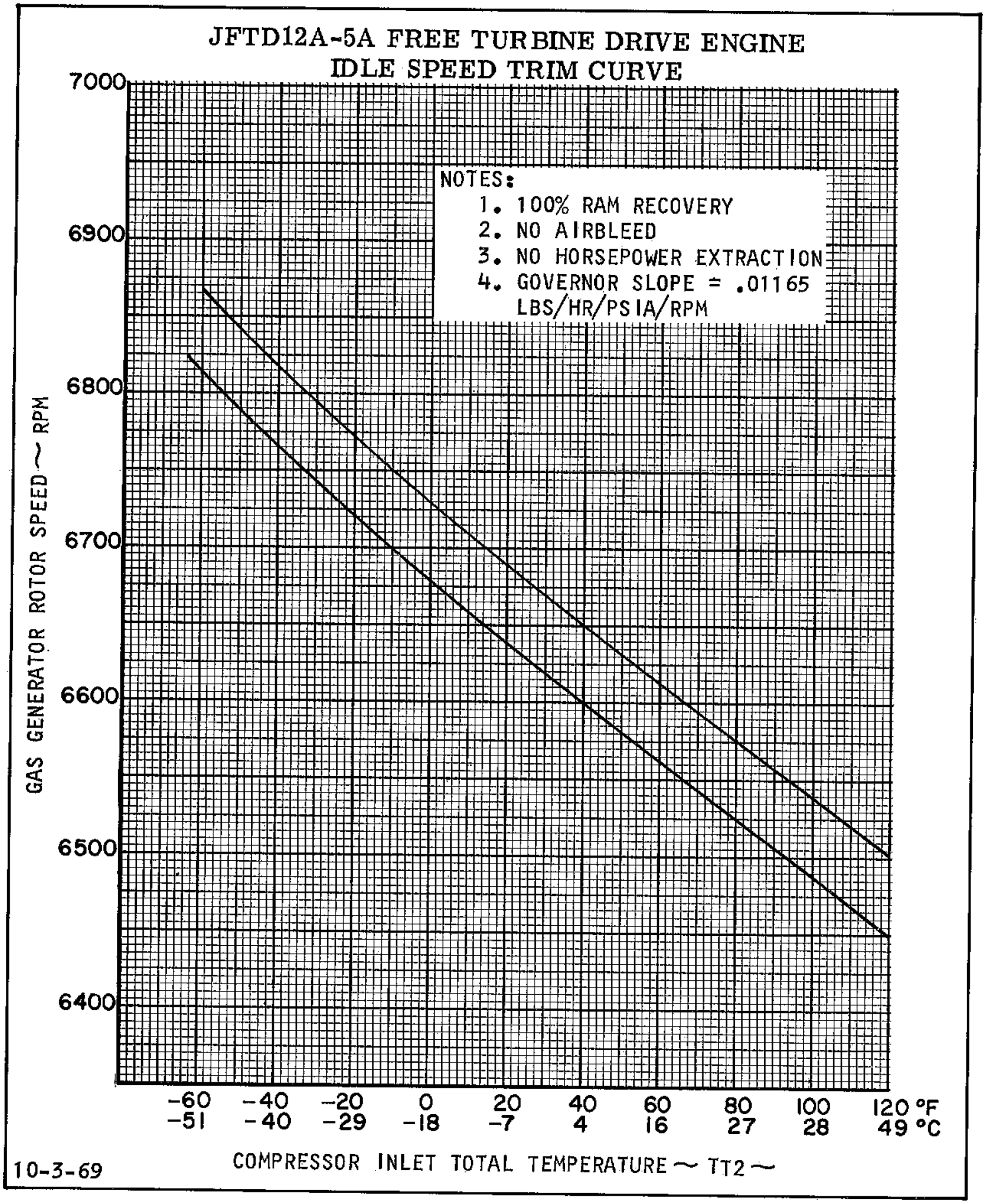
d. Install adjusting screw cap on relief valve. Tighten cap and lockwire.

2-323. EXTREME WEATHER MAINTENANCE.

2-324. COLD WEATHER PROCEDURES.

2-325. A complete discourse on the effects of cold weather upon turbojet engine operation is beyond the scope of this publication; however, it is felt that a summary of a few of the more prevalent effects will aid in troubleshooting some of the problems arising from cold weather operations.

2-326. As temperatures are reduced, the solubility of water in the fuel is also markedly reduced, which results in the water separating from the fuel, seeking the lowest point in the tank, system, and/or accessory concerned and freezing there if the temperature goes low enough. Under these conditions it also will freeze in the fuel, forming tiny needle-shaped crystals which may be found impinged on the strainers, restricting fuel flow, and in severe cases, clogging the strainers entirely. Should this condition occur it will be evidenced by a drop in, or loss of, fuel pressure to the engine. The only remedy is heat applied to the engine and fuel system components.



~~Figure 2-51Y. Idle Speed Trim Curve (JFTD12A-5A)~~

2-327. It is most important that all sumps, strainers and filters be thoroughly inspected on all preflight checks under these conditions. So long as fuel will flow freely from the drains in the tanks and strainers it can be surmised that the system is free of ice. Any indication that the flow is restricted is cause for the application of heat.

2-328. In the event that water has collected in the sumps and/or strainers and frozen there (indicated by a lack of flow from the drain) heat must be applied liberally and the drain opened frequently. Catch all drainage in a clean container and inspect for the presence of water globules in the fuel.

CAUTION

Fuel draining from the affected component after several minutes of heat application does not necessarily indicate that all ice has been melted. Lumps of ice may still remain in the unit and could be a serious flight operation hazard. Continue to apply heat for a short time after fuel begins to flow from the drain and inspect the drainage frequently until it is evident that all water has been removed.

2-329. It is well to note that a similar situation may exist in the lubricating system, with the water coming from condensation of air in the tank or engine case area. When a hot engine is shut down under low temperature conditions and allowed to stand for a period of time in the open, the changes of ice in the fuel and lubrication systems are much more prevalent. Extra precautions should be observed to prevent formation of ice and the system should be checked for the presence of any ice during the preflight inspection.

CAUTION

When starting an engine which has been exposed to low temperatures overnight, carefully observe the fuel and oil pressures. The lack of any indication of either fuel and/or oil pressures, or a pressure indication below the normal operating limits, are causes for immediate engine shutdown. Inspect for ice in the system or move the aircraft indoors and/or apply heated air before attempting another start.

2-330. HOT WEATHER PROCEDURES. Normal starting procedures are used in hot weather. Temperatures will probably be on the high side of operating ranges. Ground testing must be complete but accomplished as rapidly as possible.

2-331. TABLE OF LIMITS. (See Table 2-9.)

2-332. GENERAL. (See Figures 2-53 through 2-58, 2-63 through 2-70, and Table 2-9.) Reference numbers for the fits, clearances, backlashes, torques and spring pressures are found in both the figures and the tables which comprise this portion of the manual. The figures shall be used to illustrate the location of each area to be inspected while the tables shall supply (under the corresponding reference number) the description and limits for that which is being inspected. In cases where the reference numbers on the clearance charts pertain to information unrelated to maintenance level activities, coverage of these reference numbers in the Table of Limits will be omitted. Due to the similarity between fits and clearance information for different engine models, the tables are set up in a composite form wherever possible. Therefore, in many cases, more than one figure reference appears with each reference number in the table. For this reason care shall be taken to select only that information which applies to the figure being used. References to Figures 2-59 through 2-62 no longer apply due to the deletion of the JFTD12A-1 engine model from this manual. These references will be deleted in future revisions as the pages in this section are revised.

2-333. LIMITS. The Dimensions for Reference Column lists the dimensions of the mating features of the parts involved. The Limits column contains the desired fits and clearances between new parts. The figures in the Replace column indicate the allowable limit to which parts may wear before replacement is necessary at maintenance.

2-334. TERMS AND SYMBOLS. The symbol "T" in the Minimum and Maximum columns indicates a tight fit. An asterisk (*) in the Replace column indicates that the parts should be replaced if any looseness is found. The term "By Selection" indicates that the parts must be matched by choosing units that will provide the correct fit. The term "Fit to" means that a grinding, filing, or other fitting operation may be necessary to obtain the desired fit at assembly. The symbol (#) means that gears shall be replaced when service use may have produced scuffing, pitting, galling, or excessive wear of any of the parts. Unless otherwise specified, all fits are diametrical except spline fits which are calculated from chordal dimensions. Regarding the clearance charts, letter-number codes enclosed within a circle, such as "A12", are of contractor significance only and shall be ignored, letter-number codes within parenthesis, such as "(C-8)" relate to coordinates on the outer margins of each clearance chart to facilitate location.

2-335. UNITS. The figures in the Limits, Reference, and Replace columns shall be interpreted as follows: torque in pound-inches, spring pressure in pounds, and all other limits in inches.

2-336. GENERAL TORQUE RECOMMENDATIONS.

2-337. TORQUE APPLICATIONS.

a. The tightening limits listed in this section shall be interpreted as follows: torque values in pound-inches, angles of turn in degrees, and stretch values in inches. The tightening limits were established with the understanding that normal temperatures will prevail. If the parts involved are hot prior to the tightening operation, make sure sufficient time has elapsed for the temperature of the parts to reach that of the surrounding area before attempting the tightening operation.

b. Check torque indicating devices daily 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 as 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.

c. Tightening shall be done slowly and evenly for consistency and the best possible accuracy. There may be certain instances, other than specific torque limits, where it is obvious that the torque required for tightening a nut on a bolt or stud of given size 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.

d. 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 unform torque where required to seat the 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 degree intervals, etc.) to preclude local overstressing of the bolts or flange. Final torque should be applied in same sequence.

2-337A. TORQUE FOR 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.

b. Torque limits given in this section for antiseize coated parts apply specifically to the use of prior baked on antiseize compounds, or to wet applications of Fel-Pro C-200 and C-300, and Ease-Off 990.

2-338. NUTS, BOLTS, AND SCREWS.

2-338-1. GENERAL.

a. Torque values listed in Table 2-4 for nuts, bolts, and screws have been established to provide sufficient preload 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 2-4 apply to bolts in standard helical coil inserts as long as full thread engagement of the insert is accomplished.

b. Bolts and flanges separated by tubular gaskets shall be successively tightened and retightened to recommended torque until torque readings remain constant within limits.

2-338-2. THIN NUTS, SLOTTED NUTS.

a. The torque values in Table 2-4 shall apply to nuts where the height of the nut is greater than 75 percent of the major diameter of the thread. For thin nuts, where the height of the nut 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.

2-338-3. LOCKWIRE AND COTTER PIN 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 lockwire or a cotter pin. If the slot in the nut or the lockwire 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.

2-338A. SELF-LOCKING NUTS.

2-338A-1. TORQUE CHECK FOR REUSE OF SELF-LOCKING NUTS.

a. Check self-locking nuts for adequate torque before reuse. Discard nut if locking capability is impaired. Do not attempt repair.

TABLE 2-4. NUT, BOLT, SCREW AND SELF-LOCKING NUTS ON STUDS TORQUE LIMITS

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 (cotter pins, 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.

b. Torque limits

(1) Self-locking nuts shall be capable of meeting torque requirements in Table 2-4A when lubricated with engine oil, and at room temperature.

(2) For torque testing stainless steel, corrosion and heat resistant steel, nickel alloy steel, and AMS 6304 nuts, major, minor, and pitch diameters of bolts should be reduced 0.003 inch below dimensions specified for listed 0.190-32 UNF-3A, 0.190-24 UNC-3A and larger bolt sizes. See Table 2-4A.

c. Unplated Nuts

(1) Unplated stainless steel, corrosion resistant steel, nickel alloy steel, and AMS 6304 steel nuts that have threads undercut for plating at assembly, shall be silver plated 0.0003 to 0.0006 inch thick for test purposes, and checked for requirements of Table 2-4A on unplated bolts threaded per table 2-4A.

(2) Unplated stainless steel, corrosion resistant steel, nickel alloy steel, and AMS 6304 steel nuts that are permanently attached to brackets as other similar parts, and that are not subsequently plated at assembly, shall be checked for requirements of Table 2-4A with bolts that are plated 0.0003 to 0.0006 inch thick. Plated bolts 0.190 inch in diameter and larger shall have threads reduced 0.0003 from class 3A limits on major, minor, and pitch diameters. Bolts smaller than 0.190 inch in diameter shall have class 2A tolerances. See table 2-4A.

(3) Unplated carbon or alloy steel nuts shall be cadmium plated 0.0002 to 0.0005 inch thick and checked with cadmium plated bolts threaded per table 2-4A.

(4) Unplated aluminum nuts shall be checked with cadmium plated bolts threaded per table 2-4A.

2-338B. FREE SPINNING LOCKNUTS.

a. A free spinning locknut is a nut that spins freely on the bolt or stud until it contacts the mating surface, then additional torque causes activation of the locking feature. Use torque values listed in Table 2-4.

TABLE 2-4A. TORQUE LIMITS FOR REUSE OF SELF-LOCKING NUTS (POUND-INCHES)

Fine Thread Series			*Coarse Thread Series*		
*Mating Bolt Thread Size***	*Max Locking Torque**	*Min Break-away Torque*	*Mating Bolt Thread Size***	*Max Locking Torque**	*Min Break-away Torque*
.112 -48 NF-2A	3	0.5	.112 -40 NC-2A	3	0.5
.138 -40 NF-2A	6	1.0	.125 -40 NC-2A	4	1.0
.164 -36 NF-2A	9	1.5	.138 -32 NC-2A	6	1.0
.190 -32 UNF-3A	13	2.0	.164 -32 NC-2A	9	1.5
.250 -28 UNF-3A	30	3.5	.190 -24 UNC-3A	13	2.0
.3125-24 UNF-3A	60	6.5	.250 -20 UNC-3A	30	4.5
.375 -24 UNF-3A	80	9.5	.3125-18 UNC-3A	60	7.5
.4375-20 UNF-3A	100	14.0	.375 -16 UNC-3A	80	12.0
.500 -20 UNF-3A	150	18.0	.4375-14 UNC-3A	100	16.5
.5625-18 UNF-3A	200	24.0	.500 -14 UNC-3A	150	24.0
.625 -18 UNF-3A	300	32.0	.5625-12 UNC-3A	200	30.0
.750 -16 UNF-3A	400	50.0	.625 -11 UNC-3A	300	40.0
.875 -14 UNF-3A	600	70.0	.750 -10 UNC-3A	400	60.0
1.000 -14 NF-3A	800	92.0	.875 -9 UNC-3A	600	82.0
1.125 -12 UNF-3A	900	117.0	1.000 -8 UNC-3A	800	110.0
1.250 -12 UNF-3A	1000	143.0	1.125 -8 UNC-3A	900	137.0

*Installation or removal.
**Use the listed bolt sizes for torque testing cadmium plated nuts, carbon steel nuts, alloy steel nuts, and aluminum nuts.

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2-338C. PREVAILING TORQUE TYPE LOCKNUTS.

a. A prevailing torque type locknut is a nut that spins freely on the bolt or stud until bolt or stud enters the locking portion of the nut; then, the bolt or stud interferes with the deformed section of the nut causing a tight frictional hold on the bolt or stud thread flanks. Use torque values listed in Table 2-4B except when nut is on a stud, then use torque values listed in Table 2-4.

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 2-4B.

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

2-339. FLEXIBLE TUBE CONNECTIONS.

a. When assembling flexible fittings, the packing and fitting threads must be lubricated with a light film of engine oil or petrolatum (PMC-9609). The packing must be bottomed and the tube aligned before applying the torque listed in Table 2-5.

b. 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 the listed value, then loosened, and torqued again to the listed value.

2-340. CONE SEAT CONNECTORS.

a. The torque values for the nuts on 37 degree cone seat connectors are given in Table 2-6.

b. Do not overtighten to correct leakage. Check for burrs, nicks, and dirt. If necessary, use new parts.

2-340A. JAMNUTS.
(See Figures 2-51Y-1 and 2-51Z.)

a. The torque values listed in Table 2-6A are to be used for all steel and aluminum jamnuts (locknuts) of the type used on fittings for tube and hose connections.

b. On elbow fittings, the jamnut shall be torqued after the connecting tube or hose has been installed and properly aligned.

TABLE 2-4B. SELF-LOCKING NUTS AND BOLTS, AND BOLTS USED IN HELICAL COIL SELF-LOCKING INSERTS

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			

TABLE 2-5. FLEXIBLE TUBE CONNECTION TORQUE LIMITS

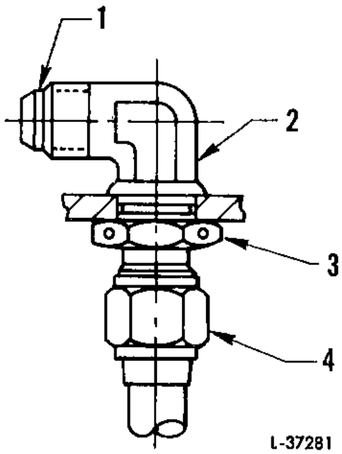
Tube dia.	Torque, lb-in.	
	For 75 durometer "A" packing; e.g. AMS 7260	For 77 durometer "C" (100 durometer "A") packing; e.g. PWA-401
.125	25- 30	55- 60
.1875	25- 30	55- 60
.250	25- 30	55- 60
.3125	30- 35	65- 70
.375	30- 35	65- 70
.500	55- 60	110-120
.625	65- 70	130-140
.750	70- 80	140-160
.875	75- 85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

TABLE 2-6. 37 DEGREE CONE SEAT CONNECTORS TORQUE LIMITS

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

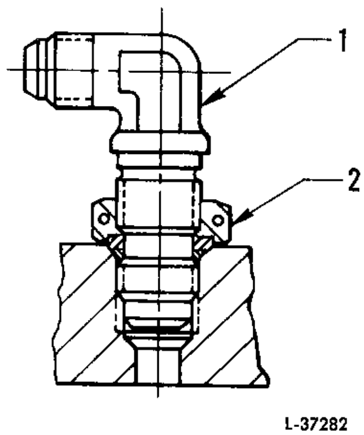
* If the nut or either of the mating sealing surfaces is aluminum, the required torque limits for aluminum fittings apply.

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



1. Cone seat connector, before assembling mating parts; see Table 2-6.
2. Bulkhead fitting
3. Jamnut; see Table 2-6A.
4. Cone seat connector nut; see Table 2-6.

Figure 2-51Y-1. Cone Seat Connector, and Bulkhead Fitting Jamnut



1. Boss fitting; see paragraph 2-137 for assembly instructions.
2. Jamnut; see Table 2-6A.

Figure 2-51Z. O-Ring and Jamnut Type Connector

TABLE 2-6A. JAMNUTS

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		

2-341. INSTALLATION OF CRUSH-TYPE ASBESTOS FILLED GASKETS.

a. Install all crush-type gaskets, except self-centering-type, with unbroken surface against flange of plug or part being tightened against seal.

b. Turn mating part until sealing surfaces are in contact; then tighten to angle of turn shown below (Table 2-7) for appropriate thread pitch.

2-342. STEEL PIPE PLUGS IN ALUMINUM AND MAGNESIUM CASES.

a. The torque values for steel pipe plugs in aluminum and magnesium cases listed in Table 2-8 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 the threads; the plug should then be reinstalled and retightened to the indicated limits.

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

TABLE 2-7. CRUSH GASKET TIGHTENING LIMITS

Thread Pitch on Part to be Tightened	Angle of Turn Aluminum Asbestos	Copper 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.		

2-343. HEX-HEAD STRAIGHT-THREADED FITTINGS AND PLUGS.(MS9015, MS9193 OR SIMILAR.)

CAUTION

Excessive tightening will result in damage to threads of mating parts.

a. The torque values listed in Table 2-8A are based on strength of thread in cast aluminum or magnesium; they may be used in stronger materials.

2-343A. INSTALLING OR ATTACHING COMPONENTS OF IGNITION SYSTEM. (See Figure 2-512-1.)

CAUTION

Excessive tightening will result in damage to threads of mating parts.

a. All plug-in type threaded connections shall be torqued to fingertight plus 45 degree maximum turn. All cigarette-type electrical connections (intermediate voltage leads and high tension leads) shall be torqued until connection is bottomed on shoulder. This normally takes approximately 140 to 160 pound-inches. All igniter plugs shall be installed in engines with torque of 300 to 360 pound-inches, unless otherwise specified.

2-343B. INSTALLING OR ATTACHING COMPONENTS OF THERMOCOUPLE SYSTEMS.

a. Exhaust gas temperature probe terminal attaching nuts and thermocouple harness to lead attaching screws shall be torqued to values listed in Table 2-8B.

b. Harness terminal and bus bar attaching nuts in the exhaust gas temperature junction box shall be torqued to values listed in Table 2-8C.

TABLE 2-8. PIPE PLUG TORQUE LIMITS

Thread Size	Torque Limits Min.	Max.	Thread Size	Torque Limits Min.	Max.
1/16 in. ANPT	30	40	1/2 in. ANPT	140	160
1/8 in. ANPT	30	40	3/4 in. ANPT	210	230
1/4 in. ANPT	70	85	1 in. ANPT	285	315
3/8 in. ANPT	95	110	1 1/4 in. ANPT	355	385

2-344. TORQUE INDICATING DEVICES.

a. Check torque indicating devices daily and calibrate by means of weights and a measured lever arm to make sure 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, 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.

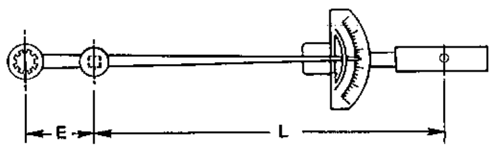
b. Torque Wrench and Extensions

(1) Occasionally, it is necessary to use special extension, or adapter wrench together with standard torque wrench. See Figure 2-52.

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

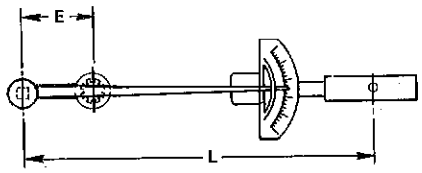
Then: $R = \frac{LT}{L+E} = \frac{15x1440}{15+3} = 1200$

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



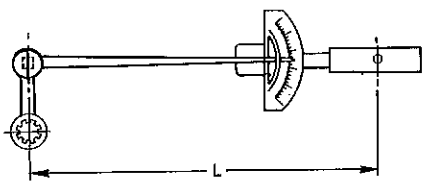
A CORRECTION OF THE INDICATED TORQUE READING IS REQUIRED WHEN AN ADAPTER IS USED, WHICH CHANGES THE EFFECTIVE LENGTH OF A TORQUE WRENCH. APPLY FOLLOWING FORMULA TO OBTAIN THE CORRECTED TORQUE READING.

$$R = \frac{L \times T}{L + E}$$



A CORRECTION OF THE INDICATED TORQUE READING IS REQUIRED WHEN AN ADAPTER IS USED, WHICH CHANGES THE EFFECTIVE LENGTH OF A TORQUE WRENCH. APPLY FOLLOWING FORMULA TO OBTAIN THE CORRECTED TORQUE READING.

$$R = \frac{L \times T}{L - E}$$



A CORRECTED TORQUE READING IS NOT REQUIRED WHEN AN ADAPTER IS USED WHICH DOES NOT CHANGE THE EFFECTIVE LENGTH OF THE TORQUE WRENCH

LEGEND

T = DESIRED TORQUE
E = EFFECTIVE LENGTH OF EXTENSION OR ADAPTER
L = EFFECTIVE LENGTH OF TORQUE WRENCH
R = CORRECTED TORQUE READING

NOTES

(1) DO NOT USE A HANDLE EXTENSION ON ANY TORQUE WRENCH.
(2) EFFECTIVE LENGTH OF PWA SPECIAL EXTENSIONS, ADAPTERS, AND WRENCHES IS STAMPED ON TOOL.

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Figure 2-52. Computing Effect of Torque Wrench Extensions

TABLE 2-9. TABLE OF LIMITS (ALL MODELS)

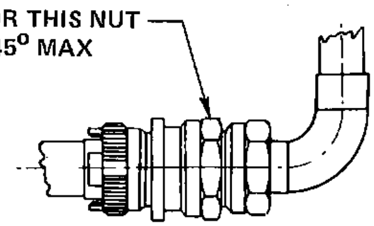
Ref. No.	Fig. No.	Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
146	2-53, -56	Area (Total All Vanes) .... (This area is produced by selecting 58 vanes to give numerical class average of 4.40 to 4.44.)			54.52	55.08	
		NOTE At 100 percent vane replacement, engines not previously incorporating above class average shall comply with above limit.					
		Area (Total All Vanes) (This area is produced by selecting 58 vanes to give a numerical class average of 6.28 to 6.34.)			55.52	56.08	
148	2-56	Bolt .... Cross Shaft Support	.2935 .2965	.2945 .2975	.002	.004	.004
149	2-56	Cross Shaft Lever .... Bearings	.6557 .6557	.6562 .6562	.0005	.0005T	
	2-63, -67	Engine Lifting Pin .... Engine Lifting Pin Bolt..........	.343 .339	.347 .342	.001	.008	.008
150	2-56	Cross Shaft Lever Bearing ...... Bearing Insert	.2495 .2480	.2500 .2495	.000	.002	
	2-63, -67	Flanged Sleeve Bushing ID .... Engine Lifting Pin Bolt..........	.3425 .339	.3435 .342	.0005	.0045	.0045

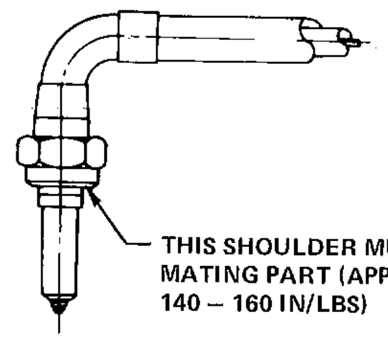
TEMPORARY REVISION NO. 4

Please insert this revision after Page 2-62B of Section II, Maintenance, to provide the correct figure reference.

On Page 2-63, Reference No. 157 is revised to read as follows:

Ref. No.	Fig. No.	Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
157	2-53, -56	Area (Total All Vanes)...... (This area is produced by selecting 58 vanes to give numerical class average of 6.69 to 6.72) (JT12A-6 and -6A only)			52.62	53.18	
	2-67	Area (Total All Vanes)...... (This area is produced by selecting 58 vanes to give a numerical class average of 11.12 to 11.19)			53.92	54.48	





LEADS –
ELECTRICAL CONNECTIONS

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Figure 2-512-1. Plug-In and "Cigarette" Connector Installation

TABLE 2-8A. HEX-HEAD STRAIGHT THREADED FITTINGS AND PLUGS

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

TABLE 2-8B. TEMPERATURE PROBE NUTS AND SCREWS

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

TABLE 2-8C. HARNESS TERMINAL AND BUS BAR NUTS

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

2-344. TORQUE WRENCH AND EXTENSION. Occasionally it is necessary to use special extension or adapter wrench together with standard torque wrench (Figure 2-52). In order to arrive at resultant required torque limits, following formula shall be used:

S = Reading or setting on torque wrench.

T = Recommended torque on part.

L = Length of torque wrench (distance between center of drive and center of hand grip).

E = Length of extension or adapter (distance between center of drive and center of broached opening measured in same place as L).

$$S = \frac{T \times L}{(E+L)}$$

Example: Recommended torque is 100 pound-inches. Using a 12 inch torque wrench and a six inch adapter, determine reading on torque wrench.

$$S = \frac{100 \times 12}{(6+12)} = \frac{1200}{18} = 66.6 \text{ pound-inches}$$

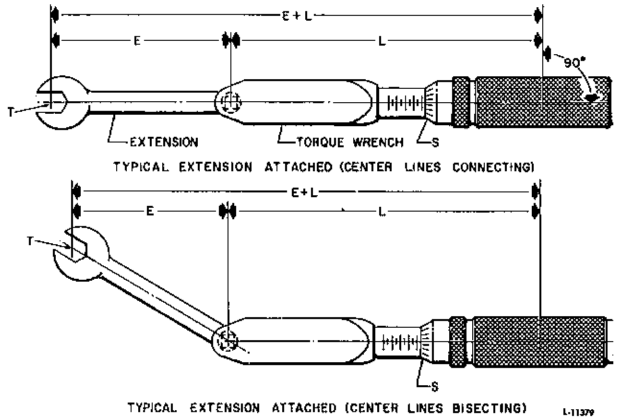

Figure 2-52. Torque Wrench and Extension

NOTE

Effective length of P&WA special extensions, adapters, and wrenches is stamped on tool.

TABLE 2-9. TABLE OF LIMITS (ALL MODELS)

Ref. No.	Fig. No.	Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
146	2-53, -56	Area (Total All Vanes) . . . . (This area is produced by selecting 58 vanes to give numerical class average of 4.40 to 4.44.)			54.52	55.08	

NOTE

At 100 percent vane replacement, engines not previously incorporating above class average shall comply with this limit.

Ref. No.	Fig. No.	Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
		Area (Total All Vanes) (This area is produced by selecting 58 vanes to give a numerical class average of 6.28 to 6.34.)			55.52	56.08	
148	2-56	Bolt	.2935	.2945			
		Cross Shaft Support	.2965	.2975	.002	.004	.004
149	2-56	Cross Shaft Lever	.6557	.6562			
		Bearings	.6557	.6562	.0005	.0005T	
	2-59,-63, -67	Engine Lifting Pin	.343	.347			
		Engine Lifting Pin Bolt.	.339	.342	.001	.008	.008
150	2-56	Cross Shaft Lever Bearing	.2495	.2500			
		Bearing Insert	.2480	.2495	.000	.002	
	2-59, -63, -67	Flanged Sleeve Bushing ID	.3425	.3435			
		Engine Lifting Pin Bolt.	.339	.342	.0005	.0045	.0045

TABLE 2-9. TABLE OF LIMITS (ALL MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
151	2-56	Fuel Control Lever	.6557	.6562			
		Bearing	.6557	.6562	.0005	.0005T	
153	2-56	Cross Shaft Spline	.0457	.0467			
		Cross Shaft Lever Spline	.0490	.0500	.0023	.0043	.009
	2-67	2nd Stage Inner Airseal Ring to Turbine Case Dimension.......			.005	.081	
153A	2-63	2nd Stage Inner Airseal Ring to Turbine Case Dimension.......			.005	.081	
154	2-56	Cross Shaft Spline	.0457	.0467			
		Spacer Spline	.0490	.0500	.0023	.0043	.009
157	2-53, -56	Area (Total All Vanes) .... (This area is produced by selecting 58 vanes to give numerical class average of 6.69 to 6.72.) (JT12A-6 and -6A only)			52.62	53.18	
	2-70	Area (Total All Vanes) .... (This area is produced by selecting 58 vanes to give a numerical class average of 11.12 to 11.19.)			53.92	54.48	
158	2-53, -56, -63, -67	Area (Total All Vanes) .... (This area is produced by selecting 96 vanes to give numerical class average of 4.98 to 5.24.)			79.70	80.70	
190	2-53, -56	Radial Clearance First Stage Turbine Blade Outer Airseal (Front)					
		P/N 394808 prior to Change B ...			.060	.085	
		P/N 394808 B			.0165	.0415	
		P/N 394808 C and P/N 560890 C..			.0165	.0415	.0495
		P/N 394808 E and P/N 560890 E..			.022	.047	.055
220	2-56	Gap Fuel Drain Valve............			.023	.050	
221	2-56	Side Clearance					
		1st Stage Turbine Airseal Lug ...	.1860	.1880			
		Turbine Case Slot	.1970	.2030	.0090	.0170	.027
270	2-63	Radial Clearance First Stage Turbine Blade Outer Airseal (Front)					
		P/N 394808 prior to change B ...			.060	.085	
		P/N 394808B			.0165	.0415	
		P/N 394808 C and P/N 560890 C..			.0165	.0415	.0495
		P/N 394808 E and P/N 560890 E..			.022	.047	.055
292	2-63, -67	Gap Fuel Drain Valve............			.023	.050	
293	2-67	Connector - Tube	.185	.186			
		Bushing - Sleeve	.183	.185	.000	.003T	

TABLE 2-9. TABLE OF LIMITS (ALL MODELS) (continued)

Ref. No.	Figure No.	Description	Max. Cycles	Max. Hours
		NOTE Replace hubs or disks when they exceed either maximum cycles or hours, whichever occurs first. An asterisk (*) designates disks with no further potential for life extension.		
300	2-63, -67	Disk Life Hours		
		Hub - Compressor Rotor Front		
		(P/N 409401)	*10000	8000
		(P/N 447901)	*10000	8000
		(P/N 596901)	*10000	8000
		(P/N 667901)	10000	8000
		(P/N 712701).................	*10000	8000
		(P/N 748001).................	*10000	8000
301	2-63, -67	Disk - Compressor Rotor 2nd Stage		
		(P/N 406302)	3000	3000
		(P/N 406302 - Chg. G or SB 744) ..	*6000	8000
		(P/N 448802)	4000	4000
		(P/N 448802 - Chg. F or SB 744) ..	*8000	8000
		(P/N 541902)	*6000	8000
		(P/N 597402)	*8000	8000
302	2-63, -67	Disk - Compressor Rotor 3rd Stage		
		(P/N 406203)	2000	2000
		(P/N 406203 - Chg. G or SB 744) ..	*4000	7500
		(P/N 410703)	4000	4000
		(P/N 410703 - Chg. F or SB 744) ..	*8000	8000
		(P/N 541903)	*4000	7500
303	2-63, -67	Disk - Compressor Rotor 4th Stage		
		(P/N 406204)	2500	2500
		(P/N 406204 - Chg. H or SB 744) ..	4000	4000
		(P/N 448804)	*12000	8000
		(P/N 541904)	4000	4000
304	2-63, -67	Disk - Compressor Rotor 5th Stage		
		(P/N 406205)	2500	2500
		(P/N 406205 - Chg. H or SB 744) ..	4000	4000
		(P/N 541905)	4000	4000
		(P/N 541905 - See SB 3421)	2500	2500
		(P/N 496705).................	*8000	8000
		(P/N 496705 - See SB 3421)	4000	4000
		(P/N 701505).................	8000	8000
305	2-63, -67	Disk - Compressor Rotor 6th Stage		
		(P/N 417806)	2500	2500
		(P/N 417806 - Chg. G or SB 744) ..	4000	4000
		(P/N 541906).................	4000	4000
		(P/N 541906 - See SB 3421)	2200	2200
		(P/N 496706).................	*8000	8000
		(P/N 701106).................	8000	8000
306	2-63, -67	Disk - Compressor Rotor 7th Stage		
		(P/N 426107)	2500	3000
		(P/N 426107 - Chg. G or SB 744) ..	*2500	6000
		(P/N 448807)	*10000	8000
		(P/N 541907)	*2500	6000

TABLE 2-9. TABLE OF LIMITS (ALL MODELS) (continued)

Ref. No.	Figure No.	Description	Max. Cycles	Max. Hours
307	2-63, -67	Disk - Compressor Rotor 8th Stage		
		(P/N 406208)	4500	4500
		(P/N 406208 - Chg. J or SB 744)	*5000	8000
		(P/N 541908)	*5000	8000
		(P/N 541908 - See SB 3421)	2200	2200
		(P/N 701108)	5000	8000
		(P/N 725008)	8000	8000
308	2-63, -67	Disk - Compressor Rotor 9th Stage		
		(P/N 406209)	3000	3000
		(P/N 406209 Chg. J or SB 744)	*8000	8000
		(P/N 541909)	*8000	8000
		(P/N 541909 - See SB 3421)	2500	2500
		(P/N 701409)	*8000	8000
320	2-63, -67	Disk - 1st Stage Turbine		
		(P/N 405801)	8000	8000
321	2-63, -67	Disk - 2nd Stage Turbine		
		(P/N 420102)	8000	8000
340	2-53, -56	Hub - Compressor Rotor Front		
		(P/N 409401)	*10000	8000
		(P/N 447901)	*10000	8000
		(P/N 596901)	*10000	8000
		(P/N 667901)	10000	8000
		(P/N 712701)	*10000	8000
		(P/N 748001)	*10000	8000
341	2-53, -56	Disk - Compressor Rotor 2nd Stage		
		(P/N 406302)	3000	3000
		(P/N 406302 - Chg. G or SB 744)	*6000	8000
		(P/N 448802)	4000	4000
		(P/N 448802 - Chg. F or SB 744)	*8000	8000
		(P/N 541902)	*6000	8000
		(P/N 597402)	*8000	8000
		(P/N 670802)	*8000	8000
		(P/N 726402)	*8000	8000
		(P/N 726502)	*6000	8000
342	2-53, -56	Disk - Compressor Rotor 3rd Stage		
		(P/N 406203)	2000	2000
		(P/N 406203 - Chg. G or SB 744)	*4000	7500
		(P/N 410703)	4000	4000
		(P/N 410703 - Chg. F or SB 744)	*8000	8000
		(P/N 541903)	*4000	7500
		(P/N 670403)	*8000	8000
		(P/N 726403)	*4000	7500

TABLE 2-9. TABLE OF LIMITS (ALL MODELS) (continued)

Ref. No.	Figure No.	Description	Max. Cycles	Max. Hours
343	2-53, -56	Disk - Compressor Rotor 4th Stage		
		(P/N 406204)	2500	2500
		(P/N 406204 - Chg. H or SB 744) .	*4000	6000
		(P/N 448804)	*12000	8000
		(P/N 541904)	*4000	6000
344	2-53, -56	Disk - Compressor Rotor 5th Stage		
		(P/N 406205)	2500	2500
		(P/N 406205 - Chg. H or SB 744) .	*4000	6000
		(P/N 496705)	*8000	8000
		(P/N 496705 - See SB 3421)	4000	4000
		(P/N 541905)	*4000	6000
		(P/N 541905 - See SB 3421)	2500	2500
		(P/N 701505)	*8000	8000
345	2-53, -56	Disk - Compressor Rotor 6th Stage		
		(P/N 417806)	2500	2500
		(P/N 417806 - Chg. C or SB 744) .	*4000	6000
		(P/N 496706)	*8000	8000
		(P/N 541906)	*4000	6000
		(P/N 541906 - See SB 3421)	2200	2200
		(P/N 701106)	8000	8000
346	2-53, -56	Disk - Compressor Rotor 7th Stage		
		(P/N 426107)	2500	3000
		(P/N 426107 - Chg. G or SB 744) .	*2500	6000
		(P/N 448807)	*10000	8000
		(P/N 541907)	*2500	6000
347	2-53, -56	Disk - Compressor Rotor 8th Stage		
		(P/N 406208)	4500	4500
		(P/N 406208 - Chg. J or SB 744) .	*5000	8000
		(P/N 541908)	*5000	8000
		(P/N 541908 - See SB 3421)	2200	2200
		(P/N 701108)	5000	8000
		(P/N 725008)	8000	8000
348	2-53, -56	Disk - Compressor Rotor 9th Stage		
		(P/N 406209)	3000	3000
		(P/N 406209 - Chg. J or SB 744) .	*8000	8000
		(P/N 541909)	*8000	8000
		(P/N 541909 - See SB 3421)	2500	2500
		(P/N 701409)	*8000	8000
349	2-53, -56	Disk - First Stage Turbine		
		(P/N 405801)	8000	8000
350	2-53, -56	Disk - Second Stage Turbine		
		(P/N 405802)	8000	8000

TABLE 2-9. TABLE OF LIMITS (ALL MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
364	2-53, -56	Fuel Nozzle Air Swirl Guide Nut . . .			250	275	
366	2-53, -56	Tail Cone Mounting Bolts.			45	51	
	2-63, -67	Diffuser Case Rear Flange Locknuts			35	40	
368	2-53, -56	Gearbox Drive Bearing Nozzle			7	10	
	2-63, -67	Fuel Nozzle Air Swirl Guide			250	275	
519	2-54, -57, -65, -69	Starter-Generator Drive Oil Seal (Rubber)	1.501	1.505			
		Support	1.498	1.500	.001T	.007T	.001T
		Starter-Generator Drive Oil Seal (Carbon)	1.626	1.628			
		Support	1.621	1.622	.004T	.007T	.001T
615	2-57	Accessory and Component Drives Gearbox Housing	2.670	2.671			
		Component Drive Gearbox Main Bearing Support	2.669	2.670	.000	.002	.003
	2-65	Gearbox Drive Bearing Upper Housing	2.3196	2.3204			
		Gearbox Drive Bearing Lower Housing	2.3196	2.3204	.0008T	.0008	
	2-69	Gearbox Drive Bearing Upper Housing	2.3196	2.3204			
		Gearbox Drive Bearing Lower Housing.	2.3196	2.3204	.0008	.0008T	
616	2-57	Gearbox Drive Bearing Upper Housing	2.3196	2.3204			
		Gearbox Drive Bearing Lower Housing	2.3196	2.3204	.0008	.0008T	
827	2-54, -57	Fuel Pressurizing and Dump Valve Body Plug Torque			60	70	
828	2-54, -57, -65, -69	Component Drive Gearbox Housing Bushing Torque			275	300	
829	2-54, -57, -65, -69	Component Drive Gearbox Housing Plug Torque			120	130	
830	2-54, -57, -65, -69	Component Drive Gearbox Main Gearshaft Nut Torque . . . . (Tighten to specified limits. Loosen to 0 lb.-in. Then retighten to specified limits.)			250		
831	2-54, -57, -65, -69	Component Drive Gearbox Main Gearshaft Nut Torque . . . . (Tighten to specified limits. Loosen to 0 lb.-in. Then retighten to specified limits.)			500		

All data from pages 2-66A through 2-66B-2 and 2-66C through 2-66G/2-66H deleted.

TABLE 2-9. COMPRESSOR AND TURBINE SECTIONS (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
80	2-53	Turbine Second Stage Disk	5.899	5.901			
		Turbine Shaft	5.897	5.899	.000	.0045T	
82	2-53	Turbine Exhaust Case Front Flange	18.098	18.102			
		Turbine Rotor Second Stage Seal	18.102	18.106	.000	.008T	.010
83	2-53	Select Spacer to Obtain First Stage Turbine Disk Locating Dim			1.407	1.417	
84	2-53	Turbine Exhaust Case	17.845	17.855			
		Turbine Rotor Second Stage Seal	17.855	17.865	.000	.020	.020
85	2-53	Compressor Blade Lock Total End Clearance - 3rd Stage				.020	
86	2-53	Compressor Rotor Rear Hub Spline	.0977	.0987			
		Component Drive Gear Spline	.0982	.0992	.0005T	.0015	.0022
88	2-53	Turbine Rotor Inner Seal	8.149	8.151			
		First Stage Disk	8.147	8.149	.0005	.004T	
89	2-53	Turbine Rotor Inner Seal	7.949	7.951			
		Second Stage Disk	7.951	7.953	.000	.004T	.002
90	2-53	Diffuser Inner Case Rear Flange	7.075	7.077			
		Combustion Chamber Inner Case Flange	7.077	7.079	.000	.004T	.000
91	2-53	Fuel Nozzle Air Swirl Guide	1.480	1.484			
		Fuel Nozzle Cup Adapter	1.486	1.490	.002	.010	.010
92	2-53	Fuel Nozzle Primary Strainer Body Sleeve	.247	.248			
		Fuel Metering Nozzle	.249	.251	.001	.004	.004
93	2-53	Fuel Nozzle Primary Strainer Body	.2465	.2485			
		Fuel Metering Nozzle	.2490	.2510	.0005	.0045	.0045
95	2-53	Fuel Nozzle Primary Strainer Body (Small Diameter)	.199	.203			
		Primary Strainer Body Sleeve	.204	.208	.001	.009	.009
96	2-53	Compressor Rear Bearing Oil Nozzle Connector	.437	.439			
		Oil Strainer Ferrule	.434	.436	.001	.007	.007
97	2-53	Compressor Rotor Disk Spacer	6.467	6.469			
		Disks	6.469	6.471	.000	.0045T	
98	2-53	Compressor Rotor Front Hub	7.474	7.476			
		Second Stage Airseal	7.472	7.474	.000	.004T	.000
99	2-53	Compressor Rotor Third Stage Disk	6.549	6.551			
		Spacer	6.547	6.549	.000	.0045T	
100	2-53	Compressor Second Stage Vane and Shroud	16.988	16.992			
		Third Stage Vane and Shroud	16.988	16.992	.004	.004T	.007

TABLE 2-9. COMPRESSOR AND TURBINE SECTIONS (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
102	2-53	Compressor Front Bearing Oil Strainer Ferrule	.343 .340	.344 .341	.002	.004	.004
104	2-53	Compressor Inlet Pressure Probe Elbow Sensing Boss	.4975 .499	.4985 .501	.0005	.0035	.0035
105	2-53	Compressor Inlet Pressure Probe Elbow Sensing Boss	.620 .624	.622 .626	.002	.006	.006
106	2-53	Gearbox Mounting Shoulder Bolt Mounting Lug Sleeve Bushing and Diffuser Case Mounting Lugs	.366 .374	.368 .376	.006	.010	.010
110	2-53	Compressor Blade Lock Total End Clearance Stages 4 through 9				.015	
111	2-53	1. Position seal on rotor with rear knife-edge engaged over spoiler at one location. 2. Move seal until all radial clearance is on side opposite engaged location. 3. Move seal rearward, starting at engaged location and proceeding all around until the seal is properly in place.					
116	2-53	Bleed Valve Linkage Rod End Spring Housing	.990 .998	.994 1.002	.004	.012	.012
117	2-53	Side Clearance Compressor Stator Spacer Compressor Inlet Case Lugs	.747 .739	.753 .745	.002	.014	.017
119	2-53	Housing - Compressor Bleed Valve Rod	.606 .598	.610 .602	.004	.012	.015
123	2-53	Flanged Sleeve Bushing Compressor Inlet Case	.5320 .5305	.5326 .5315	.0005T	.0021T	.0005T
124	2-53	Radial Clearance First Stage Compressor Blade			.020	.040	
125	2-53	Radial Clearance Second Stage Compressor Blade			.020	.040	

TABLE 2-9. COMPRESSOR AND TURBINE SECTIONS (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
126	2-53	Radial Clearance Third Stage Compressor Blade			.020	.040	
127	2-53	Radial Clearance Fourth Stage Compressor Blade			.020	.040	
128	2-53	Radial Clearance Fifth Stage Compressor Blade			.0345	.0525	
129	2-53	Radial Clearance Sixth Stage Compressor Blade			.030	.050	
130	2-53	Radial Clearance Seventh Stage Compressor Blade.			.025	.045	
131	2-53	Radial Clearance Eighth Stage Compressor Blade			.025	.045	
132	2-53	Radial Clearance Ninth Stage Compressor Blade			.034	.054	
133	2-53	Radial Clearance Second Stage Compressor Rotor Airseal. .			.020	.030	
134	2-53	Radial Clearance Third Stage Compressor Rotor Airseal . .			.020	.030	
135	2-53	Radial Clearance Fourth Stage Compressor Rotor Airseal			.020	.030	
136	2-53	Radial Clearance Fourth to Fifth Stage Compressor Rotor Disk Spacer.			.010	.020	
137	2-53	Radial Clearance Fifth Stage Compressor Rotor Airseal . . .			.010	.020	
138	2-53	Radial Clearance Sixth Stage Compressor Rotor Airseal . . .			.013	.023	
139	2-53	Radial Clearance Seventh Stage Compressor Rotor Airseal			.013	.023	
140	2-53	Radial Clearance Eighth Stage Compressor Rotor Airseal . .			.026	.035	
141	2-53	Radial Clearance Ninth Stage Compressor Rotor Airseal. . .			.028	.032	
142	2-53	Radial Clearance First Stage Turbine Blade Outer Airseals (Rear) P/N 394808 Prior to Change B . . . . P/N 394808B . . . . P/N 394808C and P/N 560890C . . . . P/N 394808E and P/N 560890E			 .060 .060 .0165 .022	 .085 .085 .0415 .047	 .0495 .055
143	2-53	Radial Clearance Second Stage Turbine Blade Outer Airseal			.023	.055	

TABLE 2-9. COMPRESSOR AND TURBINE SECTIONS (JT12A-6 [L] , AND -8 [L] MODELS) (continued)

Ref No.	Fig. No.	Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
144	2-53	Compressor Disk 5th Stage	10.328	10.332			
		Compressor Rotor Seal 5th Stage	10.334	10.345	.002T	.017T	.002T
145	2-53	Compressor Rotor Disk 3rd Stage	8.688	8.692			
		Compressor Rotor Seal 3rd Stage	8.694	8.705	.002T	.017T	.002T
146	2-53	Area (Total All Vanes) (This Area is Produced by Selecting 58 Vanes to Give a Numerical Class Average of 4.40 to 4.44)			54.52	55.08	
		NOTE At 100 percent vane replacement, engines not previously incorporating above class average shall comply with this limit.					
		Area (Total All Vanes) (This Area is Produced by Selecting 58 Vanes to Give a Numerical Class Average of 6.28 to 6.34)			55.52	56.08	
156	2-53	Anti-Icing Air Valve	1.0625	1.0630			
		Body	1.0675	1.0680	.0045	.0055	.0055
157	2-53	Area (Total All Vanes) (This Area is Produced by Selecting 58 Vanes to Give a Numerical Class Average of 6.69 to 6.72)			52.62	53.18	
158	2-53	Area (Total All Vanes) (This Area is Produced by Selecting 96 Vanes to Give a Numerical Class Average of 4.98 to 5.24.)			79.70	80.70	
159A	2-53	Second Stage Inner Airseal Ring-to-Turbine Case Dimension			.005	.081	
161	2-53	Compressor Rotor Disk 6th Stage	10.888	10.892			
		Compressor Rotor Seal 6th Stage	10.894	10.905	.002T	.017T	.002T
162	2-53	Compressor Rotor Disk 7th Stage	11.448	11.452			
		Compressor Rotor Seal 7th Stage	11.454	11.465	.002T	.017T	.002T
163	2-53	Compressor Rotor Disk 8th Stage	12.008	12.012			
		Compressor Rotor Front Seal 8th Stage	12.014	12.025	.002T	.017T	.002T
164	2-53	Compressor Rotor Disk 9th Stage	12.408	12.412			
		Compressor Rotor Front Seal 9th Stage	12.414	12.425	.002T	.017T	.002T
165	2-53	Checking Dimensions Only - main accessory drive shaftgear backlash 0.011 minimum to 0.019 maximum with compressor rotor assembly toward front of engine and 0.003 minimum with rotor assembly toward rear of engine.					
166	2-53	Gap - Fuel Drain Valve			.023	.050	
~~171~~	~~2-53~~	~~Strap~~	~~.093~~	~~.095~~			
		Pin	.0905	.0925	.0005	.0045	.0085

TABLE 2-9. COMPRESSOR AND TURBINE SECTIONS (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
172	2-53	Carriage	.248	.252	.002	.010	
		Strap	.242	.246			
173	2-53	Carriage	.093	.095			
		Pin	.0905	.0925	.0005	.0045	
174	2-53	Guide	.5010	.5028			
		Carriage	.4953	.4975	.0035	.0075	
175	2-53	Bearing	.1872	.1875			
		Pin	.1866	.1871	.0001	.0009	
176	2-53	Carriage	.1869	.1875			
		Pin	.1866	.1871	.0002T	.0009	
177	2-53	Guide	.5010	.5028			
		Bearing	.4996	.5000	.001	.0032	
178	2-53	Connecting Link	.299	.301			
		Carriage	.2965	.2985	.0005	.0045	
179	2-53	Connecting Link	.3730	.3735			
		Carriage	.3745	.3755	.0010	.0025	
180	2-53	Ball Bearing	.1872	.1875			
		Connecting Link	.1866	.1871	.0001	.0009	
181	2-53	Ball Bearing	.4996	.5000			
		Guide	.5010	.5028	.001	.0032	
182	2-53	Guide	1.1819	1.1829			
		Ball Bearing	1.1807	1.1811	.0008	.0022	
183	2-53	Arm	.3902	.3923			
		Ball Bearing	.3934	.3937	.0011	.0035	
184	2-53	Valve Arm Spline	.0302	.0312			
		Linkage Arm Spline	.0327	.0337	.0015	.0035	
185	2-53	Linkage Arm	.2485	.2490			
		Pin	.2475	.2480	.0005	.0015	
186	2-53	Linkage Arm	.185	.195			
		Connector	.167	.169	.016	.028	
187	2-53	Connector	.2495	.2505			
		Pin	.2475	.2480	.0015	.0030	
188	2-53	Arm	.2475	.2480			
		Connecting Link	.2495	.2505	.0015	.0030	
189	2-53	Connector	.1905	.1910			
		Bolt	.1895	.1900	.0005	.0015	
190	2-53	Radial Clearance First Stage Turbine Blade Outer Front Airseal (Front)					
		P/N 394808 Prior to Change B			.060	.085	
		P/N 394808B			.0165	.0415	
		P/N 394808C and P/N 560890C			.0165	.0415	.0495
		P/N 394808E and P/N 560890E			.022	.047	.055

TABLE 2-9. COMPRESSOR AND TURBINE SECTIONS (JT12A-6, -6A L , AND -8 L MODELS) (continued)

Ref. No.	Fig. No.	Description	Cycles Max. Replace at	Replace at (Hours)
		Disk Life to be Limited to Maximum Accumulated Hours or Cycles, Whichever Occurs First. (See Compressor and Turbine Disk Flight Cycle Limits - Section III.)		
340	2-53	Hub - Compressor Rotor Front		
		(P/N 409401)	10000	8000
		(P/N 447901)	10000	8000
		(P/N 596901)	10000	8000
341	2-53	Disk - Compressor Rotor Second Stage		
		(P/N 406302)	3000	3000
		(P/N 406302 - Chg. G or SB 744). . . .	8000	8000
		(P/N 448802)	4000	4000
		(P/N 448802 - Chg. F or SB 744). . . .	8000	8000
		(P/N 541902)	8000	8000
		(P/N 597402)	8000	8000
342	2-53	Disk - Compressor Rotor Third Stage		
		(P/N 406203)	2000	2000
		(P/N 406203 - Chg. G or SB 744). . . .	7500	7500
		(P/N 410703)	4000	4000
		(P/N 410703 - Chg. F or SB 744). . . .	8000	8000
		(P/N 541903)	7500	7500
343	2-53	Disk - Compressor Rotor Fourth Stage		
		(P/N 406204)	2500	2500
		(P/N 406204 - Chg. H or SB 744). . . .	4000	6000
		(P/N 448804)	12000	8000
		(P/N 541904)	4000	6000
344	2-53	Disk - Compressor Rotor Fifth Stage		
		(P/N 406205)	2500	2500
		(P/N 406205 - Chg. H or SB 744). . . .	4000	6000
		(P/N 496705)	8000	8000
		(P/N 541905)	4000	6000
345	2-53	Disk - Compressor Rotor Sixth Stage		
		(P/N 417806)	2500	2500
		(P/N 417806 - Chg. G or SB 744). . . .	4000	6000
		(P/N 496706)	8000	8000
		(P/N 541906)	4000	6000
346	2-53	Disk - Compressor Rotor Seventh Stage		
		(P/N 426107)	3000	3000
		(P/N 426107 - Chg. G or SB 744). . . .	4000	6000
		(P/N 448807)	10000	8000
		(P/N 541907)	4000	6000
347	2-53	Disk - Compressor Rotor Eighth Stage		
		(P/N 406208)	4500	4500
		(P/N 406208 - Chg. J SB 744).	8000	8000
		(P/N 541908)	8000	8000
348	2-53	Disk - Compressor Rotor Ninth Stage		
		(P/N 406209)	3000	3000
		(P/N 406209 - Chg. J or SB 744). . . .	8000	8000
		(P/N 541909)	8000	8000
349	2-53	Disk - First Stage Turbine		
		(P/N 405801)	8000	8000

TABLE 2-9. COMPRESSOR AND TURBINE SECTIONS (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Figure No.	Description	Cycles Max. Replace At	Replace at (Hours)
350	2-53	Disk - Second Stage Turbine (P/N 405802)	8000	8000

Ref. No.	Figure No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
1000	2-53	Fourth Stage Outer Shroud	16.7476	16.7520			
		Stator Spacer	16.747	16.751	.0050T	.0014	
1001	2-53	Fourth Vane and Shroud Support	17.1646	17.1690			
		Fourth Outer Shroud Support Ring	17.168	17.172	.0010T	.0074	
1002	2-53	Axial Clearance					
		Fourth Vane and Shroud Support					
		Fourth Outer Shroud Support Ring			.0006T	.0110T	
1003	2-53	Side Clearance					
		Compressor 5th Stage Outer Shroud Lug	.4876	.4920			
		Sixth Stage Outer Shroud Slot	.4970	.5014	.0050	.0138	
1004	2-53	Compressor 7th Stage Vane and Shroud	16.3136	16.3182			
		Sixth Stage Vane and Shroud	16.3120	16.3164	.0062T	.0028	
1005	2-53	Compressor 9th Stage Outer Shroud	16.3396	16.3442			
		Eighth Stage Outer Shroud	16.3378	16.3424	.0064T	.0028	
1006	2-53	Compressor Rotor 9th Stage Airsealing Ring	12.9884	12.9910			
		Diffuser Inner Case Front Flange	12.991	12.994	.0000	.0056	
1007	2-53	Diffuser Inner Case Front Flange	13.916	13.922			
		Compressor 9th Stage Inner Shroud	13.9228	13.9274	.0008	.0114	
1008	2-53	Compressor 9th Stage Outer Shroud	16.7596	16.7642			
		Diffuser Outer Case Front Flange	16.758	16.762	.0062T	.0024	
1009	2-53	Compressor 6th Stage Vane and Shroud	16.3696	16.3740			
		Fifth Stage Vane Shroud	16.3680	16.3724	.0060T	.0028	
1010	2-53	Compressor 8th Stage Vane and Shroud	16.2976	16.3022			
		Seventh Stage Vane and Shroud	16.2958	16.3004	.0064T	.0028	
1011	2-53	Compressor 5th Stage Shroud	16.5336	16.5380			
		Fourth Stage Shroud	16.5320	16.5364	.0060T	.0028	
1012	2-53	Side Clearance					
		Compressor 6th Stage Outer Shroud Lug	.4896	.4940			
		Seventh Stage Outer Shroud Slot	.4970	.5014	.0030	.0118	
1013	2-53	Side Clearance					
		Compressor 4th Stage Outer Shroud Lug	.4896	.4940			
		Fifth Stage Outer Shroud Slot	.4970	.5014	.0030	.0118	
1014	2-53	Side Clearance					
		Compressor 7th Stage Outer Shroud Lug	.4896	.4940			
		Eighth Stage Outer Shroud Slot	.4970	.5014	.0030	.0118	
1015	2-53	Side Clearance					
		Sixth Stage Vane Shroud Lug	.4896	.4940			
		Diffuser Case Support Ring Slot	.4980	.5040	.0040	.0144	
1016	2-53	Side Clearance					
		First Stage Turbine Airseal Lug	.1860	.1880			
		Turbine Case Slot	.1970	.2030	.0090	.0170	

TABLE 2-9. COMPRESSOR AND TURBINE SECTIONS (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
		Part A: Torque Limits and Stretch					
351	2-53	Compressor Front Bearing Inner Race Retaining Nut (Tighten to 1300 lb. in. Loosen to 0 lb. in. Retighten to 1300 lb. in. Then turn through an angle of 10° Min. to 14° Max.)					
352	2-53	Compressor Front Bearing Outer Race Retaining Nut (Tighten to 2000 lb. in. Loosen to 0 lb. in. Retighten to 2000 lb. in. Then turn through an angle of 5° Min. to 8° Max.)					
353	2-53	Compressor Rear Bearing Outer Race Retaining Nut (Tighten to 2000 lb. in. Loosen to 0 lb. in. Retighten to 2000 lb. in. Then turn through an angle of 12° Min. to 17° Max.)					
354	2-53	Compressor Rear Bearing Oil Scoop (Tighten to 1300 lb. in. Loosen to 0 lb. in. Retighten to 1300 lb. in. Then turn through an angle of 8° Min. to 20° Max.)					
355	2-53	Turbine Shaft Locking Bolt (Tighten to 800 lb. in. Loosen to 0 lb. in. Retighten to 800 lb. in. Then turn through an angle of 16° Min. to 24° Max.)					
356	2-53	Main Component Drivegear Retaining Nut (Tighten to 400 lb. in. Loosen to 0 lb. in. Retighten to 400 lb. in. Then turn to next locking position.)			.025	.025	
358	2-53	Compressor Rotor Tierod Extension Procedure for Tightening Nut on Tierods. 1. Tighten all Tierod Nuts simultaneously in pairs 180° apart by increments of 25 lb. in. to 75 lb. in. then further to a torque of 85 lb. in. in sequence shown in schematic view. 2. Loosen nuts simultaneously in pairs 180° apart to 0 lb. in. and retighten to 8 lb. in. Torque; then further tighten to required minimum stretch. Loosening and retightening to be done simultaneously in pairs 180° apart in sequence shown in schematic view. 3. Repeat this process until all Tierods have been stretched to minimum Tierod Extension. 4. Secure all nuts by bending tablocks but do not reposition nuts during this process. Tierod Extension is measured from threaded end of tierod to rear face of front flange of bearing sleeve or (optional) to shoulder on hub provided to retain the bearing sleeve. 5. Tierod must be held from turning at same end at which stretch is being set.					

TABLE 2-9. TABLE OF LIMITS (ALL MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
832	2-54, -57, -65, -69	Anti-Icing Air Valve Bearing Nut (Tighten nut to obtain 10 lb.-in. then tighten to next locking position.)					
833	2-54, -57, -65, -69	Oil Pressure Transmitter Connector Insert			700	750	
834	2-54, -57, -65, -69	Oil Filter Cover Retaining Nuts (Locknuts Only)			55	60	
1003	2-66, -70	Case - Free Turbine Inlet, Assembly of Nut - Plain Dee After Tightening - 14 Places				.050 Gap	
1004	2-66	Fuel Control Flexible Shaft Flange Bearing	 .8661 .8659	 .8667 .8661	 .0000	 .0008	
1005	2-66	Flexible Shaft Fuel Control Core Bearing	 .3152 .3148	 .3156 .3150	 .0002T	 .0008T	
1006	2-66	Flexible Shaft Fuel Control Core Bearing	 .409 .412	 .411 .414	 .001	 .005	
1007	2-66	Flexible Shaft Fuel Control Core Gearshaft	 .2475 .2520	 .2485 .2560	 .0035	 .0085	
1008	2-66	Fuel Control Flexible Shaft Flange Seal	 .998 1.001	 1.000 1.005	 .001T	 .007T	
1009	2-66	Oil Cooler Outlet Fuel Tube To Oil Pressure Transmitter Boss			.080		
		Tube Clearances: Unless Otherwise Specified Clearance Between Tubes (Except Where Clipped Together) And Between Tubes and Other External Engine Parts Must Be 0.125 Inch Minimum.					
1021	2-58	Oil Cooler Outlet Fuel Tube To Oil Pressure Transmitter Boss			.080		
		Tube Clearances: Unless Otherwise Specified Clearance Between Tubes (Except Where Clipped Together) And Between Tubes And Other External Engine Parts Must Be 0.125 Inch Minimum					
1030	2-55, -58, -66, -70	Immersion Thermocouple Lead Nut (0.164-32 Reference)			8	12	
1031	2-55, -58, -66, -70	Immersion Thermocouple Lead Nut (0.190-32 Reference)			10	15	

TABLE 2-9. TABLE OF LIMITS (ALL MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
1032	2-55, -66, -67	Fuel Heater Valve Actuator Assembly Screw (0.164-32 Reference)			12	15	
	2-58	Torque to 15 to 19 lb.-in. (four places)					
1033	2-55, -66, -70	Torque to 15 to 18 lb.-in. (four places)					
	2-58	Ignition Exciter Mounting Bolts			50	60	
1034	2-55, -66, -70	Ignition Exciter Mounting Bolts			50	60	
1035	2-66, -70	Nut, Fuel Control Flexible Shaft			.120	.150	
1051	2-55, -66, -70	Igniter Plug			300	360	
1052	2-55, -58, -66, -70	Oil Tank Mounting Strap Turnbuckle			4	6	
1053	2-55, -58	Oil Cooler Thermostat			900	1080	
	2-66, -70	Pressurizing and Dump Valve Mounting Bolts			65	85	
1054	2-55, -58	P&D Valve Mounting Bolts			65	85	
1055	2-55, -58	Pressure Switch Mounting Bolts . . .			30	40	
1301	2-64, -68	Free Turbine Air Inlet Seal . . . . . . Sealing Ring . . . . (Radial Clearance Based on Size Tolerance Only)	7.732 7.678	7.736 7.682	.025	.029	.035
1302	2-64, -68	Free Turbine Inlet Duct. . . . . Inlet Seal	8.161 8.159	8.163 8.161	.000	.004	
6056	2-55	Oil Cooler Outlet Fuel Tube To Oil Pressure Transmitter Boss			0.080		
		Tube Clearances: Unless Otherwise Specified Clearance Between Tubes (Except Where Clipped Together) And Between Tubes And Other External Engine Parts Must Be 0.125 Inch Minimum.					

Tables 2-10 through 2-11H and 2-12 through 2-17 Deleted.

All data from pages 2-69 through 2-70-1/2-70-2, 2-70A through 2-70D, 2-71 through 2-78A/2-78B, 2-79 through 2-86A/2-86B, 2-87 through 2-96B, 2-97 through 2-104-1/2-104-2, 2-104C/2-104D, and 2-105 through 2-108 deleted.

TABLE 2-9. COMPRESSOR AND TURBINE SECTIONS (JT12A-6, -6A[L], AND -8[L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
359	2-53	Turbine Bearing Outer Race Retaining Nut (Tighten to 2000 lb. in. Loosen to zero lb. in. Retighten to 2000 lb. in. Then turn through an angle of 5° Min. to 8° Max.)					
360	2-53	Turbine Bearing Inner Race Retaining Nut (Tighten to 1500 lb. in. Loosen to zero lb. in. Retighten to 1500 lb. in. Then turn through an angle of 7° Min. to 10° Max.)					
361	2-53	Turbine Disks Nut (Tighten to specified limits, loosen to zero lb. in. Then retighten to specified limits)			175	200	
362	2-53	Turbine Bearing Support Bolts			65	72	
364	2-53	Fuel Nozzle Air Swirl Guide Nut			250	275	
365	2-53	Compressor Rotor Front Tierod Stretch Procedure for Tightening Rear Nut on Front Tierod: 1. Tierod must be held from turning at all times. 2. Required tierod stretch is measured from rear face to front hub. 3. With front nuts set, tighten rear nuts simultaneously in pairs 180 degrees apart by increments of 25 lb. in. to a torque of 75 lb. in. in sequence shown in schematic view. 4. Loosen nuts simultaneously in pairs 180 degrees apart to zero lb. in. and retighten to eight lb. in. torque. Then further tighten to required minimum stretch. Loosening and retightening to be done simultaneously in pairs 180 degrees apart in sequence shown in schematic view. Secure nuts by bending tablocks but do not reposition nuts during this process.			.008	.008	
366	2-53	Tail Cone Mounting Bolts.			45	51	
		Part B: Spring Pressures					
401	2-53	Turbine Shaft Lock Spring at 1.250 inches			91.25	10.875	8.625
402	2-53	Compressor Rear Bearing Seal Spring at 0.575 inch.			1.625	1.750	1.563
403	2-53	Turbine Bearing Seal Spring at 0.600 inch			1.5625	1.6875	1.500
404	2-53	Fuel Nozzle Primary Strainer Body Spring at 0.372 inch.			1.75	2.25	1.65
405	2-53	Compressor Bleed Valve Linkage Spring at 1.539 inches			227.687	236.312	223.375
406	2-53	Spring - Helical, Compression at 0.600 inch			1.875	2.125	1.775
407	2-53	Spring - Helical Compression					
		at 0.880 inch.			33.687	36.687	
		at 1.080 inches			24.000	26.000	

TABLE 2-10. ACCESSORY SECTION (JT12A-6, -6A [L], AND -8 [L] MODELS)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
501	2-54	Hydraulic Pump Drive Front Oil Seal	1.251	1.253			
		Housing	1.247	1.249	.002T	.006T	.002T
502	2-54	Hydraulic Pump Drive Gearshaft					
		Front Bearing	1.8502	1.8504			
		Liner	1.8504	1.8510	.0000	.0008	.001
503	2-54	Hydraulic Pump Drive Gearshaft	1.1813	1.1817			
		Front Bearing	1.1809	1.1811	.0002T	.0008T	*
504	2-54	Hydraulic Pump Drive Gearshaft					
		Rear Bearing	2.1651	2.1654			
		Liner	2.1649	2.1656	.0005T	.0005	.0007
505	2-54	Hydraulic Pump Drive Gearshaft	1.1813	1.1817			
		Rear Bearing	1.1809	1.1811	.0002T	.0008T	*
506	2-54	Hydraulic Pump Drive Rear Oil Seal	1.501	1.505			
		Pad	1.498	1.500	.001T	.007T	.001T
508	2-54	Fuel Control Drive Oil Seal	1.501	1.505			
		Boss	1.498	1.500	.001T	.007T	.001T
509	2-54	Fuel Control Drive Gearshaft Front					
		Bearing	2.0469	2.0472			
		Bushing	2.0470	2.0475	.0002T	.0006	.0008
510	2-54	Fuel Control Drive Gearshaft	.9845	.9849			
		Front Bearing	.9841	.9843	.0002T	.0008T	*
511	2-54	Fuel Control Drive Gearshaft Rear Bearing	1.8502	1.8504			
		Bushing	1.8502	1.8508	.0002T	.0006	.0008
512	2-54	Fuel Control Drive Gearshaft	.7876	.7880			
		Rear Bearing	.7872	.7874	.0002T	.0008T	*
513	2-54	Component Drive Gearbox Main Gearshaft					
		Front Bearing	1.8502	1.8504			
		Bushing	1.8502	1.8508	.0002T	.0006	.0008
514	2-54	Component Drive Gearbox Main Gearshaft	.6695	.6699			
		Front Bearing	.6691	.6693	.0002T	.0008T	*
515	2-54	Component Drive Gearbox Main Gearshaft					
		Splines	.0486	.0496			
		Fuel Control Drive Gear Splines	.0491	.0501	.0005T	.0015	.0035
516	2-54	Component Drive Gearbox Main Gearshaft					
		Splines	.0486	.0496			
		Gear Splines	.0491	.0501	.0005T	.0015	.0035
517	2-54	Component Drive Gearbox Main Gear					
		Bearings	2.4406	2.4409			
		Bushing	2.4410	2.4415	.0001	.0009	.0011
518	2-54	Component Drive Gearbox Main Gear	.9845	.9849			
		Bearing	.9841	.9843	.0002T	.0008T	*
519	2-54	Starter-Generator Drive Oil Seal (Rubber)	1.501	1.505			
		Support	1.498	1.500	.001T	.007T	.001T

TABLE 2-10. ACCESSORY SECTION (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
519	2-54	Starter-Generator Drive Oil Seal (Carbon)	1.626	1.628			
		Support	1.621	1.622	.004T	.007T	
520	2-54	Starter-Generator Drive Gearshaft					
		Outer Bearing	2.1651	2.1654			
		Bushing	2.1655	2.1660	.0001	.0009	.0011
521	2-54	Starter-Generator Drive Gearshaft	1.3782	1.3786			
		Outer Bearing	1.3778	1.3780	.0002T	.0008T	*
522	2-54	Starter-Generator Driveshaft	1.028	1.029			
		Gearshaft	1.0295	1.0305	.0005	.0025	.0030
523	2-54	Starter-Generator Driveshaft Splines	.0466	.0476			
		Gearshaft Splines	.0491	.0501	.0015	.0035	.0055
524	2-54	Starter-Generator Drive Gearshaft					
		Inner Bearing	2.1651	2.1654			
		Liner	2.1649	2.1656	.0005T	.0005	.0007
525	2-54	Starter-Generator Drive Gearshaft	1.1813	1.1817			
		Inner Bearing	1.1809	1.1811	.0002T	.0008T	*
526	2-54	Main Oil Pump Drive Gearshaft Splines	.0485	.0495			
		Starter-Generator Driveshaft Splines	.0490	.0500	.0005T	.0015	.0035
527	2-54	Main Oil Pump Drive Gearshaft	.580	.581			
		Starter-Generator Drive Gearshaft	.578	.579	.001T	.003T	*
528	2-54	Main Oil Pump Bodies	3.398	3.399			
		Component Drive Gearbox Housing	3.3995	3.4005	.0005	.0025	.0035
529	2-54	Main Oil Pump Drive Gearshaft	.5605	.5610			
		Inner Cover	.562	.563	.001	.0025	.0035
530	2-54	Main Oil Pump Drive Gearshaft	.5605	.5610			
		Pressure Gear	.5615	.5635	.0005	.003	.004
531	2-54	Main Oil Pump Gears	.6855	.6860			
		Bodies and Covers and Supports	.687	.688	.001	.0025	.0035
532	2-54	Main Oil Pump Drive Gearshaft Spline	.0465	.0475			
		Gear Spline	.0490	.0505	.0015	.004	.006
533	2-54	Main Oil Pump Gears	1.499	1.501			
		Bodies and Covers and Supports	1.504	1.506	.003	.007	.008
534	2-54	Main Oil Pump Drive Gearshaft	.4090	.4095			
		Drain Gear	.410	.411	.0005	.002	.003
535	2-54	Main Oil Pump Gear	.6865	.6875			
		Gear	.6855	.6860	.0005	.002	.003
536	2-54	Main Oil Pump Idler Shaft	.6038	.6043			
		Inner Cover	.6018	.6028	.001T	.0025T	*
538	2-54	Main Oil Pump Idler Shaft	.6015	.6020			
		Body Plate	.6025	.6035	.0005	.002	.003
539	2-54	Main Oil Pump Pressure Gear	.6855	.6860			
		Body Plate	.689	.690	.003	.0045	.0055

TABLE 2-10. ACCESSORY SECTION (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
540	2-54	Main Oil Pump Idler Shaft Bodies and Outer Cover	.6015 .6025	.6020 .6035	.0005	.002	.003
541	2-54	Main Oil Pump Idler Gear Straight Shaft	.6030 .6015	.6040 .6020	.001	.0025	.0035
542	2-54	End Clearance Main Oil Pump Idler Gear Outer Bodies	.3745 .378	.375 .380	.003	.0055	.0060
543	2-54	End Clearances Main Oil Pump Idler Gear Inner Body	.3115 .315	.312 .317	.003	.0055	.0060
544	2-54	Component Drive Gearbox Main Gearshaft Upper Bearing Support	1.8502 1.8505	1.8504 1.8511	.0001	.0009	.0011
545	2-54	Components Drive Gearbox Main Gearshaft Upper Bearing	.7876 .7872	.7880 .7874	.0002T	.0008T	*
546	2-54	Component Drive Gearbox Main Gearshaft Lower Bearing Liner	1.6533 1.6527	1.6535 1.6533	.0000	.0008T	.0002
547	2-54	Component Drive Gearbox Main Gearshaft Lower Bearing	.7876 .7872	.7880 .7874	.0002T	.0008T	*
548	2-54	Starter-Generator Drive Bearing Bushing Support	2.351 2.345	2.352 2.346	.005T	.007T	.0044T
549	2-54	Tachometer Drive Bearing Support Component Drive Gearbox Housing	2.029 2.030	2.030 2.031	.000	.002	.0025
550	2-54	Tachometer Drive Bearing Support	.9447 .9450	.9449 .9456	.0001	.0009	.0011
551	2-54	Tachometer Drive Gearshaft Inner Bearing	.4723 .4722	.4727 .4724	.0005T	.0001	.0001
552	2-54	Tachometer Drive Gearshaft Spacer (Inner End)	.4723 .474	.4727 .480	.0013	.0077	.0107
553	2-54	Tachometer Drive Gearshaft End Clearance			.0101	.0281	.0281
554	2-54	Tachometer Drive Oil Seal Housing	1.126 1.123	1.130 1.125	.001T	.007T	.001T
555	2-54	Tachometer Drive Gearshaft Outer Bearing	.4716 .4722	.4720 .4724	.0002	.0008	.0010
556	2-54	Tachometer Drive Gearshaft Spacer (Outer End)	.4716 .474	.4720 .480	.002	.0084	.0114
557	2-54	End Clearance Main Oil Pump Drivegear Inner Cover	.4995 .503	.500 .505	.003	.0055	.0060

TABLE 2-10. ACCESSORY SECTION (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
565	2-54	Main Component Driveshaft					
		Lower Bearing Bushing	1.839	1.840			
		Housing	1.833	1.834	.005T	.007T	.0045T
566	2-54	Relief Valve Cylinder	.537	.538			
		Valve Housing	.540	.541	.002	.004	.0045
568	2-54	Hydraulic Pump Drive Bearing Bushing	2.351	2.352			
		Support	2.345	2.346	.005T	.007T	.0044T
569	2-54	Hydraulic Pump Drive Bearing Bushing	2.036	2.037			
		Housing	2.030	2.031	.005T	.007T	.0044T
570	2-54	Fuel Pressurizing Valve	.9283	.9287			
		Liner	.9297	.9303	.001	.002	.0025
571	2-54	Hydraulic Pump Pad Front					
		Seal Housing Liner	1.348	1.349			
		Housing	1.342	1.343	.005T	.007T	.0046T
572	2-54	Main Gearshaft Front Bearing Liner	2.036	2.037			
		Housing	2.030	2.031	.005T	.007T	.0044T
573	2-54	Fuel Dump Valve	1.048	1.049			
		Body	1.050	1.051	.001	.003	.004
575	2-54	Fuel Control Drive Bearing Bushing	2.2345	2.2355			
		Boss	2.2285	2.2295	.005T	.007T	.0043T
576	2-54	Fuel Check Valve Guide	.122	.126			
		Plug	.136	.140	.010	.018	.024
577	2-54	Fuel Dump Valve	.674	.675			
		Seal Ring	.676	.678	.001	.004	.005
578	2-54	Fuel Pressurizing and Dump Valve					
		Inlet Strainer Spring Seat	.803	.805			
		Plug	.809	.811	.004	.008	.010
579	2-54	Main Gearshaft Bearing Rear Liner	2.629	2.630			
		Gearbox Cover	2.623	2.624	.005T	.007T	.0043T
580	2-54	Fuel Pressurizing Valve Liner	1.045	1.047			
		Body	1.049	1.051	.002	.006	.010
581	2-54	Gearbox Mounting Lug Bushing	.5015	.5030			
		Housing	.499	.500	.0015T	.004T	.0012T
582	2-54	Fuel Control Drive Bearing Bushing	2.036	2.037			
		Gearbox Housing	2.030	2.031	.005T	.007T	.0044T
583	2-54	Starter-Generator					
		Drive Bearing Liner	2.289	2.290			
		Gearbox Housing	2.283	2.284	.005T	.007T	.0044T
584	2-54	Anti-Icing Shutoff Valve Housing	.3745	.3751			
		Bearing	.3746	.3750	.0005	.0005T	.0007
585	2-54	Anti-Icing Shutoff Valve Shaft	.1242	.1246			
		Bearing	.1247	.1250	.0001	.0008	.0008

TABLE 2-10. ACCESSORY SECTION (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
586	2-54	Anti-Icing Shutoff Valve Housing	.270	.274			
		Spacer	.264	.266	.004	.010	.012
587	2-54	Anti-Icing Shutoff Valve Housing	.5100	.5105			
		Thrust Ring	.5098	.5100	.0000	.0007	.0007
588	2-54	Anti-Icing Shutoff Valve Housing	.6250	.6255			
		Bearing	.6246	.6250	.0000	.0009	.0011
589	2-54	Anti-Icing Shutoff Valve Shaft	.2494	.2500			
		Bearing	.2497	.2500	.0003T	.0006	.0006
590	2-54	Anti-Icing Shutoff Valve Shaft	.1242	.1246			
		Spacer	.125	.127	.0004	.0028	.0040
591	2-54	Anti-Icing Shutoff Valve Shaft	.278	.280			
		Housing	.284	.288	.004	.010	.014
592	2-54	Anti-Icing Shutoff Valve					
		Shaft Spline	.0206	.0216			
		Anti-Icing Shutoff Valve Spline	.0221	.0231	.0005	.0025	.0035
593	2-54	Anti-Icing Shutoff Valve					
		Shaft Spline	.0206	.0216			
		Actuator Spline	.0221	.0231	.0005	.0025	.0035
594	2-54	Anti-Icing Shutoff Valve	.969	.973			
		Housing	1.000	1.002	.027	.033	.036
595	2-54	Gap					
		Anti-Icing Shutoff Valve					
		Seal Ring Gap at 1.000 Gage	.010	.020			
		Housing	1.000	1.002	.010	.026	.026
596	2-54	Anti-Icing Shutoff Valve Groove	.027	.031			
		Seal Ring	.025	.026	.001	.006	.007
597	2-54	Heater Bypass Valve	.182	.183			
		Guide	.187	.188	.004	.006	.007
598	2-54	Sleeve Spacer	.249	.251			
		Fuel Heater Mounting Lugs	.252	.256	.001	.007	.0085
599	2-54	Main Oil Pump Housing and Cover	3.338	3.339			
		Component Drive Gearbox Housing	3.3395	3.3405	.0005	.0025	.0035
600	2-54	Main Oil Pump Cover	3.278	3.279			
		Component Drive Gearbox Housing	3.2795	3.2805	.0005	.0025	.0035
601	2-54	Tachometer Drive Housing	.6025	.6035			
		Main Oil Pump Straight Shaft	.6015	.6020	.0005	.002	.0025
602	2-54	Tachometer Drive Housing	1.125	1.126			
		Main Oil Pump Gearshaft Support	1.1235	1.1245	.0005	.0025	.0035
603	2-54	Splines					
		Main Oil Pump Gear..................	.0485	.0495			
		Tachometer Drive Shaftgear	.0490	.0500	.0005T	.0015	.0035
604	2-54	Seal............................	1.126	1.130			
		Tachometer Drive Bearing Housing.......	1.123	1.125	.001T	.007T	.001T

TABLE 2-10. ACCESSORY SECTION (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
605	2-54	Tachometer Drive Housing	1.250	1.251			
		Tachometer Drive Bearing Housing	1.2485	1.2495	.0005	.0025	.003
606	2-54	Tachometer Drive Bevel Gearshaft	.4723	.4727			
		Tachometer Drive Bearing Spacer	.475	.477	.0023	.0047	.0053
607	2-54	Tachometer Drive Bearing Housing	.9450	.9456			
		Bearing	.9447	.9449	.0001	.0009	.0011
608	2-54	Tachometer Drive Shaftgear	.4723	.4727			
		Bearing	.4722	.4724	.0001	.0005T	*
609	2-54	Tachometer Drive Housing	1.639	1.641			
		Tachometer Drive Bearing Housing	1.635	1.637	.002	.006	.008
610	2-54	Main Oil Pump Shaft	.6015	.6020			
		Main Oil Pump Support	.6060	.6085	.004	.007	.008
801	2-54	Backlash Main Oil Pump Spur Gearshaft Main Oil Pump Spur Idler Gear			.0045	.0195	
802	2-54	Backlash Fuel Control Drive Spur Gearshaft Hydraulic Pump Drive Spur Gearshaft			.004	.020	
803	2-54	Backlash Fuel Control Drive Spur Gear Fuel Control Drive Spur Gearshaft			.004	.020	
804	2-54	Backlash Starter-Generator Drive Spur Gearshaft Main Component Drive Gearbox Gearshaft			.004	.020	
805	2-54	Backlash Tachometer Drive Bevel Gearshaft Tachometer Drive Bevel Gear			.007	.025	
806	2-54	Backlash Main Component Drive Gearbox Gear Main Component Drive Gearbox Gearshaft			.007		
807	2-54	Backlash Tachometer Drive Bevel Gearshaft Tachometer Drive Bevel Gear			.011	.037	
809	2-54	Backlash Main Oil Pump Drive Gearshaft Gearshaft			.009	.031	
811	2-54	Accessory and Component Drives Gearbox Housing	4.375	4.376			
		Hydraulic Pump Drive Bearing Support	4.374	4.375	.000	.002	.003
812	2-54	Accessory and Component Drives Gearbox Housing	6.599	6.600			
		Component Drive Gearbox Housing Cover Assembly	6.598	6.599	.000	.002	.003
813	2-54	Accessory and Component Drives Gearbox Housing	4.375	4.376			
		Fuel Control Boss	4.374	4.375	.000	.002	.003

TABLE 2-10. ACCESSORY SECTION (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Figure No.	Description Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
814	2-54	Accessory and Component Drives Gearbox Housing	4.375	4.376			
		Starter-Generator Drive Bearing Support.	4.374	4.375	.000	.002	.003
815	2-54	Accessory and Component Drives Gearbox Housing	2.670	2.671			
		Component Drive Gearbox Main Bearing Support	2.669	2.670	.000	.002	.003
		Part A: Torque Limits and Stretch					
827	2-54	Fuel Pressurizing and Dump Valve Body Plug			60	70	
828	2-54	Component Drive Gearbox Housing Bushing			275	300	
829	2-54	Component Drive Gearbox Housing Plug.			120	130	
830	2-54	Component Drive Gearbox Main Gearshaft Nut (Tighten to specified limits, loosen to 0 lb. in., then retighten to specified limits.).			250		
831	2-54	Component Drive Gearbox Main Gearshaft Nut (Tighten to specified limits, loosen to 0 lb. in., then retighten to specified limits.).			500		
832	2-54	Anti-icing Air Valve Bearing Nut (Tighten nut to obtain 10 lb. in., then tighten to next locking position.)					
833	2-54	Oil Pressure Transmitter Connector Insert.			700	750	
834	2-54	Oil Filter Cover Retaining Nuts (Locknuts only)			55	60	
		(Sleeve Nuts only).			25	30	
		Part B: Spring Pressures					
862	2-54	Compensating Relief Valve Spring at 1.600 inches		6.0625	7.0625	5.750	
864	2-54	Main Oil Strainer Bypass Valve Spring at 1.470 inches			13.375	14.625	12.750
865	2-54	Main Oil Strainer Support Spring at 0.650 inch.			40.875	45.125	38.750
866	2-54	Fuel Pressurizing Valve Spring at 1.893 inches			13.000	15.000	12.300
		at 1.334 inches			31.6875	35.6875	30.062
867	2-54	Fuel Dump Valve Spring at 2.300 inches			38.625	42.125	36.875
		at 2.017 inches			61.6875	68.6875	58.500
868	2-54	Fuel Check Valve Spring at 0.600 inch.			1.875	2.125	1.750
869	2-54	Fuel Pressurizing and Dump Valve Inlet Strainer Spring at 0.520 inch.			5.125	5.375	5.000
		at 0.395 inch.			7.500	8.000	7.250

TABLE 2-10. ACCESSORY SECTION (JT12A-6, -6A [L], AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
558	2-54	End Clearance					
		Main Oil Pump Idler Gear	.4993	.500			
		Inner Cover	.503	.505	.003	.0057	.0062
559	2-54	End Clearance					
		Main Oil Pump Drivegear	.3113	.312			
		Inner Body	.315	.317	.003	.0057	.0062
560	2-54	End Clearance					
		Main Oil Pump Gears	.3743	.375			
		Outer Bodies	.378	.380	.003	.0057	.0062

TABLE 2–10. ACCESSORY SECTION (JT12A) (continued)

Ref. No.	Fig. No.	Description	Dimensions Min.	For Ref. Max.	Limits Min.	Limits Max.	Replace
569	2–54	Hydraulic Pump Drive Bearing Bushing	2.036	2.037			
		Housing	2.030	2.031	.005T	.007T	.0044T
570	2–54	Fuel Pressurizing Valve	.9283	.9287			
		Liner	.9297	.9303	.001	.002	.0025
571	2–54	Hydraulic Pump Pad Front					
		Seal Housing Liner	1.348	1.349			
		Housing	1.342	1.343	.005T	.007T	.0046T
572	2–54	Main Gearshaft Front Bearing Liner	2.036	2.037			
		Housing	2.030	2.031	.005T	.007T	.0044T
573	2–54	Fuel Dump Valve	1.048	1.049			
		Body	1.050	1.051	.001	.003	.004
575	2–54	Fuel Control Drive Bearing Bushing	2.2345	2.2355			
		Boss	2.2285	2.2295	.005T	.007T	.0043T
576	2–54	Fuel Check Valve Guide	.122	.126			
		Plug	.136	.140	.010	.018	.024
577	2–54	Fuel Dump Valve	.674	.675			
		Seal Ring	.676	.678	.001	.004	.005
578	2–54	Fuel Pressurizing & Dump Valve					
		Inlet Strainer Spring Seat	.803	.805			
		Plug	.809	.811	.004	.008	.010
579	2–54	Main Gearshaft Bearing Rear Liner	2.629	2.630			
		Gearbox Cover	2.623	2.624	.005T	.007T	.0043T
580	2–54	Fuel Pressurizing Valve Liner	1.045	1.047			
		Body	1.049	1.051	.002	.006	.010
581	2–54	Gearbox Mounting Lug Bushing	.5015	.5030			
		Housing	.499	.500	.0015T	.004T	.0012T
582	2–54	Fuel Control Drive Bearing Bushing	2.036	2.037			
		Gearbox Housing	2.030	2.031	.005T	.007T	.0044T
583	2–54	Starter & Generator					
		Drive Bearing Liner	2.289	2.290			
		Gearbox Housing	2.283	2.284	.005T	.007T	.0044T
584	2–54	De-Icing Shut-Off Valve Housing	.3745	.3751			
		Bearing	.3746	.3750	.0005	.0005T	.0007
585	2–54	De-Icing Shut-Off Valve Shaft	.1242	.1246			
		Bearing	.1247	.1250	.0001	.0008	.0008
586	2–54	De-Icing Shut-Off Valve Housing	.270	.274			
		Spacer	.264	.266	.004	.010	.012
587	2–54	De-Icing Shut-Off Valve Housing	.5100	.5105			
		Thurst Ring	.5098	.5100	.0000	.0007	.0007
588	2–54	De-Icing Shut-Off Valve Housing	.6250	.6255			
		Bearing	.6246	.6250	.0000	.0009	.0011
589	2–54	De-Icing Shut-Off Valve Shaft	.2494	.2500			
		Bearing	.2497	.2500	.0003T	.0006	.0006
590	2–54	De-Icing Shut-Off Valve Shaft	.1242	.1246			
		Spacer	.125	.127	.0004	.0028	.0040

Pratt & Whitney Aircraft

JT12A MAINTENANCE MANUAL

TABLE 2—10. ACCESSORY SECTION (JT12A) (continued)

Ref. No.	Fig. No.	Description	Dimensions Min.	For Ref. Max.	Limits Min.	Limits Max.	Replace
591	2—54	De-Icing Shut-Off Valve Shaft	.278	.280			
		Housing	.284	.288	.004	.010	.014
592	2—54	De-Icing Shut-Off Valve					
		Shaft Spline	.0206	.0216			
		De-Icing Shut-Off Valve Spline	.0221	.0231	.0005	.0025	.0035
593	2—54	De-Icing Shut-Off Valve					
		Shaft Spline	.0206	.0216			
		Actuator Spline	.0221	.0231	.0005	.0025	.0035
594	2—54	De-Icing Shut-Off Valve	.969	.973			
		Housing	1.000	1.002	.027	.033	.036
595	2—54	Gap					
		De-Icing Shut-Off Valve					
		Seal Ring Gap at 1.000 Gage	.010	.020			
		Housing	1.000	1.002	.010	.026	.026
596	2—54	De-Icing Shut-Off Valve Groove	.027	.031			
		Seal Ring	.025	.026	.001	.006	.007
597	2—54	Heater By-Pass Valve	.182	.183			
		Guide	.187	.188	.004	.006	.007
598	2—54	Sleeve Spacer	.249	.251			
		Fuel Heater Mounting Lugs	.252	.256	.001	.007	.0085
599	2—54	Main Oil Pump Housing & Cover	3.338	3.339			
		Component Drive Gearbox Housing	3.3395	3.3405	.0005	.0025	.0035
600	2—54	Main Oil Pump Cover	3.278	3.279			
		Component Drive Gearbox Housing	3.2795	3.2805	.0005	.0025	.0035
601	2—54	Tachometer Drive Housing	.6025	.6035			
		Main Oil Pump Straight Shaft	.6015	.6020	.0005	.002	.0025
602	2—54	Tachometer Drive Housing	1.125	1.126			
		Main Oil Pump Gearshaft Support	1.1235	1.1245	.0005	.0025	.0035
603	2—54	Splines					
		Main Oil Pump Gear	.0485	.0495			
		Tachometer Drive Shaftgear	.0490	.0500	.0005T	.0015	.0035
604	2—54	Seal	1.126	1.130			
		Tachometer Drive Bearing Housing	1.123	1.125	.001T	.007T	.001T
605	2—54	Tachometer Drive Housing	1.250	1.251			
		Tachometer Drive Bearing Housing	1.2485	1.2495	.0005	.0025	.003
606	2—54	Tachometer Drive Bevel Gearshaft	.4723	.4727			
		Tachometer Drive Bearing Spacer	.475	.477	.0023	.0047	.0053
607	2—54	Tachometer Drive Bearing Housing	.9450	.9456			
		Bearing	.9447	.9449	.0001	.0009	.0011
608	2—54	Tachometer Drive Shaftgear	.4723	.4727			
		Bearing	.4722	.4724	.0001	.0005T	*
609	2—54	Tachometer Drive Housing	1.639	1.641			
		Tachometer Drive Bearing Housing	1.635	1.637	.002	.006	.008

TABLE 2—10. ACCESSORY SECTION (JT12A) (continued)

Ref. No.	Fig. No.	Description	Dimensions Min.	For Ref. Max.	Limits Min.	Limits Max.	Replace
610	2—54	Main Oil Pump Shaft	.6015	.6020			
		Main Oil Pump Support	.6060	.6085	.004	.007	.008
801	2—54	Backlash Main Oil Pump Spur Gearshaft Main Oil Pump Spur Idler Gear			.0045	.0195	
802	2—54	Backlash Fuel Control Drive Spur Gearshaft Hydraulic Pump Drive Spur Gearshaft			.004	.020	
803	2—54	Backlash Fuel Control Drive Spur Gear Fuel Control Drive Spur Gearshaft			.004	.020	
804	2—54	Backlash Starter & Generator Drive Spur Gearshaft Main Component Drive Gearbox Gearshaft			.004	.020	
805	2—54	Backlash Tachometer Drive Bevel Gearshaft Tachometer Drive Bevel Gear			.007	.025	

TABLE 2-10. ACCESSORY SECTION (JT12A-6, -6A [L] , AND -8 [L] MODELS) (continued)

Ref. No.	Fig. No.	Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
870	2-54	Fuel Anti-Icing Bypass Valve Spring					
		at .865 in. . .			1.425	1.575	1.350
		at .565 in. . .			5.850	6.150	5.700
		Part C: Mounting Distances					
876	2-54	Component Drive Gearbox Gear . .			2.1110	2.1290	
880	2-54	Component Drive Gearshaft			4.152	4.168	

TABLE 2-11. EXTERNAL PARTS (JT12A-6, -6A [L] , AND -8 [L] MODELS)

Ref. No.	Fig. No.	Description	Dimensions for Ref. Min.	Dimensions for Ref. Max.	Limits Min.	Limits Max.	Replace If Over
1030	2-55	Immersion Thermocouple Lead Nut (.164-32 Ref.)			8	12	
1031	2-55	Immersion Thermocouple Lead Nut (.190-32 Ref.)			10	15	
1032	2-55	Fuel Heater Valve Actuator Assembly Screw			12	15	
1034	2-55	Ignition Exciter Mounting Bolts. . .			50	60	
1051	2-55	Igniter Plug			300	360	
1052	2-55	Oil Tank Mounting Strap Turnbuckle			4	6	
1053	2-55	Oil Cooler Thermostat			900	1080	
1054	2-55	P&D Valve Mounting Bolts			65	85	
1055	2-55	Pressure Switch Mounting Bolts . .			30	40	
1056	2-55	Solenoid Adjustment Instructions 1. Adjust 432418 pin (by shortening end adjacent to bellows assembly) until switching point is 0.015 to 0.020 above assembled height of 432424 bellows assembly to 432418 pin. 2. Install an appropriate class of 432421 spacer to accomplish a free travel limit of 0.008 to 0.015 above switching point. P/N 432418 may be shortened an additional 0.005 maximum if necessary to achieve this. 3. Install shims Nos. 432412, 432413, and 432414 to provide 0.004 to 0.006 travel beyond switching point when piston 451275 is completely depressed.					
1057	2-55	Oil Tank Cap Spring at .375 in. . .			17.000	24.000	
1058	2-55	Oil Tank Cap Spring at .266 in. . .			14.100	15.610	

TABLE 2-11A. COMPRESSOR AND TURBINE SECTION (JT12A-6A [N] AND -8 [N] MODELS)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace If Over
2	2-55A	Compressor Rotor Front Hub	2.9544	2.9549			
		Bearing	2.9525	2.9528	.0016T	.0024T	.0016T
3	2-55A	Compressor Rotor Front Hub	2.9544	2.9549			
		Compressor Front Bearing Seal Spacer . .	2.9554	2.9567	.0005	.0023	.0033
4	2-55A	Compressor Rotor Front Hub	6.397	6.399			
		Disk Second Stage.	6.399	6.401	.000	.0045T	.001
5	2-55A	Compressor Rotor Disk Spacers	9.771	9.773			
		Disks	9.769	9.771	.0005	.004T	.001
6	2-55A	Compressor Rotor Disk Spacer.	8.497	8.499			
		Disk Fourth Stage.	8.499	8.501	.000	.0045T	.001
7	2-55A	Compressor Rotor Disk Spacer.	.3815	.3825			
		Liner (Front End).	.3810	.3815	.0000	.0015	.0015
8	2-55A	Compressor Rotor Disk Spacer.	.3800	.3810			
		Liner (Rear End)	.3810	.3815	.0000	.0015T	.0000
9	2-55A	Compressor First and Second Stage Blade Side Clearance					
		First Stage Compressor Blade (FWD) . . .	.726	.736			
		Front Hub (FWD)	.737	.747	.001	.021	.021
		First Stage Compressor Blade (AFT). . . .	.460	.470			
		Front Hub (AFT)	.471	.481	.001	.021	.021
		Second Stage Compressor Blade (FWD) . .	.381	.391			
		Disk (FWD).	.392	.402	.001	.021	.021
		Second Stage Compressor Blade (AFT). . .	.245	.255			
		Disk (AFT)	.256	.266	.001	.021	.021
10	2-55A	Compressor Rotor Rear Hub	8.629	8.631			
		Disk Ninth Stage.	8.631	8.633	.000	.0045T	.001
11	2-55A	Compressor Ninth Stage Disk.	12.488	12.492			
		Airseal Ninth Stage.	12.492	12.496	.000	.008T	.000
12	2-55A	Turbine Shaft Lockring Spline.	.0444	.0458			
		Compressor Rotor Rear Hub Spline . . . . . (This clearance need not be taken at overhaul. Evidence of spline wear, so as to produce a clearance over maximum, would be controlling inspection criteria.)	.0479	.0495	.0019	.0051	.009
14	2-55A	Turbine Shaft Lock Bolt.	1.819	1.821			
		Compressor Rotor Rear Hub	1.823	1.825	.002	.006	.010
16	2-55A	Compressor Rotor Rear Hub	2.8990	2.9000			
		Rear Bearing Oil Distributing Sleeve	2.8995	2.9005	.0005T	.0015	.0015
17	2-55A	Compressor Rear Bearing Oil					
		Distributing Sleeve	3.1497	3.1502			
		Seal Face Plate	3.1507	3.1542	.0005	.0045	.0055
18	2-55A	Compressor Rear Bearing Oil					
		Distributing Sleeve	3.1497	3.1502			
		Bearing	3.1494	3.1496	.0001T	.0008T	.0001T
19	2-55A	Compressor Rotor Rear Hub Spline	.0977	.0987			
		Rear Bearing Oil Distributing Sleeve Spline (This clearance need not be taken at overhaul. Evidence of spline wear, so as to produce a clearance over maximum, would be controlling inspection criteria.)	.1007	.1017	.002	.004	.006
20	2-55A	Clearance at bolt end before tightening rear nut			.000	.030	

TABLE 2—12. COMPRESSOR AND TURBINE SECTIONS (JFTD12A)

Ref. No.	Fig. No.	Description	Dimensions For Ref. Min.	Dimensions For Ref. Max.	Limits Min.	Limits Max.	Replace
2	2—56	Compressor Rotor Front Hub	2.9544	2.9549			
		Roller Bearing	2.9525	2.9528	.0016T	.0024T	.0016T
3	2—56	Compressor Rotor Front Hub	2.9544	2.9549			
		Compressor Front Bearing Seal Spacers	2.9554	2.9567	.0005	.0023	.0033
4	2—56	Compressor Rotor Front Hub	6.397	6.399			
		Second Stage Compressor Rotor Disk	6.399	6.401	.000	.004T	.001
5	2—56	Compressor Rotor Disk Fifth Stage	9.769	9.771			
		Compressor Rotor Disk Spacers	9.771	9.773	.000	.004T	.001
6	2—56	Compressor Rotor Disk Fourth Stage	8.499	8.501			
		Compressor Rotor Air Seal	8.501	8.503	.000	.004	.004
7	2—56	Compressor Rotor Disk Fourth to Fifth Stage Spacer (Front End)	.3815	.3825			
		Compressor Rotor Disk Spacer Liner	.3810	.3815	.000	.0015	.0015
8	2—56	Compressor Rotor Disk Fourth to Fifth Stage Spacer (Rear End)	.3800	.3810			
		Compressor Rotor Disk Spacer Liner	.3810	.3815	.000	.0015T	.000
9	2—56	Compressor First Stage Blade	.941	.961			
		Compressor Rotor Front Hub	.963	.983	.001	.021	.021
10	2—56	Compressor Rotor Disk Ninth Stage	8.631	8.633			
		Compressor Rotor Rear Hub	8.629	8.631	.000	.004T	.001
11	2—56	Compressor Rotor Disk Ninth Stage	12.488	12.492			
		Compressor Rotor Rear Air Seal	12.492	12.496	.000	.004T	.000
12	2—56	Turbine Shaft Lock Splines	.0444	.0458			
		Compressor Rotor Rear Hub Splines	.0479	.0496	.0019	.0051	
14	2—56	Turbine Shaft Locking Bolt	1.819	1.821			
		Compressor Rotor Rear Hub	1.823	1.825	.002	.006	.006
15	2—56	Turbine Shaft Lock Splines	.0438	.0448			
		Turbine Shaft Lock Ring Splines	.0479	.0495	.0031	.0057	
16	2—56	Compressor Rotor Rear Hub	2.8990	2.9000			
		Compressor Rear Bearing Oil Distributing Sleeve	2.8995	2.9005	.0015	.0005T	.0015
17	2—56	Compressor Rear Bearing Oil Distributing Sleeve	3.1497	3.1502			
		Compressor Rear Bearing Seal Face Plate	3.1507	3.1542	.0005	.0045	.0055
18	2—56	Compressor Rear Bearing Oil Distributing Sleeve	3.1497	3.1502			
		Ball Bearing	3.1494	3.1496	.0001T	.0008T	.0001T
19	2—56	Compressor Rotor Rear Hub Splines	.0977	.0987			
		Compressor Rotor Bearing Oil Distributing Sleeve Splines	.1007	.1017	.002	.004	.006
20	2—56	Turbine Shaft Lock Splines	.0438	.0448			
		Turbine Shaft Locking Bolt Splines	.0479	.0495	.0031	.0057	.009
21	2—56	Compressor First Stage Vane & Shroud	17.218	17.224			
		Compressor Second Stage Vane & Shroud	17.219	17.223	.005T	.0034	

TABLE 2–12. COMPRESSOR AND TURBINE SECTIONS (JFTD12A) (continued)

Ref. No.	Fig. No.	Description	Dimensions Min.	For Ref. Max.	Limits Min.	Limits Max.	Replace
22	2–56	Compressor Second Stage Vane and Shroud Lug	.489	.493			
		Compressor Third Stage Vane and Shroud Slot	.498	.502	.005	.013	.015
23	2–56	Side Clearance Compressor Vane Outer Fifth Stage Shroud Lug	.487	.491			
		Compressor Vane Outer Sixth Stage Shroud Slot	.498	.502	.007	.015	.017
24	2–56	Compressor Vane Outer Third Stage Shroud	16.738	16.742			
		Compressor Stator Spacer	16.738	16.740	.002	.004T	.004
25	2–56	Fourth Stage Shroud	16.749	16.751			
		Compressor Stator Spacer	16.747	16.749	.000	.004T	.002
27	2–56	Compressor Vane Outer First Stage Shroud	17.7230	17.7274			
		Inlet Vane Outer Shroud Front Flange	17.718	17.722	.001	.0094	
28	2–56	Compressor Front Bearing Housing	4.221	2.222			
		Compressor Inlet Inner Case	4.219	2.221	.003T	.000	.001
29	2–56	Compressor Front Bearing	4.1329	4.1339			
		Compressor Front Bearing Housing	4.1339	4.1346	.0000	.0017	.017
30	2–56	Gap					
		Compressor Front Bearing Oil Seal Gap at 3.875 Gage	.018	.028			
		Housing	3.874	3.876	.015	.031	.031
31	2–56	Compressor Stator Spacer	18.246	18.248			
		Compressor Inlet Case	18.238	18.242	.004T	.010T	.004T
32	2–56	Compressor Inlet Case Rear Flange	19.479	19.481			
		Diffuser Case Front Flange	19.479	19.481	.002	.002T	.002
33	2–56	Fourth Vane and Shroud Support Ring	18.262	18.266			
		Diffuser Case	18.258	18.262	.000	.008T	.000
35	2–56	Fifth Stage Shroud	16.533	16.537			
		Fourth Stage Shroud	16.533	16.533	.004	.004T	.004
36	2–56	Axial Gap					
		Inlet Case Rear Flange	.099	.101			
		Fourth Vane and Shroud Support	.096	.098	.001	.005	.005
37	2–56	Bushing Sleeve Manifold Bolt	.224	.228			
		Bracket Fuel Manifold	.219	.221	.003	.009	
45	2–56	Compressor Vane Outer Ninth and Exit Stage Shroud	16.339	16.343			
		Compressor Vane Eighth Stage Shroud	16.339	16.343	.004	.004T	.004
46	2–56	Compressor Vane Outer Ninth and Exit Stage Shroud	16.759	16.763			
		Diffuser Outer Case Front Flange	16.759	16.761	.002	.004T	.002
47	2–56	(Axial Clearance)					
		Compressor Vane Outer Ninth and Exit Stage Shroud Support				.010	.010
48	2–56	Diffuser Inner Case Front Flange	13.918	13.922			
		Compressor Vane Outer Ninth and Exit Stage Shroud	13.924	13.928	.002	.010	.010

ALPHABETICAL INDEX (continued)

TABLE OF CONTENTS