ELECTRO-MOTIVE

M.I. 9669

MAINTENANCE INSTRUCTION

MODERNIZATION RECOMMENDATION

TURBOCHARGED ENGINE UPGRADE CONVERSIONS — MARINE, POWER, & DRILLING RIG —

PURPOSE: To upgrade older "E" series 645 model turbocharged engines for higher reliability and increased fuel economy.

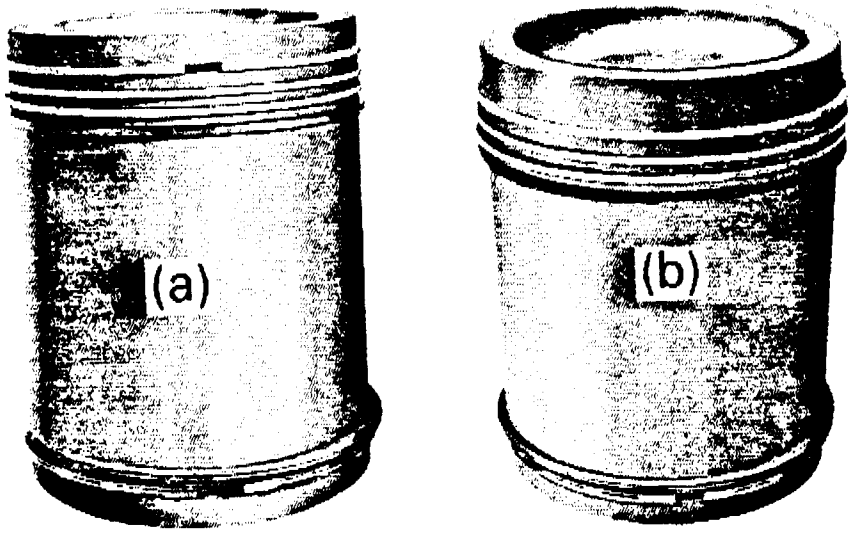
APPLICATION: Engine conversion information presented in this publication applies to "E" series 645 model turbocharged engines as listed below.

Conversion	Present	Converted
I.*	Non fire ring piston EB (i.e., 16-645E4B, 12-645E7B, etc.)	Fire ring piston EB (i.e., 16-645E4B, 12-645E7B, etc.)
II.	E (i.e., 16-645E4, 12-645E7, etc.)	As above
III.	As above	EC (i.e., 16-645E4C, etc.,)
IV.	Non fire ring piston EB	As above
V.	Fire ring piston EB	As above

*Note that the EB engine designation alone does not differentiate between non fire ring and fire ring piston application. See Fig. 1.

The fire ring refers to the top compression ring. The ring belt has been moved 1/2 inch closer to the piston crown, thereby increasing the effective length of the power stroke. As a result, the fire ring piston improves engine combustion efficiency and thermal efficiency.

M.I. 9669



Non-fire ring and fire ring pistons are distinguished on the outer skirt side by the location of the top piston ring: (a) fire ring piston; 3/4 inch. (b) non fire ring piston; 1-1/4 inch.

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Fig.1 – Piston Comparison

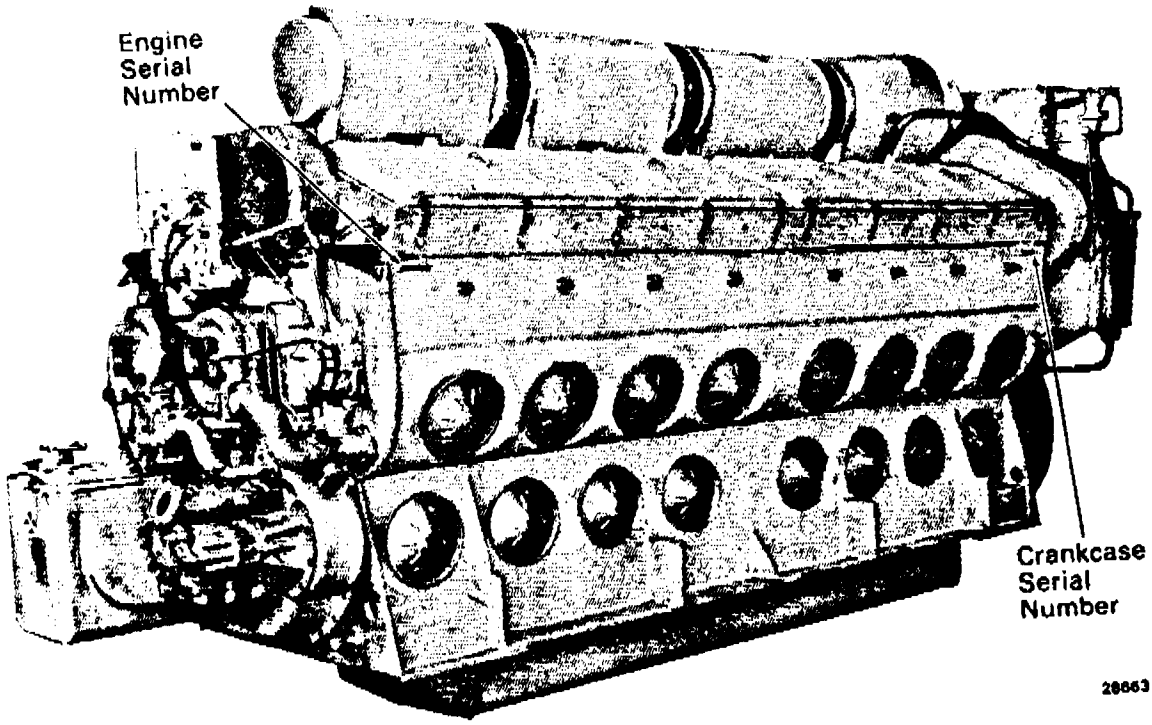

Fig.2 – Serial Number Locations

REFERENCE: Crankcase serial number considerations or part numbers of components involved in a conversion are identified in the tables listed below. Explanation of footnotes found in Tables C through G is given in Plates I and II.

Table	
A	Crankcase requirement for conversion
B	Governor rack length for marine turbocharged "E" Series engines
C	Fire ring EB and EC 8-cylinder engine turbochargers
D	Fire ring EB and EC 12-cylinder engine turbochargers
E	Fire ring EB and EC 16-cylinder engine turbochargers
F	Fire ring EB and EC 20-cylinder engine turbochargers
G	Additional components necessary for conversion
H	Power assembly components

Plate	
I	Explanation of footnotes found in 'turbocharger' Tables C - F.
II	Explanation of footnotes found in 'additional' components Table G.

Conversion I: Conversion I involves only the engine. To effect this conversion replace the 8419089 piston with the 9523619 fire ring piston. A hardened port relief and upper bore liner 9318833 or chrome liner 9090233 must accompany the fire ring piston. See also Table B for HP and governor rack information.

Conversion II thru V: These conversions involve the turbocharger and engine, including crankcase and governor.

Crankcase:

The crankcase is the main structural member of the engine. Its structural support capability for a given vintage model engine is reflected in the crankcase serial number. Crankcase serial number restrictions for a conversion are identified in Table A. See Fig. 2 for location of crankcase serial number on engine.

Governor:

Governor requirements for a conversion are presented in Table B.

Turbocharger:

Part numbers for turbochargers for EC and fire ring piston EB engines are provided in Tables C through F. Footnotes found in those tables are explained in Plate I.

Due to the various engine applications, exhaust duct design, and turbocharger gear train drive ratios, the following are steps to locate the part number for the turbocharger required.

A. Go to the appropriate 8-, 12-, 16- or 20-cylinder engine turbochargers Tables (C,D,E, or F respectively).

B. Go to the line listing the following:

1. The model of the engine to be converted.

2. The exhaust duct type (high or low) on the turbocharger on the engine to be converted. See Fig. 3.

M.I. 9669

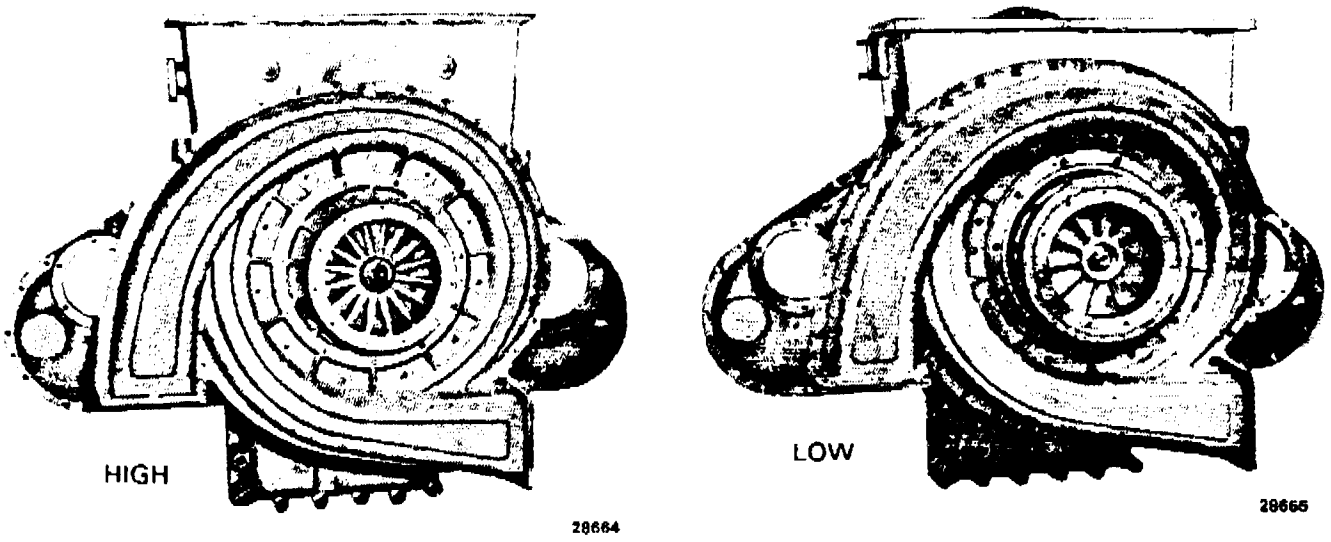

Fig.3 - High And Low Exhaust Duct Turbochargers

3. The gear train drive ratio for the turbocharger on the engine to be converted. This ratio is stamped on the turbocharger nameplate.

4. In the same line, and under the fire ring EB or EC heading (depending on the conversion being made), find the Part Number for the turbocharger to use in the conversion or find an instruction such as "go to line 5" which will lead to a Part Number.

TABLE A

CRANKCASE SERIAL NUMBER REQUIREMENT FOR CONVERSION

Engine Model (All Applications)	Crankcase Serial Number To Convert From E Turbo To EB Turbo (Fire Ring)	Crankcase Serial Number To Convert From E Turbo To EC Turbo
8-645 Turbo	Serial Number 76A And Later (January, 1976)	Same As EB With Fire Ring
12-645 Turbo	Serial Number 71D And Later (April, 1971)	Serial Number 72J And Later (September, 1972)
16-645 Turbo	Serial Number 71D And Later (April, 1971) See Note 2	Serial Number 72J And Later (September, 1972)
20-645 Turbo	Serial Number 72J And Later (September, 1972)	If Operating Only At 720 Or 750 RPM, Same As EB With Fire Ring Otherwise Serial Number 82A And Later (January, 1982)

NOTES:

1. Crankcase Serial Number is Located on Left Bank Rear End of the Engine.
2. If the Crankcase Serial Number is Earlier than 71D, the Engine Serial Number must be 73G or Later to insure that the Crankcase has been upgraded.
   There is No Restriction on reuse of Oil Pan.

TABLE B

GOVERNOR RACK LENGTH FOR TURBOCHARGED "E" SERIES MARINE ENGINE RATINGS AT 900 RPM

E7 Engines

Model	Rating BHP	Rack IN.	110% Rating BHP	Rack IN.
8	1450	0.93	1600	0.77
12	2150	0.92	2365	0.84
16	2875	0.91	3160	0.82
20	3600	~~0.86~~ .94	3960	0.79

E7B Fire Ring Engines

8	1525	0.83	1675	0.72
12	2305	0.84	2535	0.74
16	3070	0.83	3375	0.72
20	3600	0.88	3960	0.79

EC Engines

8	1525	0.85	1675	0.73
12	2305	0.88	2535	0.79
16	3070	0.86	3375	0.77
20		Model Not Available		

TABLE C

REPLACEMENT TURBOCHARGER

ENGINE CYLINDER CONFIGURATION: 8

Line No.	Engine Model	Exhaust Duct	Gear Ratio	Application	Fire Ring EB		EC
					High Exhaust Duct	Low Exhaust Duct	Low Exhaust Duct
					New/Utex	New/Utex	New/Utex
1	E4	High	19.7:1	Industrial	9096492/9317665 (2)	9554353 (5)	9546861/9551898 (5)
2	E4B	High	19.7:1	Industrial	As Above	As Above	As Above
3	E7	High	19.7:1	Marine	As Above	As Above	As Above
4	E7B	High	19.7:1	Marine	As Above	As Above	As Above
5	RE7	High	19.7:1	Marine	9503220/9526869	9554354 (5)	9546863 (5)

NOTES:

Explanation of indices is presented in Plate I.

Engine models prefixed with letter "R" indicate right-hand rotation engines; that is, clockwise rotation seen at the flywheel end. All other engines are left-hand rotation.

M.I. 9669

TABLE D

REPLACEMENT TURBOCHARGER

ENGINE CYLINDER CONFIGURATION: 12

Lin No.	Engine Model	Exhaust Duct	Gear Ratio	Application	Fire Ring EB		EC
					High Exhaust Duct New/Utex	Low Exhaust Duct New/Utex	Low Exhaust Duct New/Utex
1	E4	High	18:1	Industrial		9511706/9524135 (5)	9547270 (5)
2	E4B	High	17.9:1	Dead-Load Pick-Up	9515699/9521991 (2)	9554345 (5)	9547273/9557027 (5)
3	E4B	Low	16.8:1	Base Load	Not Applicable (4)	9531217 (5)	9547271
4	RE4B	High	17.9:1	Dead-Load Pick-Up	Not Available	9534189/9536274	9547276/9557028 (5)
5	RE4B	High	16.8:1	Base Load	9553290	9554344	9547272
6	E7	High	18:1	Marine	See Line 2	See Line 2	See Line 3
7	E7/E7B	High	16.8:1	Marine	See Line 2	See Line 2	See Line 3
8	RE7	High	18:1	Marine	Not Available	See Line 4	See Line 5
9	RE7/RE7B	High	16.8:1	Marine	Not Available	See Line 4	See Line 5
10	E9/E4B/E9B	High	16.8:1	Drill Rig Base Load		See Line 3	See Line 6

TABLE E

REPLACEMENT TURBOCHARGER

ENGINE CYLINDER CONFIGURATION: 16

Line No.	Engine Model	Exhaust Duct	Gear Ratio	Application	Fire Ring EB		EC
					High Exhaust Duct New/Utex	Low Exhaust Duct New/Utex	Low Exhaust Duct New/Utex
1	E4	High	18:1	Base Load	/9525597 (3)	9338194/9339283 (5)	9528223/9543498 (2,5)
2	E4B	High	17.9:1	Dead-Load Pick-Up	9500419/9526864 (2)	9554346 (5)	9546632/9552711 (5)
3	RE4B	High	17.9:1	Dead-Load Pick-Up	9526473/9529908	9554350 (5)	9546633/9553209 (5)
4	RE4B	High	16.8:1	Base Load	9553294	9554351 (5)	As Above
5	E7	High High	18:1 16.8:1	Marine	See Line 2	See Line 2	9528223/9543498 (2,5)
6	RE7	High High	18.2:1 16.8:1	Marine	See Line 3	See Line 3	See Line 3
	E7B	High	16.8:1	Marine	See Line 2	See Line 2	9528223/9543498 (2,5)
8	RE7B	High	16.8:1	Marine	See Line 3	See Line 3	See Line 3
9	E9	High	16.8:1	Drill Rig	9525504/9529908	9512453/9524134	9546632/9552711 (5)
10	E4B/E9B	High	16.8:1	Drill Rig Base Load	As Above	As Above	9546632/9552711 (5)
11	E10B	High	16.8:1	Base Load	9553294	9554351 (5)	9546632/9552711 (5)

M.I. 9669

TABLE F

REPLACEMENT TURBOCHARGER

ENGINE CYLINDER CONFIGURATION: 20

Line No.	Engine Model	Exhaust Duct	Gear Ratio	Application	Fire Ring EB		EC
					High Exhaust Duct	Low Exhaust Duct	Low Exhaust Duct
					New/Utex	New/Utex	New/Utex
1	E4	High	18:1	Industrial	/9525598 (3)	9338196/ (5)	9546635/9553210 (5)
2	E4B	High	17.9:1	Dead-Load Pick-Up, High Alt.	9500420/9526867	9554347/ (5)	As Above
3	RE4B	High	17.9:1	Dead-Load Pick-Up, High Alt.	9526472/9529909	Not Available	9546528/9553208 (5)
4	RE4B	High	16.8:1	Base Load, Low Alt.	9553293/	9554352/ (5)	As Above
5	E7	High	18:1 16.8:1	Marine	/9554244 (3)	9553291/ (5)	9546635/9553210 (5)
6	E7B	High	16.8:1	Marine	As Above	As Above	As Above
7	RE7	High	18.2:1 16.8:1	Marine	/9554245 (3)	9553292/ (5)	See Line 3
8	RE7B	High	16.8:1	Marine	As Above	As Above	See Line 3
9	E9	High	16.8:1	Drill Rig High Alt.	9509656/9524439	9554348 (5)	9546525/9553197
10	E4B/E9B	High	16.8:1	Base Load Drill Rig, Low Alt.	9525506/9529907	9554349 (5)	As Above
11	E10	High	16.8:1	Base Load High Alt.	See Line 9	See Line 9	As Above
12	E4B/E9B/ E10B	High	16.8:1	Base Load Drill Rig, High Alt.	See Line 9	See Line 9	As Above

M.I. 9669

TABLE G

ADDITIONAL COMPONENTS NECESSARY FOR CONVERSION

Qty. Pcs. Req. Of Pt. No. Given For Cyl. Config.				Part Number	EB Turbo With Fire Ring Piston	EC Turbo
8	12	16	20		Description Of Part Number	Description Of Part Number
15	23	31	39	9314870(1)	Universal Handhole Cover Asm. w/Handwheel	Universal Handhole Cover Asm. w/Handwheel
1	1	1	1	9314869(1)	Universal Handhole Cover Asm. w/o Handwheel	Universal Handhole Cover Asm. w/o Handwheel
1	1	1	1	9323945	Crankshaft Torsional Gear Damper	Crankshaft Torsional Gear Damper
4	6	8	10	9544257	Conn. Rod - Blade (SAE 4140)	Conn. Rod - Blade (SAE 4140)
4	6	8	10	8159138(2)	Conn. Rod - Blade (SAE 1046)	Conn. Rod - Blade (SAE 1046)
8	12	16	20	9509180	Aluminum Bronze Cylinder Head Seat Ring	Aluminum Bronze Cylinder Head Seat Ring
16	24	32	40	9317972	Water Outlet Seal Rings	Water Outlet Seal Ring
8	12	16	20	8228554	Liner Air Seal-Up Groove	Liner Air Seal-Up Groove
8	12	16	20	9316850	Liner Air Seal-Low Groove	Liner Air Seal-Low Groove
8	-	-	20	5229320(3)	Fuel Inj. (UTEX 8478053)	Fuel Inj. (UTEX 8478053)
-	12	16	-	5229335(3)	Fuel Inj. (UTEX 8478055)	Fuel Inj. (UTEX 8478055)
24	36	48	60	9319503	Cam Follower Crown Roller	Cam Follower Crown Roller
[illegible]	36	48	60	8135970(4)	Cam Follower Inner Race	Cam Follower Inner Race
[illegible]4	36	48	60	8135971(4)	Cam Follower Bushing	Cam Follower Bushing
8	12	16	20	9527320(5)	EB Fire Ring Power Asm. Less Rod	
8	12	16	20	9550599(5)		EC Power Asm. Less Rod
-	-	-	2	(6)	Camshaft Segment 8361013	8433618 Camshaft Segment
-	-	-	2	(6)	Camshaft Segment 8361012	8433602 Camshaft Segment
2	-	4	-	(6)	Camshaft Segment 8261194	8419849 Camshaft Segment
-	2	-	-	(6)	Camshaft Segment 8261442	9318994 Camshaft Segment
-	2	-	-	(6)	Camshaft Segment 8261443	9318995 Camshaft Segment
20	28	40	48	9085894(7)	Necked Down Crab Bolt	Necked Down Crab Bolt
20	28	40	48	8040808(7)	1-3/4" - 12 Hex Nut	1-3/4" - 12 Hex Nut
20	28	40	48	9319172(7)	Washer	Washer
6	8	12	16	9319170(7)	Intermediate Crab Plate	Intermediate Crab Plate
4	4	8	8	9523067(7)	End Crab Plate	End Crab Plate
-	2	-	-	9332871(7)	Center Crab Plate	Center Crab Plate

Explanation of indices is presented in Plate II.

TABLE H

POWER ASSEMBLY COMPONENTS (MINUS ROD)

1	9318833	Cyl. Liner Stud Asm.
1	9319736	Cyl. Hd. Sub. Asm.
1	8442120	Carrier Piston
1	8442226	Bearing, Insert
1	9518958	Pin, Piston*
2	9548905	Retainer, Bearing
2	9536664	Clip, Locking
2	9547667	Bolt Asm.
1	8135330	Washer, Thrust
2	8159340	Bolt Asm.
1	8442936	Gasket**
12	8384771	Insulator, Seal
12	8384772	Seal, Water
1	9516928	Ring Set, Piston
1	9338809	Piston Ring, Compression
2	8418589	Piston Ring, Compression
1	8347100	Piston Ring, Compression
1	8347103	Piston Ring, Oil Control
1	8464953	Piston Ring, Oil Control
8	8060089	Nut, 3/4"-16 Self Locking
8	8140912	Washer, Special

The above plus -

9523619 piston (14.5:1 fire ring) compose the 9527320 EB assembly with fire ring piston.

9564583 piston (16:1) with gasket 9556032 (**) compose the 9550599 EC assembly.

*Piston pin 8417645 may be used provided it is dated 80D or later.

M.I. 9669

PLATE I

NOTES RELATING TO TURBOCHARGER CHARTS

1. Early 12, 16, and 20-cylinder marine turbochargers were superseded by corresponding EB models. These early turbochargers were automatically upgraded to an EB configuration incorporating a 16.8:1 drive ratio with high-contact planetary gears when they were remanufactured.

2. Prior to the EB turbocharger consolidation, these turbochargers did not have the convertible idler gear support. Marine turbochargers require the convertible gear support, as do industrial turbochargers, to allow field modification to left or right hand rotation. Following the EB turbocharger consolidation, turbochargers can be used for either marine or industrial engines. Utex turbochargers must therefore be modified to provide this convertibility.

3. No new part number exists for this configuration. The Utex part number represents a remanufactured turbocharger which matches the design criteria for a new machine while retaining the original installation envelope.

4. This configuration will not fit the existing installation.

5. When this turbocharger is used in this installation, an adaptation is required to compensate for the 2.0 inch lower turbine exhaust duct flange. For industrial and marine engines, 2 inch high adapter 9546891 is available.

6. Whenever a turbocharger with an 18:1 drive ratio is replaced by one having a ratio of 16.8 or 17.9:1, turbo drive gear 8449232 must be installed.

PLATE II

NOTES RELATING TO TABLE G

1. EMD has adopted universal hand-hole covers 9314870 (w/handwheel) and 9314869 (w/o handwheel) as standard for turbo engines (E, EB, EC). Each cover requires gasket 8291349. These high strength covers utilize a heavy duty crossbar which is straddled by a U-shaped bracket, instead of a locating pin arrangement. The high strength cover is identified by two 1-1/4" diameter embossments on the cover face.

WARNING
On the EMD PM&I product line safety hand-hole covers may be required on the oil pan.

2. The 8159138 connecting blade rod may be used in an EB engine, provided the serial number on the rod is 80E or later or the rod is stamped "E3B" or "GP50". If not, 9544257 must be used.

3. For 750 RPM, use injector 5229325.

4. The cam follower inner race 8135970 as well as the cam follower bushing 8135971 should be replaced in the conversion.

5. See Table H.

6. If qualified the camshaft segment may be used in the conversion, otherwise use EC engine camshaft segment part number as listed.

7. The 8, 12 and 16 cylinder EB engines now incorporate as basic the cylinder head plate crab retention system. The change was made to improve the torque retention capability and to standardize the EB engines with the current production EC engine components. The plate crab will require necked down crab bolt 9085894, a 1-3/4"-12 hex nut 8040808, and washer 9319172. To apply the accessory end plate crab, minor work may be required for proper seating of the crab. 1/8" may have to be removed from the top deck head frame as shown in Fig. 4.

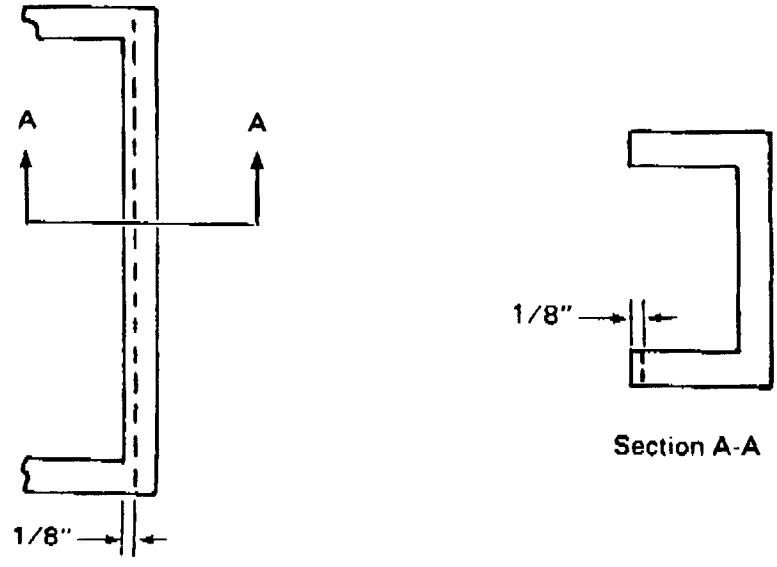

Fig.4 – Head Frame Modification