

SERVICE BULLETIN

SB00-3A

Compliance Will Enhance Safety

Supersedes SB00-3, SIL98-7,
M 89-24 And M 90-12

TECHNICAL PORTIONS
FAA APPROVED

SUBJECT: CRANKSHAFT, COUNTERWEIGHT AND CONNECTING ROD REPAIR INFORMATION

PURPOSE: Provide information that may be required by the mechanic during replacement or overhaul.

COMPLIANCE: Next Overhaul or anytime crankshaft, counterweights or connecting rods are removed.

MODELS

AFFECTED: ALL

This Service Bulletin contains:

Table 1. Engine Power Train, a list of all engine models and their major power train components.

Table 2. A history of crankshaft part numbers.

Table 3. A list of all crankshaft assemblies and their counterweight components.

Table 4. Specifications for non-current production “wide rod” crankshafts.

Table 5. Connecting Rod Specifications.

Crankshaft Counterweight Hanger Blade And Counterweight Inspection/Repair and Connecting Rod Inspection/Repair.

Use the first Table to find the crankshaft and the following tables to reference components. Use the crankshaft, counterweight and connecting rod procedures during replacement or overhaul.

Refer to the latest revision of TCM Service Bulletin SB96-7 for assembly torque values.

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TABLE 1. ENGINE POWER TRAIN

ENGINE MODEL	C/S ASSEMBLY	① CONROD	CONROD BEARING	BEARING SET	OIL CONTROL COLLAR
A-65	530199A1	A35160A2	639640	627246A2 ②530058A6	
A-75	530199A1	A35159A2	639640	627246A2 ②530058A6	
C-75	③530196A1 ④530199A1	A35160A2	639640	530058A4 530058A5	
C-85	③530196A1 ④530199A1	A35160A2	639640	530058A4 530058A5	
C-90	⑩530182	654795	639640	530058A4 530058A5	
C-145-2	530860	654795	639640	652152A1	
C-145-2H	531113	654795	639640	530516A2	
E-165	352174A2	A36121	530383	646149A1	
E-185-1,3,8,9,	537561	A36121	530383	646149A1	
E-185-1,3,8,9,	352174	A36121	530383	646149A1	
E-225-4,8	537561	A36121	530383	646149A1	
0-200-A	653012	654795	639640	627246A2	
0-200-B	653012	654795	639640	627246A2	
0-240	637069	654794	639640	637062A2	
0-300-A	530860	654795	639640	652152A1	
0-300-B	531113	654795	639640	530516A2	
0-300-C	653382	654795	639640	652152A1	
0-300-D	653382	654795	639640	652152A1	
0-470-2			No Longer Serviced		
0-470-4			No Longer Serviced		
0-470-7			No Longer Serviced		
0-470-11			No Longer Serviced		
0-470-13A			No Longer Serviced		
0-470-15			No Longer Serviced		
0-470-A	649141	655910	630826	⑤ 537401A3 ⑥ 646589A1 ⑦ 646590A1	
0-470-C	649141	655910	630826	⑤ 537401A3	
0-470-E	649141	655910	630826	⑤ 537401A3 ⑥ 646589A1 ⑦ 646590A1	
0-470-B	653697	655910	630826	⑤ 537401A3 ⑥ 646589A1	
0-470-N	653697	655910	630826	⑤ 537401A3 ⑥ 646589A1	
0-470-G	652005	655910	630826	⑦ 646591A3 ⑥ 646588A1 ⑨ 646807A1 ⑤⑧ 627795A3	626739

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TABLE 1. ENGINE POWER TRAIN (continued)

ENGINE MODEL	C/S ASSEMBLY	① CONROD	CONROD BEARING	BEARING SET	OIL CONTROL COLLAR
O-470-J	649141	655910	630826	⑤ 537401A3 ⑥ 646589A1 ⑦ 646590A2	
O-470-K	652039	655910	630826	⑤ 537401A3 ⑥ 646589A1 ⑦ 646590A2	
O-470-L	652039	655910	630826	⑤ 537401A3 ⑥ 646589A1 ⑦ 646590A2	
O-470-M	652039	655910	630826	⑤ 646807A1 ⑥ 646589A1 ⑦ 646590A2	
O-470-P	652011	655910	630826	⑦ 646591A3 ⑥ 646588A1 ⑤⑧ 627795A3	
O-470-R	649141	655910	630826	⑤ 537401A3 ⑥ 646589A1 ⑦ 646590A2	
O-470-S	649141	655910	630826	⑥ 646589A1 ⑦ 646590A2	
O-470-U	649138	655910	630826	⑥ 646589A1 ⑦ 646590A2	
GO-300-A.C.D.E	627822	654794A1	639640	626943A1	
GTSIO-520-C	653020	655910	630826	633024A2	
GTSIO-520-D	653020	655910	630826	633024A2	
GTSIO-520-H	653020	655910	630826	633024A2	
GTSIO-520-K	653020	655910	630826	633024A2	
GTSIO-520-L	653020	655910	630826	633024A2	
GTSIO-520-M	653020	655910	630826	633024A2	
GTSIO-520-N	653020	655910	630826	633024A2	
IO-240-A	653164	654793A1	642338	637062A3	
IO. IOF-240-B.	653164	654793A1	642338	637062A3	
IO-346-A	630778	655910	630826	646594A1	
IO-360-A	653138	654794A1	639640	646595A1	
IO-360-AB	653129	654793A1	642338	646597A1	
IO-360-C	653138	654794A1	639640	646595A1	
IO-360-CB	653129	654793A1	642338	646597A1	
IO-360-D	653138	654794A1	639640	646595A1	
IO-360-DB	653129	654793A1	642338	646597A1	
IO-360-ES	653129	654793A1	642338	646597A1	
IO-360-G	653139	654794A1	639640	646595A1	
IO-360-GB	653129	654793A1	642338	646597A1	
IO-360-H	653139	654794A1	639640	646595A1	
IO-360-HB	653129	654793A1	642338	646597A1	
IO-360-J	653139	654794A1	639640	646595A1	
IO-360-JB	653129	654793A1	642338	646597A1	

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TABLE 1. ENGINE POWER TRAIN (continued)

ENGINE MODEL	C/S ASSEMBLY	① CONROD	CONROD BEARING	BEARING SET	OIL CONTROL COLLAR
IO-360-K	653139	654794A1	639640	646595A1	
IO-360-KB	653129	654793A1	642338	646597A1	
IO-470-C	652011	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-D	649133	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-E	649133	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-F	649133	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-H	652011	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-J	652009	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-K	652009	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-L	652010	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-M	649133	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-N	652011	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-R	630977	A36121	530383	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-S	649133	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-U	649135	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-470-V	649135	655910	630826	⑤ 627795A3 ⑥ 646588A1 ⑦ 646591A3	626739
IO-520-A	649134	655910	630826	⑥ 646588A1 ⑦ 646591A3	626739
IO-520-B	649895	655910	630826	646593A2	629680
IO-520-BA	649896	655910	630826	646593A2	629680
IO-520-BB	649898	655911	642398	646592A2	629680
IO-520-C	649895	655910	630826	646593A2	629680

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TABLE 1. ENGINE POWER TRAIN (continued)

ENGINE MODEL	C/S ASSEMBLY	① CONROD	CONROD BEARING	BEARING SET	OIL CONTROL COLLAR
IO-520-CB	649898	655911	642398	646592A2	629680
IO-520-D	649134	655910	630826	⑥ 646588A1 ⑦ 646591A3	626739
IO-520-E	649134	655910	630826	⑥ 646588A1 ⑦ 646591A3	626739
IO-520-F	649134	655910	630826	⑥ 646588A1 ⑦ 646591A3	626739
IO-520-J	649134	655910	630826	⑥ 646588A1 ⑦ 646591A3	626739
IO-520-K	649134	655910	630826	⑥ 646588A1 ⑦ 646591A3	626739
IO-520-L	649134	655910	630826	⑥ 646588A1 ⑦ 646591A3	626739
IO-520-M ⑩	649895	655910	630826	646593A2	629680
IO-520-MB	649898	655911	642398	646592A2	629680
IO-520-P	649144-1	655910	630826	646591A4	626739
IO-550-A	649900	655911	642398	646592A2	629680
IO, IOF-550-B	649900	655911	642398	646592A2	629680
IO-550-B29, B33, B37	649900	655002	642398	646592A2	629680
IO, IOF-550-C	649900	655911	642398	646592A2	629680
IO-550-C25, C29, C30	649900	655002	642398	646592A2	629680
IO, IOF-550-D	646623	655911	642398	646592A2	626739
IO, IOF-550-E	646623	655911	642398	646592A2	626739
IO, IOF-550-F	646623	655911	642398	646592A2	626739
IO, IOF-550-G	649900	655911	642398	646592A2	629680
IO, IOF-550-L	646623	655911	642398	646592A2	626739
IO, IOF-550-N	649900	655911	642398	646592A2	629680
IO, IOF-550-P	649900	655911	642398	646592A2	629680
IO, IOF-550-R	649900	655911	642398	646592A2	629680
LIO-520-P	649144-2	655000	630826	646591A4	626739
LTSIO-360-E	653137	654794	639640	646596A1	
LTSIO-360-EB	653136	654793	642338	646597A1	
LTSIO-360-KB	653136	654793	642338	646597A1	
LTSIO-360-RB	653136	654793	642338	646597A1	
LTSIO-520-AE	649144-2	655000	630826	646591A4	626739
TSIO-360-A	653138	654794	639640	646595A1	
TSIO-360-AB	653129	654793	642338	646597A	
TSIO-360-B	653138	654794	639640	646595A1	
TSIO-360-C	653139	654794	639640	646595A1	
TSIO-360-CB	653129	654793	642338	646597A1	
TSIO-360-D	653139	654794	639640	646595A1	

TABLE 1. ENGINE POWER TRAIN (continued)

ENGINE MODEL	C/S ASSEMBLY	① CONROD	CONROD BEARING	BEARING SET	OIL CONTROL COLLAR
TSIO-360-DB	653129	654793	642338	646597A1	
TSIO-360-E	653139	654794	639640	646595A1	
TSIO-360-EB	653129	654793	642338	646597A1	
TSIO-360-F	653139	654794	639640	646595A1	
TSIO-360-FB	653129	654793	642338	646597A1	
TSIO-360-G	653139	654794A1	639640	646595A1	
TSIO-360-GB	653129	654793	642338	646597A1	
TSIO-360-H	653139	654794	639640	646595A1	
TSIO-360-HB	653129	654793	642338	646597A1	
TSIO-360-JB	653129	654793	642338	646597A1	
TSIO-360-KB	653129	654793	642338	646597A1	
TSIO-360-LB	653129	654793	642338	646597A1	
TSIO-360-MB	653129	654793	642338	646597A1	
TSIO-360-RB	653129	654793	642338	646597A1	
TSIO-360-SB	653129	654793	642338	646597A1	
TSIO-470-B	652011	646437A2	630826	⑤ 627795A3 ⑥ 646588A1	626739
TSIO-470-C	652011	646437A2	630826	⑤ 627795A3 ⑥ 646588A1	626739
TSIO-470-D	652348	646437A2	630826	⑤ 627795A3 ⑥ 646588A1	626739
TSIO-520-AE	649144-1	655000	630826	646591A4	626739
TSIO-520-AF	649134	655004	630826	⑦ 646591A3	626739
TSIO-520-B	649895	655004	630826	646593A2	629680
TSIO-520-BB	649898	655005	642398	646592A2	629680
TSIO-520-BE	649898	655005	642398	646592A2	629680
TSIO-520-C	649134	655004	630826	⑥ 646588A1 ⑦ 646591A3	626739
TSIO-520-CE	649148	655001	642398	646592A2	626739
TSIO-520-D	649895	655004	630826	646593A2	629680
TSIO-520-E	649895	655004	630826	646593A2	629680
TSIO-520-EB	649898	655005	642398	646592A2	629680
TSIO-520-G	649134	655004	630826	⑥ 646588A1 ⑦ 646591A3	626739
TSIO-520-H	649134	655004	630826	⑥ 646588A1 ⑦ 646591A3	626739
TSIO-520-J	649895	655004	630826	646593A2	629680
TSIO-520-JB	649898	655005	642398	646592A2	629680
TSIO-520-K	649895	655004	630826	646593A2	629680
TSIO-520-KB	649898	655005	642398	646592A2	629680
TSIO-520-L	649895	655004	630826	646593A2	629680
TSIO-520-LB	649898	655005	642398	646592A2	629680
TSIO-520-M	649134	655004	630826	⑥ 646588A1 ⑦ 646591A3	626739
TSIO-520-N	649895	655004	630826	646593A2	629680
TSIO-520-NB	649898	655005	642398	646592A2	629680
TSIO-520-P	649134	655004	630826	⑥ 646588A1 ⑦ 646591A3	626739

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TABLE 1. ENGINE POWER TRAIN (continued)

ENGINE MODEL	C/S ASSEMBLY	① CONROD	CONROD BEARING	BEARING SET	OIL CONTROL COLLAR
TSIO-520-R	649134	655004	630826	⑥ 646588A1 ⑦ 646591A3	626739
TSIO-520-T	649134	655004	630826	⑥ 646588A1 ⑦ 646591A3	626739
TSIO-520-UB	649898	655005	642398	646592A2	629680
TSIO-520-	655213	655006	642398	646592A2	629680
TSIO-520-VB	649898	655005	642398	646592A2	629680
TSIO-520-WB	649898	655005	642398	646592A2	629680
TSIO-550-A	649900	655001	642398	646592A2	629680
TSIO-550-B	649900	655001	642398	646592A2	629680
TSIO, TSIOF-550C	649900	655001	642398	646592A2	629680
TSIO, TSIOF-550-E	649900	655001	642398	646592A2	629680
TSIOL-550-A	652359	655001	642398	646592A2	629680
TSIOL-550-B	652359	655001	642398	646592A2	629680
TSIOL-550-C	652359	655001	642398	646592A2	629680

FOOT NOTES:

- ① See Table 5 for new and old connecting rod part numbers and hardware to connecting rod specified usage.
- ② With 633141 thrust washer.
- ③ Tapered crankshaft with removable prop flange.
- ④ Flange (prop) type crankshaft.
- ⑤ Has flange type bearing for use with Phase 1 style crankcase and crankshaft. See TCM Service Bulletin M78-9 or latest revision.
- ⑥ Thrust washer type bearings for use with Phase 2 style crankcase and crankshaft. See TCM Service Bulletin M78-9 or latest revision.
- ⑦ For use with Phase 3 style crankcase and crankshaft. See TCM Service Bulletin M78-9 or latest revision.
- ⑧ For 0-470-G engines with modernized crankshafts using oil transfer collar.
- ⑨ For 0-470-G engines with modified crankshafts. Remove and discard nylon wipers for 0470G.
- ⑩ Non-Production Engine

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TABLE 2. CRANKSHAFT ASSEMBLY PART NUMBER HISTORY

SPEC.	CRANKSHAFT ASSEMBLY	SUPERSEDES	SUPERSEDES	SUPERSEDES	SUPERSEDES
O-200-A	653012	531434			
O-200-B	653012	531434			
O-300-A	530860				
O-300-C	① 653382	652110	628124		
O-300-D	② 653382	652110	628124		
O-470-A	649141	633225	537290		
O-470-B	653697	633227	539576		
O-470-C	649141	633225	537290		
O-470-E	649141	633225	537290		
O-470-F	649141	633225	537290		
O-470-G	652005	633256			
O-470-J	649141	633225	537290		
O-470-K	652039	633219	539665		
O-470-L	652039	633219	539665		
O-470-M	652039	633219	539665		
O-470-N	653697	633227	539576		
O-470R	649141	633225	537290		
O-470-S	649141	633225			
O-470-U	649138	643911	641905		
GO-300-A, C, D, E	627822				
GIO-550-A ③	652800A1				
GTSIO-520-C	653020	652832	652821	652001	635104
GTSIO-520-D	653020	652832	652821	652001	635104
GTSIO-520-H	653020	652832	652821	652001	635104
GTSIO-520-K	653020	652832	652821	652001	635104
GTSIO-520-L	653020	652832	652821	652001	635104
GTSIO-520-M	653020	652832	652821	652001	635104
GTSIO-520-N	653020	652832	652821	652001	635104
IO-240-A	653164				
IO, IOF-240-B	653164				
IO-346-A	630778				
IO-360-A	653138	652047	649785	639200	634479
IO-360-AB	653129	652014	643627	642350	
IO-360-C	653138	652047	649785	639200	634479
IO-360-CB	653129	652014	643627	642350	
IO-360-D	653138	652047	649785	639200	634479
IO-360-DB	653129	652014	643627	642350	
IO-360-ES	653129				
IO-360-G	653139	652048	639786		
IO-360-GB	653129	652014	643627	642350	

TABLE 2. CRANKSHAFT ASSEMBLY PART NUMBER HISTORY (continued)

SPEC.	CRANKSHAFT ASSEMBLY	SUPERSEDES	SUPERSEDES	SUPERSEDES	SUPERSEDES
IO-360-H	653139	652048	639786		
IO-360-HB	653129	652014	643627	642350	
IO-360-J	653139	652048	639786		
IO-360-JB	653129	652014	643627	642350	
IO-360-K	653139	652048	639786		
IO-360-KB	653129	652014	643627	642350	
IO-470-C	652011	652006	633258	626784	
IO-470-D	649133	630927	627530		
IO-470-E	649133	630927	627530		
IO-470-F	649133	630927	627530		
IO-470-G	649133	630927	627530		
IO-470-H	652011	652008	628995	630977	627348
IO-470-J	652009	643089	633246	628358	
IO-470-K	652009	643089	633246	628358	
IO-470-L	652010	643090	630886	628694	
IO-470-M	649133	630927	627530		
IO-470-N	652011	652006	643091	630932	629309
IO-470-P	629882				
IO-470-R	630977	629366			
IO-470-S	649133	630927	627530		
IO-470-U	649135	632195			
IO-470-V	649135	632195			
IO-520-A	649134	631716			
IO-520-B	649895	633620			
IO-520-BA	649896	639243			
IO-520-BB	649898	646438	642396		
IO-520-C	649895	633620			
IO-520-CB	649898	646438	642396		
IO-520-D	649134	631716			
IO-520-E	649134	631716			
IO-520-F	649134	631716			
IO-520-J	649134	631716			
IO-520-K	649134	631716			
IO-520-L	649134	631716			
IO-520-M	649895	633620			
IO-520-MB	649898	646438	642396		
IO-520-P	649144-1				
IO-550-A	649900	646604			
IO, IOF-550-B	649900	646604			
IO, IOF-550-C	649900	646604			
IO, IOF-550-D	646623				
IO, IOF-550-E	646623				
IO, IOF-550-F	646623				
IO, IOF-550-G	649900				
IO, IOF-550-L	646623				

TABLE 2. CRANKSHAFT ASSEMBLY PART NUMBER HISTORY (continued)

SPEC.	CRANKSHAFT ASSEMBLY	SUPERSEDES	SUPERSEDES	SUPERSEDES	SUPERSEDES
IO-550-M ③	654359				
IO, IOF-550-N	649900				
IO, IOF-550-P	649900				
IO, IOF-550-R	649900				
LIO-520-P	649144-2				
LTSIO-360-E	653137	652045	641382		
LTSIO-360-EB	653136	652015	643633		
LTSIO-360-KB	653136	652015	643633		
LTSIO-360-RB	653136				
LTSIO-520-AE	649144-2	643126-1			
TSIO-360-A	653138	652047	649785	639200	634479
TSIO-360-AB	653129	652014	643627	642350	
TSIO-360-B	653138	652047	649785	639200	634479
TSIO-360-C	653139	652048	639786		
TSIO-360-CB	653129	652014	643627	642350	
TSIO-360-D	653139	652048	639786		
TSIO-360-DB	653129	652014	643627	642350	
TSIO-360-E	653139	652048	639786		
TSIO-360-EB	653129	652015	643633	642376	
TSIO-360-F	653139	652048	639786		
TSIO-360-FB	653129	652014	643627	642350	
TSIO-360-G	653139	652048	639786		
TSIO-360-GB	653129	652014	643627	642350	
TSIO-360-H	653139	652048	639786		
TSIO-360-HB	653129	652014	643627	642350	
TSIO-360-JB	653129	652014	643627	642350	
TSIO-360-KB	653129	652015	643633	642376	
TSIO-360-LB	653129	652014	643627	642350	
TSIO-360-MB	653129	652014	643627		
TSIO-360-RB	653129				
TSIO-360-SB	653129				
TSIO-470-B	652011	652008	628995		
TSIO-470-C	652011	652008	628995		
TSIO-470-D	652348	652007	632494		
TSIO-520-AE	649144-1	643126			
TSIO-520-AF	649134	631716			
TSIO-520-B	649895	633620			
TSIO-520-BB	649898	646438	642396		
TSIO-520-BE	649898	646438	642396		
TSIO-520-C	649134	631716			
TSIO-520-CE	649148	646683			
TSIO-520-D	649895	633620			
TSIO-520-E	649895	633620			
TSIO-520-EB	649898	646438	642396		
TSIO-520-G	649134	631716			
TSIO-520-H	649134	631716			
TSIO-520-J	649895	633620			

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TABLE 2. CRANKSHAFT ASSEMBLY PART NUMBER HISTORY (continued)

SPEC.	CRANKSHAFT ASSEMBLY	SUPERSEDES	SUPERSEDES	SUPERSEDES	SUPERSEDES
TSIO-520-T	649134	631716			
TSIO-520-UB	649898	646438	642396		
TSIO-520-VB	649898	646438	642396		
TSIO0520-WB	649898	646438	642396		
TSIO-550-A	649900				
TSIO-550-B	649900				
TSIO, TSIOF-550-C	649900				
TSIO, TSIOF-550-E	649900				
TSIOL-550-A	652359				
TSIOL-550-B	652359				
TSIOL-550-C	652359				

- ① 653382 Crankshaft, 653381 Gear and 4 each 630692 Screws must be used together.
- ② 653382 Crankshaft, 630690 Gear and 4 each 630692 Screws must be used together.
- ③ Used in non-production engines only.

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02	02	2000	10	29	2004			

TABLE 3. CRANKSHAFT ASSEMBLIES

C/S ASSY.	HNGR. BLD. BUSH. ③	BUSH. I.D.	CWT. QTY.	C/S CWT.	CWT. BUSH.	BUSH. I.D.	CHEEK LOC.	CWT. PIN	PIN DIA.	CWT. ORDER	RET. PLATE	RET. RING
530860	531015 &	<u>.4613</u> .4643	1	531017	531016	<u>.4613</u> .4643	2	630261-15	<u>.3758</u> .3768	5	530868	402805
	530863	<u>.435</u> .438	1	530864	530866	<u>.435</u> .438	2	②		6		-3
531113	531015 &	<u>.4613</u> .4643	1	531017	531016	<u>.4613</u> .4643	2	630261-15	<u>.3758</u> .3768	5	530868	402805
	530863	<u>.435</u> .438	1	530864	530866	<u>.435</u> .438	2	②		6		-3
627822	626566	<u>.732</u> .739	2	627821	626564	<u>.732</u> .739	2	630261-11	<u>.491</u> .492	3	633976	629004
			2				5			3		
			2				8			3		
628124	531015 &	<u>.4613</u> .4643	1	531017	531016	<u>.4613</u> .4643	2	630261-15	<u>.3758</u> .3768	5	530868	402805
	530863	<u>.435</u> .438	1	530864	530866	<u>.435</u> .438	2	②		6		-3
646623	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-105	<u>.565</u> .566	6	643629	629104
			1	639196		5	643626-103	<u>.474</u> .475	4			
			1	639196		5	643626-104	<u>.527</u> .528	5			
649133	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104
			2	639195		5			6			
649134	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104
			1	639196		5	643626-103	<u>.474</u> .475	4			
			1	639196		5	643626-104	<u>.527</u> .528	5			
649135	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104
			1	639196		5	643626-104	<u>.527</u> .528	5			
			1	639196		5	643626-106	<u>.507</u> .508	4 1/2			
649138	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104
			1	639195		5	643626-104	<u>.527</u> .528	5			
			1	639195		5	643626-106	<u>.507</u> .508	4 1/2			
649141	350998	<u>.622</u> .626	1	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104
			1	639195		2	643626-104	<u>.527</u> .528	5			
649144-1	350998	<u>.622</u> .626	1	639195	639193	<u>.622</u> .626	2	643626-104	<u>.527</u> .528	5	643629	629104
			1	639195		2	643626-105	<u>.565</u> .566	6			
649144-2	350998	<u>.622</u> .626	1	639195	639193	<u>.622</u> .626	2	643626-104	<u>.527</u> .528	5	643629	629104
			1	639195		2	643626-105	<u>.565</u> .566	6			
649148	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-105	<u>.565</u> .566	6	643629	629104
			1	639196		5	643626-103	<u>.474</u> .475	4			
			1	639196		5	643626-104	<u>.527</u> .528	5			

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TABLE 3. CRANKSHAFT ASSEMBLIES (continued)

C/S ASSY.	HNGR. BLD. BUSH ③	BUSH I.D.	CWT. QTY.	C/S CWT.	CWT. BUSH.	BUSH I.D.	CHEEK LOC.	CWT. PIN	PIN DIA.	CWT. ORDER	PLATE	RET. RING	
649895	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104	
			1	639196		5	643626-103	<u>.474</u> .475	4				
			1	639196		5	643626-104	<u>.527</u> .528	5				
649896	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104	
			1	639196		5	643626-101	<u>.556</u> .557	6				
			1	639196		5	643626-103	<u>.474</u> .475	4				
649898	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-105	<u>.565</u> .566	6	643629	629104	
			1	639196		5	643626-103	<u>.474</u> .475	4				
			1	639196		5	643626-104	<u>.527</u> .528	5				
649900	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-105	<u>.565</u> .566	6	643629	629104	
			1	639196		5	643626-103	<u>.474</u> .475	4				
			1	639196		5	643626-104	<u>.527</u> .528	5				
652005	350998	<u>.622</u> .626	1	639197	639193	<u>.622</u> .626	2	643626-105	<u>.565</u> .566	6	643629	629104	
			1	639197		2	643626-108	<u>.594</u> .595	4				
652009	350998	<u>.622</u> .626	1	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104	
			1	639195		2	643626-104	<u>.527</u> .528	5				
652010	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104	
			2	639195		5	643626-104	<u>.527</u> .528	5				
652011	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104	
			2	639195		5			6				
652039	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104	
			2	639195		5			6				
652348	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-101	<u>.556</u> .557	6	643629	629104	
			1	639196		5	643626-103	<u>.474</u> .475	4				
			1	639196		5	643626-104	<u>.527</u> .528	5				
652359	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-105	<u>.565</u> .566	6	643629	629104	
			1	639196		5	643626-103	<u>.474</u> .475	4				
			1	639196		5	643626-106	<u>.507</u> .508	4 1/2				
653020	628975	<u>.754</u> .757	2	652833	628978	<u>.754</u> .757	2	643626-104	<u>.527</u> .528	3	631808	629004	
			2			5			3				
			2			8			3				
653129	639580	<u>.604</u> .607	1	639199	639198	<u>.604</u> .607	2	643626-110	<u>.498</u> .499	4 1/2	653143	629004	
			1	639199		2	643626-111	<u>.552</u> .553	6				

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TABLE 3. CRANKSHAFT ASSEMBLIES (continued)

C/S ASSY.	HNGR. BLD. BUSH ③	BUSH I.D.	CWT. QTY.	C/S CWT.	CWT. BUSH.	BUSH I.D.	CHEEK LOC.	CWT. PIN	PIN DIA.	CWT. ORDER	PLATE	RET. RING
653136	639580	<u>.604</u> .607	1	639199	639198	<u>.604</u> .607	2	643626-110	<u>.498</u> .499	4 1/2	653143	629004
			1	639199			2	643626-111	<u>.552</u> .553	6		
653137	639580	<u>.604</u> .607	1	639199	639198	<u>.604</u> .607	2	643626-110	<u>.498</u> .499	4 1/2	653143	629004
			1	639199			2	643626-111	<u>.552</u> .553	6		
653138	639580	<u>.604</u> .607	1	639199	639198	<u>.604</u> .607	2	643626-109	<u>.545</u> .546	6	653143	629004
			1	639199			2			6		
653139	639580	<u>.604</u> .607	1	639199	639198	<u>.604</u> .607	2	643626-110	<u>.498</u> .499	4 1/2	653143	629004
			1	639199			2	643626-111	<u>.552</u> .553	6		
653382	639580	<u>.604</u> .607	1	639199	639198	<u>.604</u> .607	2	643626-112	<u>.520</u> .521	5	653143	629004
			1	639199			2	643626-112		5		
653697	350998	<u>.622</u> .626	2	639195	639193	<u>.622</u> .626	2	643626-105	<u>.565</u> .566	6	643629	629104
			2	639195			5	643626-105	<u>.565</u> .566	6		
652800A1 ①	628975	<u>.754</u> .757	2	652833	628978	<u>.754</u> .757	2	643626-104	<u>.527</u>	3	652594	629004
			2	652833			5		.528	3		
			2	652833			8			3		
654359 ①	350998	<u>.622</u> .626	1	639195	639193	<u>.622</u> .626	2	643626-105	<u>.565</u>	6	643629	629104
			1				2		.566	6		

① Used in non-production engines only.

② If replacing 630261 pin with 643626 pin the 643629 plate must be used.

③ Replacement crankshaft blade bushing may be purchased in standard and oversize dimensions as listed below:

Crankshaft Blade Bushing P/N	STANDARD	P .0015	P .003	P .005	P .010	P .015
350998	AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE
530863	AVAILABLE	N/A	AVAILABLE	AVAILABLE	N/A	N/A
531015	AVAILABLE	N/A	AVAILABLE	AVAILABLE	N/A	N/A
537038	AVAILABLE	N/A	N/A	N/A	N/A	N/A
626566	AVAILABLE	N/A	N/A	AVAILABLE	N/A	N/A
628975	AVAILABLE	N/A	AVAILABLE	AVAILABLE	AVAILABLE	N/A
639580	AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE	AVAILABLE

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TABLE 4. WIDE ROD CRANKSHAFTS
(NOT CURRENT PRODUCTION)

C/S ASSEMBLY	HNGR. BLD. BUSH	BUSH I.D.	CWT. QTY.	C/S ① CWT..	CWT. ② BUSH.	BUSH I.D.	CHEEK LOC.	CWT. PIN ⑤	PIN DIA.	CWT. ORDER	PLATE ③	RET. ④ RING
352174 (E-185-1,3,8,9,11)	350996	<u>.622</u> .626	2	352117	350977	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
537561 (E-185-1,3,8,9,11 & E-225-4,8)	350998	<u>.622</u> .626	1	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	537038	<u>.6534</u> .6554	1	537049	537044	<u>.6534</u> .6554	2	630261-4	<u>.5554</u> .5574	5		
537290 (O-470-A,C,E,F,J & R)	350998	<u>.622</u> .626	1	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	537038	<u>.6534</u> .6554	1	537049	537044	<u>.6534</u> .6554	2	630261-4	<u>.5554</u> .5574	5		
539576 (O-470-B & N)	350998	<u>.622</u> .626	1	352117	350997	<u>.622</u> .626	2	630261-2	<u>.5652</u> .5662	6	352115	352116
	537038	<u>.6534</u> .6554	1	537049	537044	<u>.6534</u> .6554	2	630261-1	<u>.5947</u> .5967	6		
627576 (O-470-G)	350998	<u>.622</u> .626	1	352117	350997	<u>.622</u> .626	2	630261-5	<u>.5931</u> .5951	9	352115	352116
	537038	<u>.6534</u> .6554	1	625818	625817	<u>.6483</u> .6523	2	630261-5	<u>.5931</u> .5951	6		
539665 (O-470-K,L,M)	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	5	630261-4	<u>.5554</u> .5574	6		
627587 (O-470-P)	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	5	630261-4	<u>.5554</u> .5574	6		
626784 (IO-470-C)	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	5	630261-4	<u>.5554</u> .5574	6		
627530 (IO-470-D, E,F,G,M, & S)	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	5	630261-4	<u>.5554</u> .5574	6		
627348 (IO-470-H)	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	5	630261-4	<u>.5554</u> .5574	6		
629366 (IO-470-R)	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	5	630261-4	<u>.5554</u> .5574	6		
629882 (IO-470-P,T)	350998	<u>.622</u> .626	1	352117	350997	<u>.622</u> .626	2	630261-2	<u>.5554</u> .5574	6	352115	352116
	350998	<u>.622</u> .626	1	352117	350997	<u>.622</u> .626	2	630261-2	<u>.5554</u> .5574	6		


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TABLE 4. WIDE ROD CRANKSHAFTS (continued)
(NOT CURRENT PRODUCTION)

C/S ASSEMBLY	HNGR. BLD. BUSH	BUSH I.D.	CWT. QTY.	C/S. ① CWT.	CWT. ② BUSH.	BUSH I.D.	CHEEK LOC.	CWT. PIN	PIN DIA.	CWT. ORDER	PLATE ③	RET. ④ RING
628358 (IO-470-J,K)	350998	<u>.622</u> .626	1	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	537038	<u>.6534</u> .6554	1	537049	537044	<u>.6534</u> .6554	2	630261-4	<u>.5554</u> .5574	5		
628694 (IO-470-L)	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	5	630261-3	<u>.527</u> .528	5		
629309 (IO-470-N)	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	2	630261-4	<u>.5554</u> .5574	6	352115	352116
	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	5	630261-4	<u>.5554</u> .5574	6		
632195 (IO-470-U & V)	350998	<u>.622</u> .626	2	352117	350997	<u>.622</u> .626	2	630261-4	<u>.622</u> .626	6	352115	352116
	350998	<u>.622</u> .626	1	631968	350997	<u>.622</u> .626	5	630261-3	<u>.622</u> .626	5		
	350998	<u>.622</u> .626	1	631968	350997	<u>.622</u> .626	5	630261-32	<u>.622</u> .626	4 1/2		

- ① Counterweight P/N 352117 superseded by P/N 639195
Counterweight P/N 537049 superseded by P/N 639205; P/N 639205 superseded by P/N 639205A1
Counterweight P/N 625818 superseded by P/N 639210; P/N 639210 superseded by P/N 639210A1
- ② Bushing P/N 350997 superseded by 639193
Bushing P/N 537044 superseded by 639204
- ③ Plate P/N 352115 superseded by P/N 629105; P/N 629105 superseded by P/N 635623;
P/N 635623 superseded by P/N 643629
- ④ Snap Ring P/N 352116 superseded by P/N 629104
- ⑤ Counterweight Suppression: When using P/N 630621-pins you must use P/N 635623 retainer plates
 When using P/N 643626-pins you must use P/N 643629 retainer plates

Original Part Number	Pin Diameter	Superseded Part Number	Pin Diameter	Current Part Number	Pin Diameter
630261-4	.5554 - .5574	630261-35	.5559 - .5569	643626-101	.556 - .557
630261-27	.474 - .475	630261-38	.474 - .475	643626-103	.474 - .475
630261-3	.5270 - .5280	630261-37	.5270 - .5280	643626-104	.527 - .528
630261-2	.5652 - .5662	630261-40	.5652 - .5662	643626-105	.565 - .566
630261-32	.507 - .508	630261-39	.507 - .508	643626-106	.507 - .508
N/A	N/A	630261-34	.4902 - .4906	643626-107	.490 - .491
630261-5	.5931 - .5951	630261-36	.5931 - .5951	643626-108	.594 - .595
N/A	N/A	630261-41	.545 - .546	643626-109	.545 - .546
N/A	N/A	630261-43	.498 - .499	643626-110	.498 - .499
N/A	N/A	630261-44	.552 - .553	643626-111	.552 - .553
N/A	N/A	N/A	N/A	643626-112	.520 - .521
630261-11	.4916 - .4921	N/A	N/A	N/A	N/A
630261-15	.3758 - .3768	N/A	N/A	N/A	N/A
630261-17	.6700 - 6710	N/A	N/A	N/A	N/A

COUNTERWEIGHT IDENTIFICATION SEE FIGURES 1A THROUGH 1 I.

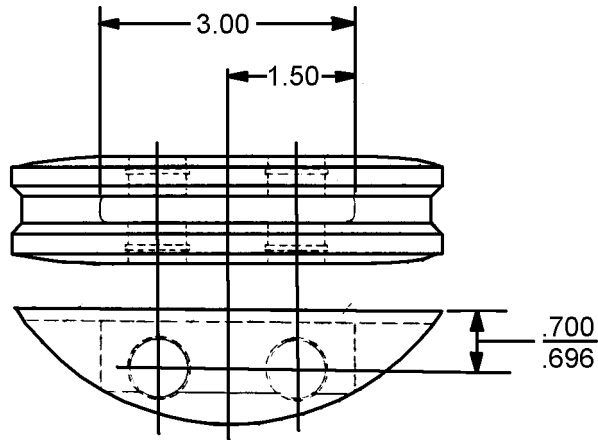


FIGURE 1A. 530864 COUNTERWEIGHT ASSEMBLY MADE WITH 530865 COUNTERWEIGHT AND 530866 BUSHINGS

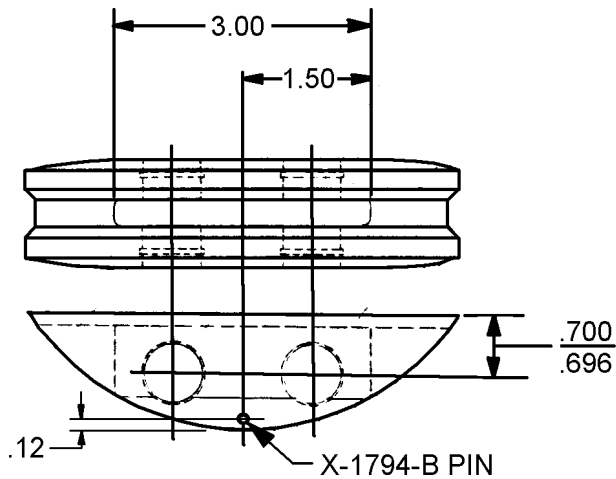


FIGURE 1B. 531017 COUNTERWEIGHT ASSEMBLY MADE WITH 530865 COUNTERWEIGHT AND 531016 BUSHINGS

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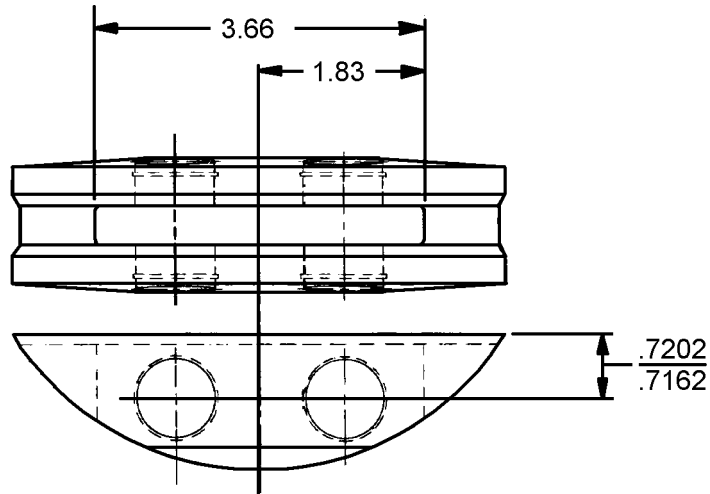


FIGURE 1C. 639196 COUNTERWEIGHT ASSEMBLY MADE WITH 631903 COUNTERWEIGHT AND 639193 BUSHINGS

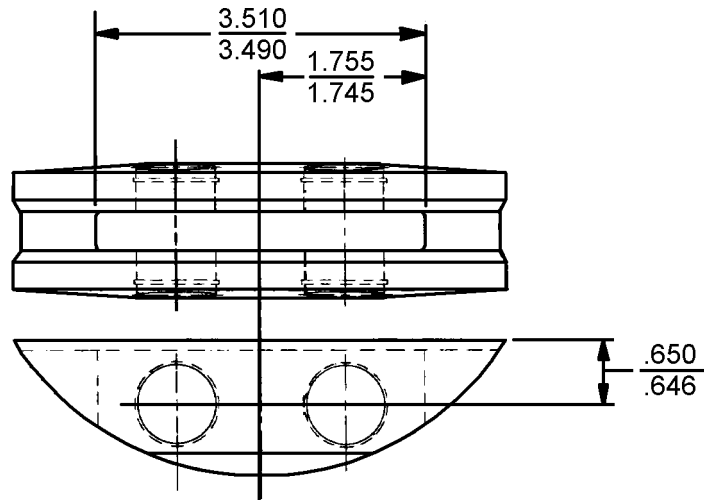


FIGURE 1D. 639197 COUNTERWEIGHT ASSEMBLY MADE WITH 633339 COUNTERWEIGHT AND 639193 BUSHINGS

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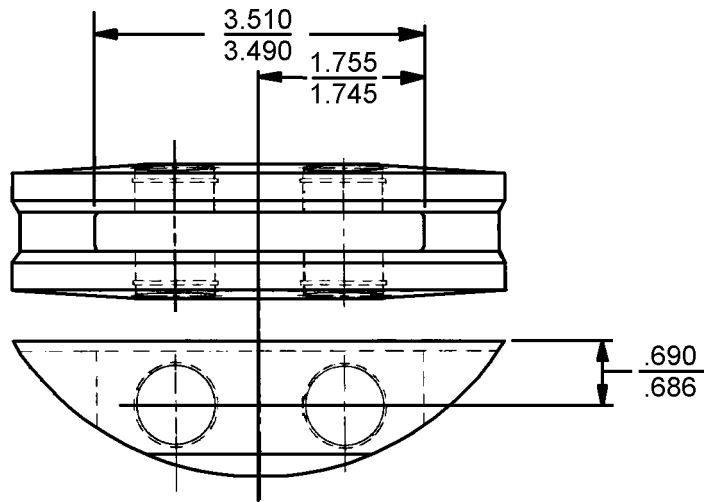


FIGURE 1E. 639195 COUNTERWEIGHT ASSEMBLY MADE WITH 351000 COUNTERWEIGHT AND 639193 BUSHINGS

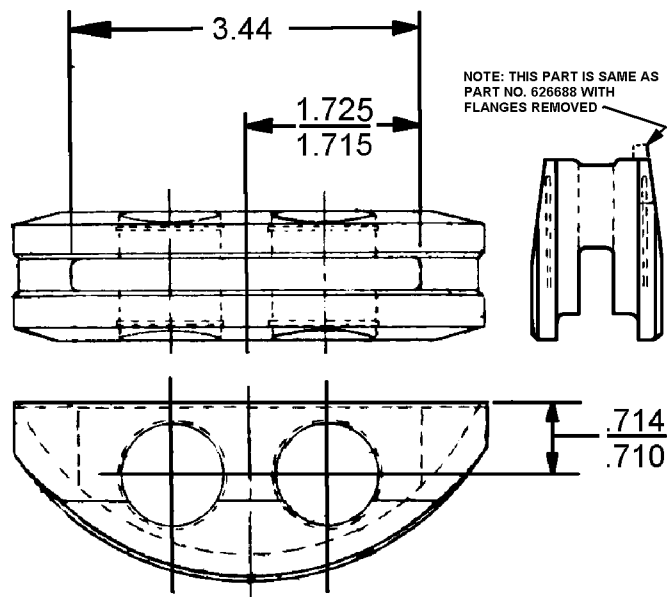


FIGURE 1F. 639199 COUNTERWEIGHT ASSEMBLY MADE WITH 629693 COUNTERWEIGHT AND 639198 BUSHINGS

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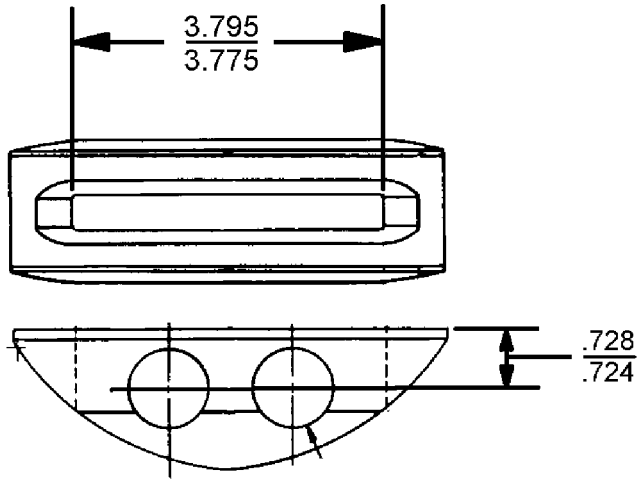


FIGURE 1G. 652833 COUNTERWEIGHT ASSEMBLY MADE WITH 652834 COUNTERWEIGHT AND 628978 BUSHINGS

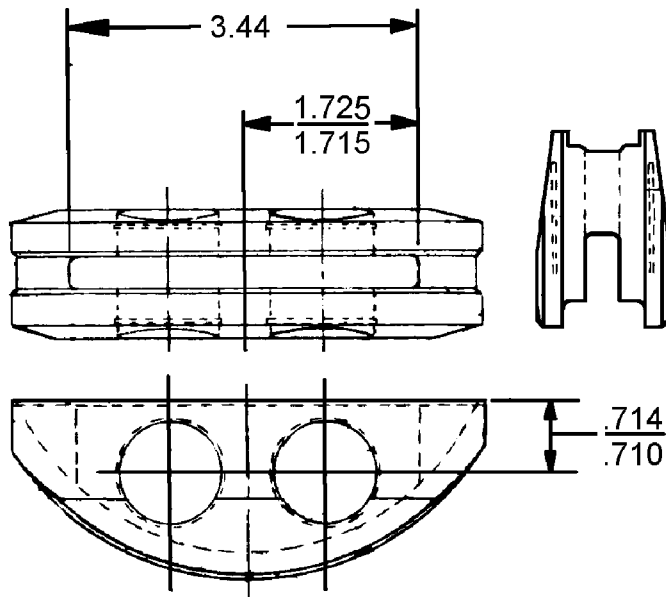


FIGURE 1H. 627821 COUNTERWEIGHT ASSEMBLY MADE WITH 626688 COUNTERWEIGHT AND 626564 BUSHINGS

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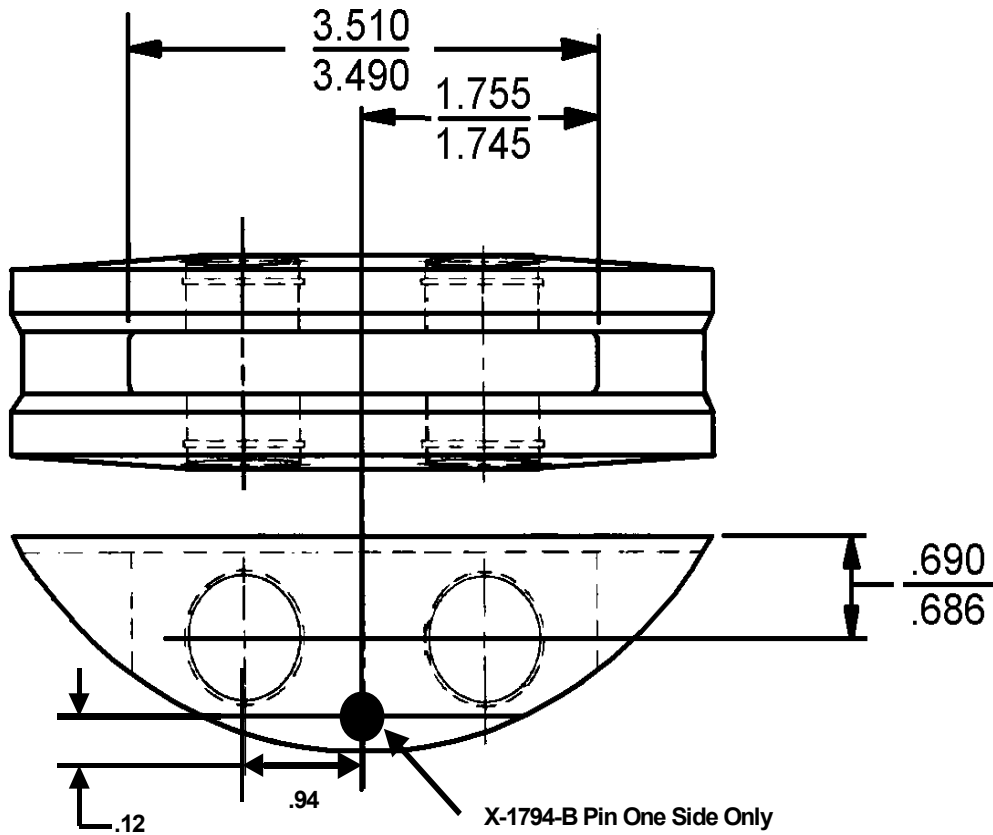


FIGURE 1 I. 639205 & 639210 COUNTERWEIGHT ASSEMBLY MADE WITH 351000 COUNTERWEIGHT
639205 COUNTERWEIGHT USES 639204 BUSHINGS
639210 COUNTERWEIGHT USES 630209 BUSHINGS

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CRANKSHAFT COUNTERWEIGHT HANGER BLADE AND COUNTERWEIGHT INSPECTION AND BUSHING REPLACEMENT

Special Instructions For GTSI0-520 Engines

Service bulletin M90-12 mandated the replacement of all part number 631810 counterweights with part number 652833 or later design counterweights. Earlier design counterweights part number 631810 must be discarded.

NOTE: Part number 652833 or later design counterweights that do not meet the inspection criteria must be replaced. Scrap all part number 631810 counterweights.

Starter adapter viscous dampers must be replaced with new items at engine overhaul, whenever the starter adapter is overhauled or replaced, or whenever inspection per the latest revision of CSB94-4D indicates distress to either the starter shaft gear or to the crankshaft gear. If either gear shows distress, both gears must be replaced in addition to the starter adapter.

NOTE: Refer to CSB94-4D or latest revision for specific instructions on starter adapter inspection and replacement.

The following is for all Models:

Inspection And Bushing Replacement

Crankshaft hanger blade and counterweight bushing replacement must be performed using the specified procedure and the following special tools:

1. Borrough's 8077A Crankshaft Hanger Blade Bushing Removal/Installation set or equivalent.
2. Borrough's 8077C Counterweight Bushing Removal/Installation Fixture or equivalent.

3. Federal Dimension Air Gauge with correct size Setting Ring and Air Plug or equivalent. See Figures 3 and 4 for specified bore sizes.

Or

Starrett No. 78 Series 3 point contact inside micrometers. Contact the L.S. Starrett Company
1-800-541-8887.

Warning

Removing and replacing bushings with makeshift tools and methods may result in irreparable damage to the crankshaft and / or counterweight.

Counterweight Removal and Inspection

1. Remove the counterweight snap rings from the two bores in the counterweight using snap ring pliers with a 90 degree bend.
2. Remove the counterweight pin retaining plates from their bores. The plates are a close tolerance fit and may require slight rocking to remove them.
3. Remove Counterweight pins with a magnet.

Counterweight Inspection

Only the case hardened (tufrided) counterweight assemblies P/N 639195, 639196, 639197, 639199, 639205, or later design and 627821, 530864, 531017 (non-tufrided) counterweight assemblies may be considered for bushing replacement. Discard all other earlier design counterweights.

1. Inspect the bump surface of the counterweight as shown in Figure 2. The bump surface contact marks must not exceed .005 inches in depth.
2. Counterweight bushings must be removed using the specified tools and discarded. Inspect the counterweights using the following procedure:

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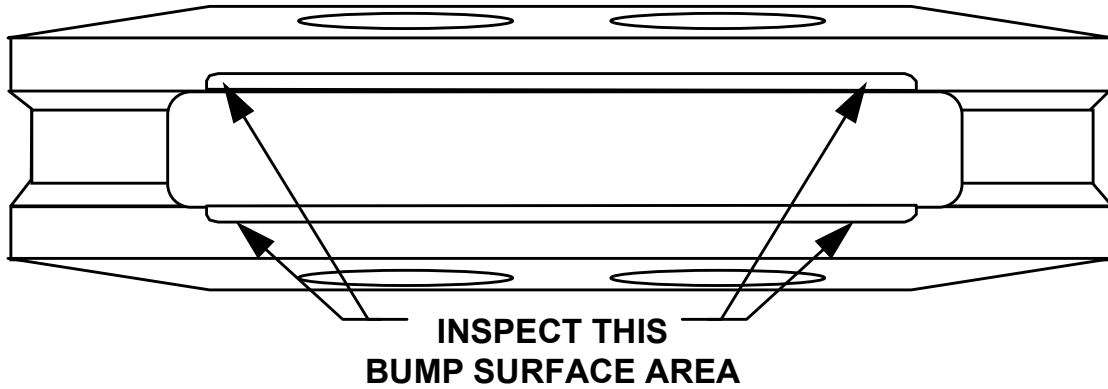


FIGURE 2. COUNTERWEIGHT BUMP SURFACE INSPECTION

- a) Presence of tufting on counterweight assemblies P/N 639195, 639196, 639197, 639199, 639205, may be determined by using a 4% solution (by volume) of copper sulfate and water (CUSO₄). After removing the counterweight bushing, thoroughly clean the bushing bore. Place one drop of the 4% copper sulfate solution on the cleaned surface of the counterweight bushing bore. Allow at least 15 seconds for the chemical reaction to take place. Formation of red deposits indicates the absence of tufting. Discard all counterweights with this indication.
- b) The crankshaft and counterweights must be magnetic particle inspected by a certified technician.

CAUTION...

Before magnetic particle inspection of any part, it must be completely cleaned and free of dirt, carbon, varnish, gum and paint. Plug small holes leading to obscure cavities with tight-fitting wood plugs or with a hard grease which is soluble in lubricating oil. This will prevent particles from lodging in places where they would be difficult to remove and places not subject to visual

inspection. After magnetic particle inspection remove all such plugs and clean the part thoroughly in solvent. Dry the part with compressed air. Check for complete demagnetization.

Where magnetic particle inspection is required, use fluorescent method, wet continuous procedure. Refer to the latest revision of ASTM E 1444 for specific methods and procedures based on type of inspection being performed.

ACCEPT / REJECT CRITERIA

Rejectable discontinuities are any of the following: fatigue cracks, forming cracks, grinding and heat treat cracks, embrittlement cracks, seams, laps, burst.

Parts which contain linear indications which cannot be reworked or indications which break into corners, edges, holes, thread roots, fillets, or keyways must be rejected.

The particular magnetic particle manufacturer's information regarding use, safety data and disposal must be followed carefully.

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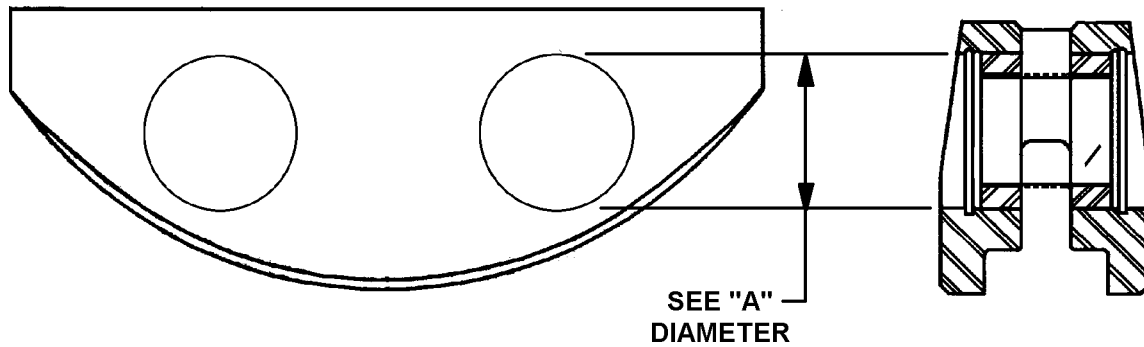


FIGURE 3. COUNTERWEIGHT BUSHING BORE INSPECTION

COUNTERWEIGHT ASSEMBLY	COUNTERWEIGHT	“A” DIAMETER
530864	530865	.687 / .688
531017	530865	.687 / .688
627821	626688	1.000 / 1.001
639195	351000	.8745 / .8755
639205		
639210		
639196	631903	.8745 / .8755
639197	633339	.8745 / .8755
639199	629693	1.000 / 1.001

- c) Crankshafts must be ultrasonically inspected in accordance with MSB96-10. Refer to the applicable engine overhaul manual for specific instructions. Crankshafts exhibiting reject-able indications must be discarded.
- d) The counterweight bushing bores must be smooth. Counterweights with worn, pitted, fretted or out of round bushing bores must be discarded. Use an air gauge with correct size air plug and setting ring to verify the bushing bore diameter. Bushing bores must measure

as specified total indicator reading (T.I.R.) See Figure 3, Counterweight

Bushing Bore Inspection, for bushing bore diameters. Counterweights with bushing bores exceeding the specified dimensions must be scrapped.

- e) Carefully inspect the counterweight counterbores for signs of wear in the wall that retains the counterweight pin retaining plates. This area is adjacent to the inside edge of the retaining ring groove. It may appear as an additional step and/or taper of the hole into the

retaining ring groove. If any wear is evident the counterweight must be replaced.

- f) If no plate wear is evident, check the retaining ring groove in each hole for wear patterns which can affect the seating of the retaining ring. Any worn condition which may affect retaining ring seating will require replacement of the counterweight.
- g) Crankshaft counterweights are matched in pairs with a maximum weight variation of two (2) grams. If either counterweight is damaged a matched pair must be procured and replaced on that cheek.
- h) The counterweight bushings must be replaced using the specified tools. Refer to

Figures 5A and 5B for specifications regarding counterweight bushing removal and replacement. The replacement bushings must have an interference fit of .0015 to .003 inch into the bushing bores.

- 3. The crankshaft counterweight hanger blade bushings must be replaced using the specified tools and following procedure. Refer to Figure 6 for specifications regarding crankshaft hanger blade bushing removal and replacement.

- a) After removal, measure the inside diameter of the crankshaft counterweight hanger blade bushing holes.

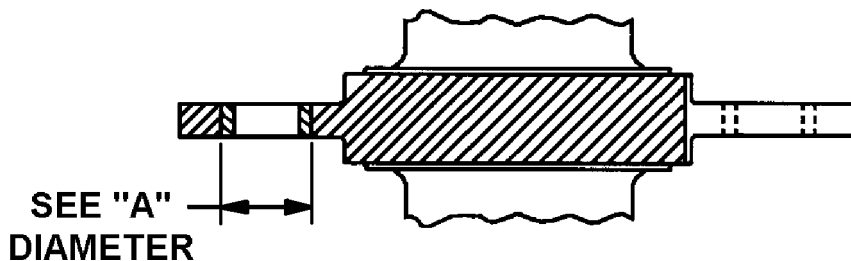


FIGURE 4. CRANKSHAFT HANGER BLADE BUSHING BORE INSPECTION

CRANKSHAFT ASSEMBLY	“A” DIAMETER
530860	.687 / .688
646623	.8745 / .8755
649133	.8745 / .8755
649134	.8745 / .8755
649135	.8745 / .8755
649138	.8745 / .8755
649141	.8745 / .8755
649148	.8745 / .8755
649895	.8745 / .8755
649896	.8745 / .8755
649898	.8745 / .8755
649900	.8745 / .8755
652005	.8745 / .8755
652009	.8745 / .8755
652010	.8745 / .8755

CRANKSHAFT ASSEMBLY	“A” DIAMETER
652011	.8745 / .8755
652039	.8745 / .8755
652348	.8745 / .8755
652359	.8745 / .8755
653020	1.1245 / 1.1255
653129	.815 / .816
653136	.815 / .816
653137	.815 / .816
653138	.815 / .816
653697	.8745 / .8755
649144-1	.8745 / .8755
649144-2	.8745 / .8755
652800A1	1.1245 / 1.1255
654359	.8745 / .8755
653382	.815 / .816

- a) The bushing holes must be smooth. Crankshafts with worn, pitted, fretted or out of round bushing holes must be discarded.
- b) Using the same tools that were used for bushing removal install the new bushings. The replacement bushings must have an interference fit of .0015 to .003 inch into the bushing holes.
- c) Refer to Figure 6 for specifications regarding crankshaft hanger blade bushing removal and replacement. The new bushings must be installed into the same positions as the original bushings. Replacement crankshaft blade bushings are available in standard and some oversize dimensions. Refer to note ③ Table 3.

4. Dimensional verification of installed bushings:

- a) Because of the close tolerances required, the replaced bushings must be inspected using an air gauge with correct size air plug and setting ring. Refer to Figures 5A, 5B and 6.
- b) After the bushings have been installed in both the counterweights and the crankshaft hanger blades, a magnetic particle inspection as specified, must be performed by a certified technician. This inspection is to insure that no cracks have developed during the bushing removal and installation process.

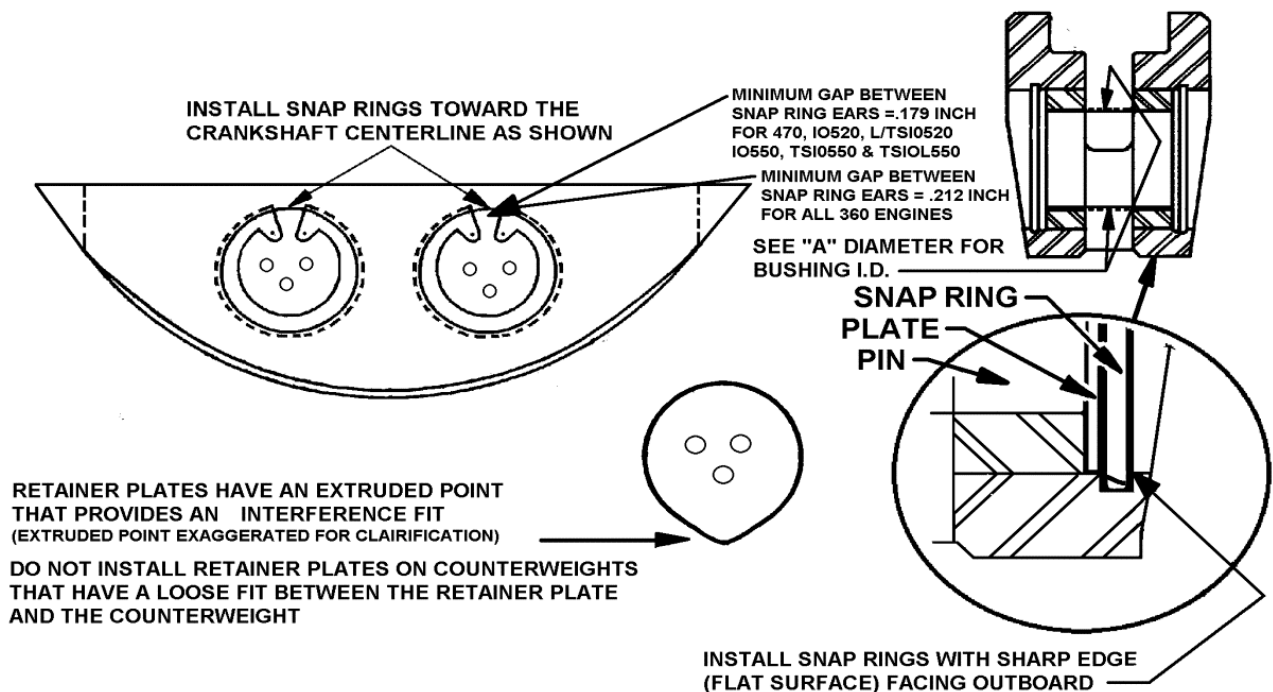


FIGURE 5A. COUNTERWEIGHT BUSHING REPLACEMENT AND ASSEMBLY FOR 360, 470, IO-520, L/TSIO-520, IO-550, TSIO-550, TSIO550 CRANKSHAFTS

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COUNTERWEIGHT ASSEMBLY	DIAMETER "A" (Installed)
530864	.435 / .438
531017	.4613 / .4643
639195	.622 / .626
639196	.622 / .626
639197	.622 / .626
639199	.604 / .607
639205	.6514 / .6554
639210	.6483 / .6523
652833	.754 / .757

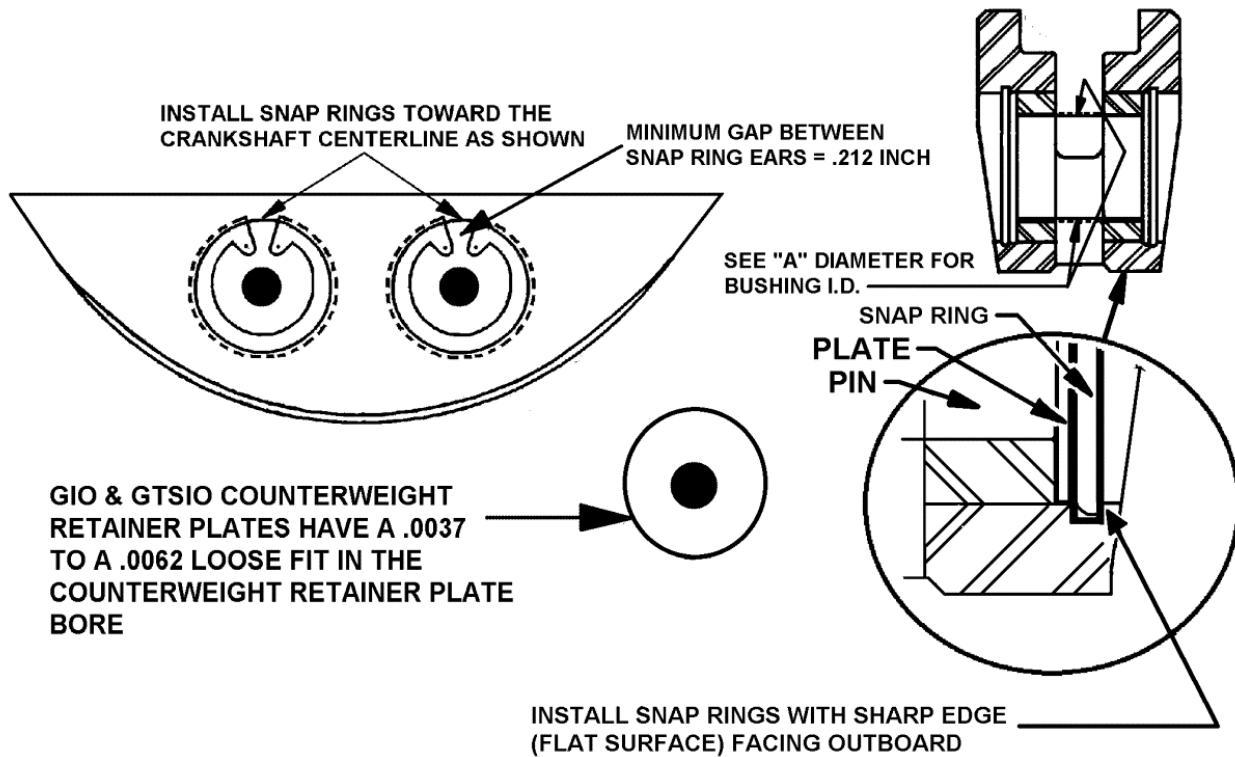


FIGURE 5B. COUNTERWEIGHT BUSHING ASSEMBLY FOR GTSIO-520 AND GIO-550 CRANKSHAFTS

NOTE

GTSIO-520 COUNTERWEIGHT BUSHING REPLACEMENT IS NOT ALLOWED

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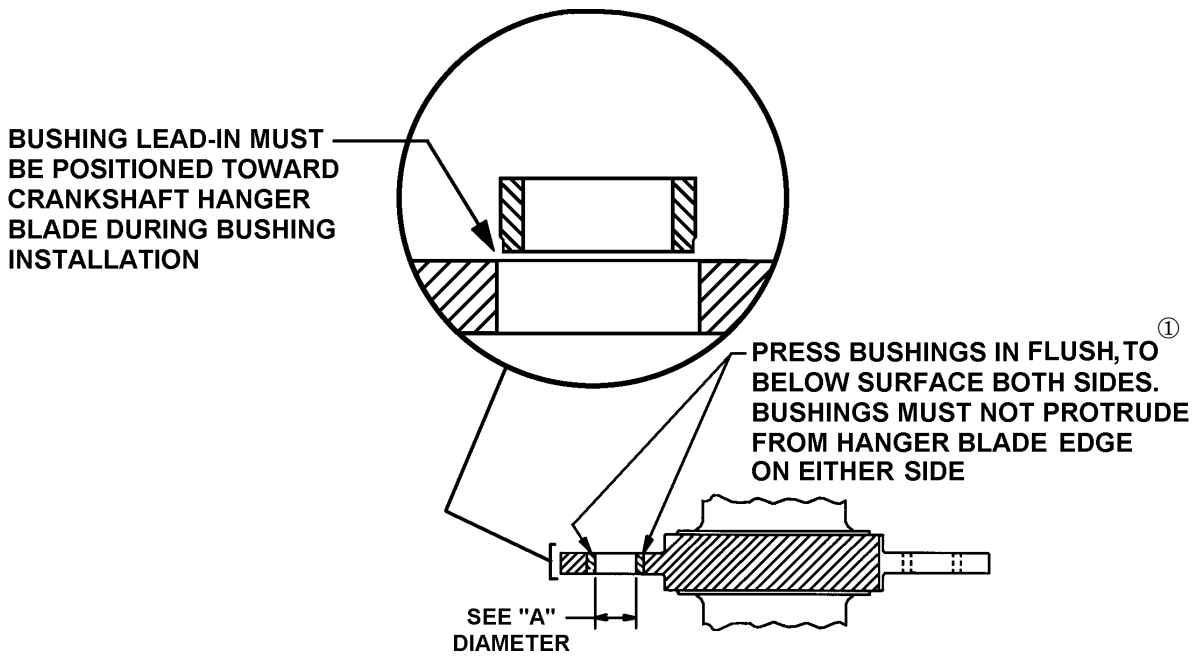


FIGURE 6. CRANKSHAFT HANGER BLADE BUSHING INSTALLATION

CRANKSHAFT ASSEMBLY	CRANKSHAFT	DIAMETER "A" (Installed)
530860	530789	.4613 / .4643
646623	643687	.622 / .626
649133	649132	.622 / .626
649134	649132	.622 / .626
649135	649132	.622 / .626
649138	649137	.622 / .626
649141	649137	.622 / .626
649144-1	649143	.622 / .626
649144-2	649146	.622 / .626
649148	649147	.622 / .626
649895	649894	.622 / .626
649896	649894	.622 / .626
649898	649897	.622 / .626
649900	649899	.622 / .626
652005	652004	.622 / .626
652009	652004	.622 / .626

CRANKSHAFT ASSEMBLY	CRANKSHAFT	DIAMETER "A" (Installed)
652010	652004	.622 / .626
652011	652004	.622 / .626
652039	649137	.622 / .626
652348	652004	.622 / .626
652359	649899	.622 / .626
653020	653019	.754 / .756
653129	652012	.604 / .607
653136	652013	.604 / .607
653137	652044	.604 / .607
653138	652046	.604 / .607
653139	652046	.604 / .607
653383	653382	.604 / .607
653697	649137	.622 / .626
E-652800	E-649474	.622 / .626
654359	643687	.622 / .626

① Except as follows: 652012 Flush to .004 Below Surface
 652013 Flush to .004 Below Surface
 652044 Flush
 652046 Flush
 653019 Flush to .005 Below Surface

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CONNECTING ROD INSPECTION AND REPAIR

CLEANING:

Thoroughly clean connecting rods using an approved solvent or degreaser. Insure all surfaces are free of varnish, oil and residue that will affect reliability of visual, dimensional and magnetic particle inspection.

INITIAL INSPECTION:

Perform the following visual and dimensional inspections.

Insure that connecting rod and cap mate marks are adjacent to each other and that the position numbers stamped on or adjacent to the bolt boss match. **Scrap connecting rods and caps that do not meet this criteria.**

Visually inspect connecting rod for corrosion pitting, rust, discoloration (bluing), galling, impact damage, nicks, bending and twisting. **Scrap connecting rods with any of these indications.**

Remove nuts and bolts from connecting rod and separate rod and cap. Visually inspect connecting rod and cap parting surface. Contact signatures resulting from assembly forces are normal and acceptable. However, connecting rods exhibiting fretting signatures that have resulted in the loss of metal as indicated by removal of the original machining marks, either locally or over the entire surface, are not acceptable for continued service. **Scrap connecting rods with fretting at the parting surfaces, DO NOT REWORK.**

Visually inspect nut seat area. Excessive fretting signatures indicating loss of material or

signatures of edge loading of the bolt under head surface contact area is cause for rejection and scrap.

Visually inspect dowel surfaces at rod and cap bolt holes. Indications of distortion or scoring are cause for rejection and scrap.

Insuring that the mate marks are adjacent to each other and the position numbers match, assemble the connecting rod and cap by installing one bolt through cap and rod. With the cap seated firmly against the rod, you must be able to install the remaining bolt using hand pressure only. **Scrap connecting rods not meeting this criteria.**

Lubricate connecting rod bolt and nut threads with clean 50 weight aviation oil. Torque nuts to the value specified in the latest revision of TCM Service Bulletin SB96-7.

NOTE

The new design Spirallock nuts are free running during installation. Locking is achieved through thread design when the nut is properly torqued.

Inspect the inside diameter joint of the rod to cap with both bolts and nuts installed and torqued. Mismatch (or a step) of more than 0.001 inch is not acceptable. An acceptable method of checking mismatch is to use a dial indicator as follows:

Place the rod on a surface plate so that the splitline is at the 6 and 12 o'clock position. Use vee blocks to hold the rod in place. Using a dial indicator mounted on a height gauge, zero out on one side of the splitline. Move the indicator across the splitline. There must be no more than 0.001 indicator movement.

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Warning

Removing and installing the connecting rod pin bushing with makeshift tools can damage connecting rods resulting in subsequent failure.

Remove piston pin bushing from connecting rod using Borrough's part number 8098, or equivalent, Connecting rod Bushing Removal/ Installation Set and an arbor press.

Inspect piston pin bushing bore and surrounding area for nicks, gouges and mechanical damage. **Scrap connecting rods with any of these indications.**

Using precision measuring equipment, such as dial bore gauge or air gauge, verify that the connecting rod meets the dimensional specifications provided in Table 5. Reference Figure 7. Measure "D" diameter 15 to 30 degrees either side of connecting rod split line and 90 from the first measurement. Difference between the two measurements must not exceed .0015. **Connecting rods and caps not meeting these specifications must be scrapped.**

Inspect the rod channel rails for damage such as nicks, gouges or mechanical damage. Scrap rods with any of these indications.

***NOTE:** Connecting Rods with forging number 626119 must also meet the inspection criteria specified in TCM CSB96-13*

MAGNETIC PARTICLE INSPECTION:

Parts must be clean and free of rust, scale, oil or other residue that may affect reliability of magnetic particle inspection. Connecting rods will be inspected using both the circular and longitudinal method of magnetization. Use florescent method, wet continuous procedure, Refer to the latest revision of ASTM E 1444 for specific methods and procedures based on type of inspection being performed.

Acceptable indications must be associated with steel inclusions or shallow imperfections on the forging surface. Accept light indications running parallel to the rod axis or around the pin boss and cap ends less than 1/2 inch in length.

Indications associated with forging laps or with heat treatment are deemed cracks and are not acceptable.

The area of blend between the piston pin boss extending one inch into the channel section of the connecting rod, the bolt spotface areas and the channel rail edges are critical and must be free of any indications.

Any indication transverse to the rod axis is not acceptable.

Reject and scrap connecting rods exhibiting unacceptable indications.

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CONNECTING ROD PISTON PIN BUSHING INSTALLATION:

Warning

Removing and installing the connecting rod pin bushing with makeshift tools can damage connecting rods resulting in subsequent failure.

Verify that the piston pin bushing being installed is the correct part number for the application.

The piston pin bushing may be chilled slightly to aid installation.

Using Borroughs Tool Part Number 8098, Connecting Rod Bushing Removal and Installation set, or equivalent, and an arbor press install the piston pin bushing as follows.

1. Position connecting rod over the pilot so the mate marks and piston pin bore chamfer are facing up.
2. Place the bushing on the pilot so that the bushing split is located 45 degrees from the center line of the connecting rod, facing the crankpin end.
3. Position the ram onto the pilot.
4. Using the arbor press, carefully press the bushing flush with the piston pin bore.

5. Visually inspect connecting rod for nicks or damage that may have occurred during bushing installation. **Scrap connecting rods exhibiting these conditions.**
6. Verify the piston pin bushing split is correctly positioned. Reference Figure 7.

PISTON PIN BUSHING BORING

Boring of the piston pin bushing requires the following equipment:

1. Borough's Tool Part Number 8111A, or equivalent.
2. Adapter Kit Part Number 8042C (E-series, 470 and 520) or Part Number 8072C (O-200, IO-240, 300 series and 360 series) or equivalent.
3. Vertical mill, or equivalent, capable of maintaining 1750 R.P.M.
4. Boring tool of the correct sizes.

Bore bushing as follows.

1. Place the connecting rod on the base plate and secure with retainers provided.
2. Select the correct adapter kit and boring tool for the connecting rod.
3. Using a vertical mill, or equivalent, bore the connecting rod bushing to size. Maintain 1750 RPM during boring process.

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POST INSTALLATION INSPECTION:

Using a Maar-Federal Tool and Supply Co. Inc., Dimension Air D-2500 or D-4000 Air Plug Gauge, the correct size Setting Ring and Air Plug for diameter being measured verify that the piston pin bushing is within the minimum and maximum limits for the connecting rod as specified in Table 5.

If the piston pin bushing does not meet dimensional specifications, the bushing will have to be removed and a new bushing installed and bored to size.

Using a profilometer check piston pin bushing surface finish. Surface finish must not exceed 16 R_a.

Check connecting rod bushing for alignment and twist after bushing installation using Borrough's tool number 8111A, or equivalent. An alternate method would be to use a surface plate, matched vee blocks, precision machined press to fit arbors at least eight inches in length for the pin and crank end of the rod, and two calibrated parallel blocks of flat machined steel at least eight inches long, one half inch wide, and two and one half inches high.


To check connecting rod twist, insert the push to fit arbors into the pin and crank end of the rod. Place the connecting rod crank pin end onto the vee blocks. Place the pin end arbor on the two machined parallel steel blocks spaced equal distance from the center line of the rod, but not less than six inches apart

Use flat feeler stock to detect clearance between the machined steel blocks and the pin end arbor. Refer to Figure 7 for specified limits. To check connecting rod alignment, rotate the pin end of the connecting rod to a vertical position with the arbor resting against a positive stop. Using a dial indicator mounted on a vertical stand resting on the surface plate, measure the vertical distance of the pin end arbor from the surface plate at points equal distance from the centerline of the connecting rod. Refer to Figure 7 for the specified limits. **Connecting rods exceeding the limits specified in Figure 7 must have the piston pin bushing replaced and reamed or the connecting rod must be scrapped.**

TOOLS AND EQUIPMENT:

Tools referred to in this Service Bulletin may be purchased from:

-
- Borough's Tools available from:
 - Kent - Moore
 - 29784 Little Mack
 - Roseville, MI 48066-2298
 - Phone: 1-800-253-0138
-
- Maar-Federal Tool and Supply Co. Inc.
 - 1144
 - Eddy Street
 - Providence, RI 02940
 - Phone: 1-800-343-2050
-

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WARNING
FAILURE TO COMPLY WITH THESE SPECIFICATIONS AND INSTRUCTIONS
WILL RESULT IN ENGINE MALFUNCTION AND STOPPAGE.

.0005 INCH MAXIMUM CONVERGENCE OF THESE AXES
(WITH NEW BUSHING)

EXAMPLE: LONGITUDINAL AXIS, CENTER-TO-CENTER
DISTANCE OF L1 MINUS L2 MUST NOT EXCEED
.004 OF AN INCH AFTER CONNECTING ROD
BUSHING HAS BEEN FINISH MACHINED.

NICKS OR BURRS .01 INCH DEEP OR LESS MAY
BE BLENDED USING CROCUS CLOTH. BLENDED
AREA MUST HAVE A CORNER RADIUS OF .06-.09.
CONNECTING RODS WITH "V" NOTCH SHAPE NICKS
EXCEEDING .02 INCH IN DEPTH MUST BE DISCARDED.

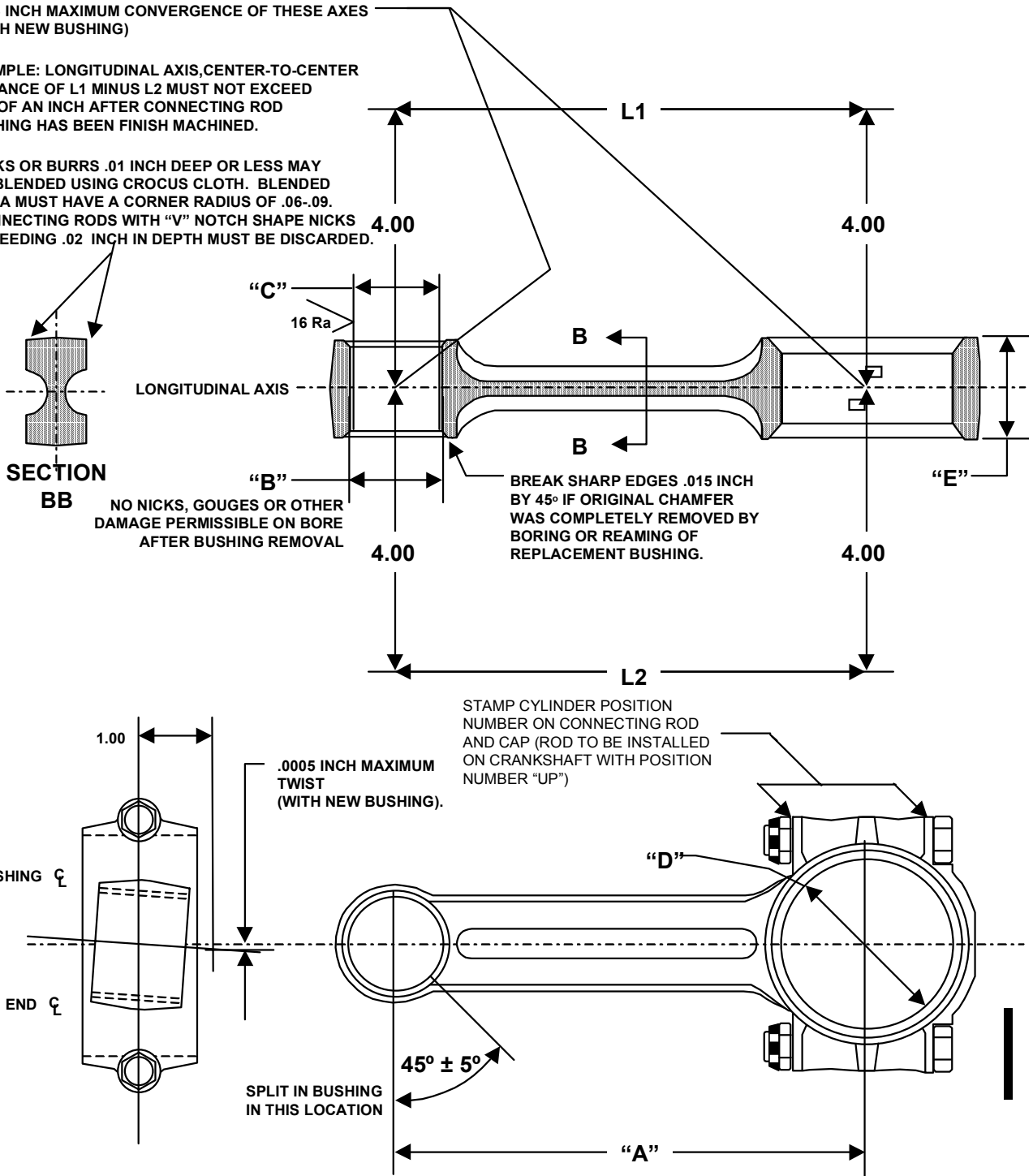


FIGURE 7. CONNECTING ROD AND BUSHING DIMENSIONS

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TABLE 5. CONNECTING ROD SPECIFICATIONS

Engine Model	Con-Rod Part Number	Forging Part Number	②④ Nut P/N Bolt P/N	Connecting Rod Bores Centerline Distance "A"	Pin end I.D. No Bushing "B"	Bushing I.D. Bushing P/N "C"	Crankpin Bore I.D. "D"	C/S end width "E"
O / IO / TSIO-470'S Small Bore IO & TSIO-520 's IO-346	655910 ① Superseded 655000 655004 654999 646778	646126 Superseded 632041	654490 Nut 655958 Bolt	6.6230 6.6270	1.2340 1.2350	1.1267 1.1269 530658	2.3755 2.3760	1.521 1.525
E-Series O-470- 2,4,11,13A,15 IO-470- C,G,J,K,P,R	654796 ①③ Superseded 646478 A36121 ⑦	646126 Superseded 632041	654487 Nut 655960 Bolt	6.6230 6.6270	1.2340 1.2350	1.1263 1.1265 530658	2.3755 2.3760	1.583 1.587
360 Large Bore IO-240-A&B	654793 ①③ Superseded 646320 642268	646116 Superseded 626119	654487 Nut 655959 Bolt	6.3730 6.3770	1.0620 1.0630	1.0000 1.0005 538684	2.0615 2.0620	1.2215 1.2255
360 Small Bore GO-300	654794 ①③ Superseded 646321 626128	646116 Superseded 626119	654487 Nut 655959 Bolt	6.3730 6.3770	1.0620 1.0630	1.0000- 1.0005 538684	2.0615 2.0620	1.3015 1.3055
O-200 / O-300 C-90 / C-145	654795 ①③ Superseded 646322 530184 ⑥ 5561⑥	646116 Superseded 626119 530186⑥	654487 Nut 655959 Bolt	6.3730 6.3770	1.0620 1.0630	.9230-.9235 530192	2.0615 2.0620	1.3015 1.3055
IO / TSIO520 Large Bore TSIO-520-BE	655911 ① Superseded 655005 ③ 646476 646475	646126 Superseded 632041	654490 Nut 655958 Bolt	6.6230 6.6270	1.2340 1.2350	1.1267 1.1269 530658	2.3755 2.3760	1.461 1.465
L / TSIO-520-AE	655910 ① Superseded 655000 ③ 646480 643166	646126 Superseded 632041	654490 Nut 655958 Bolt	6.6230 6.6270	1.2340 1.2350	1.1267 1.1269 530658	2.3755 2.3760	1.521 1.525
TSIO-520-CE IO / TSIO-550's TSIOL-550's	655911 ① Superseded 655001 646482	646126 Superseded 632041	654490 Nut 655928 Bolt	6.6230 6.6270	1.2340 1.2350	1.1267 1.1269 530658	2.3755 2.3760	1.461 1.465
IO-550-B29, B33, B37, C25, C29, C30 TSIO-520-UB17	655911 ①⑤ Superseded 655001 654440	646126 Superseded 632041	654490 Nut 655928 Bolt	6.6230 6.6270	1.2340 1.2350	1.1267 1.1269 530658	2.3755 2.3760	1.461 1.465
GTSIO-520's	655910 ① Superseded 655004	626126 Superseded 632041	654490 Nut 655958 Bolt	6.6230 6.6270	1.2340 1.2350	1.1267 1.1269 530658	2.3755 2.3760	1.521 1.525

① Connecting Rod Assembly must utilize correspondingly identified bolt and nut from Table 5.

② The most current part number connecting rod nuts and bolts must not be used on or with superseded part number nuts and bolts.

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- ③ Current part number (serviceable) connecting rods must use the most current part number connecting rod new nuts and bolts. The most current connecting rod new nut and bolt part numbers can be used with old (serviceable) connecting rods of the same style. (Hex head rod bolts must replace hex head rod bolts, contour head rod bolts must replace contour head rod bolts.)
- ④ See the most recent revision of TCM Service Bulletin SB96-7 for connecting rod nut torque specifications.
- ⑤ Used in balanced set P/N 655913.
- ⑥ P/N 530184 connecting rod (identified by forging number 530186), A35159 (Identified by forging number 5561) and A35160 (Also identified by forging number 5561) must be serviced as follows:
 - a) P/N 530213 bolt, P/N 24804 or P/N 626140 nut and P/N 639292 cotter pin, torqued to value specified in latest revision of TCM SB96-7
- ⑦ P/N A36121 connecting rod assemblies utilizing the P/N 632041 forging must be serviced in accordance with Table 5 of this bulletin. P/N A36121 Connecting rod assemblies utilizing the P/N 40742 forging must be serviced as follows:
 - a) P/N 35972 connecting rod bolt, P/N 24804 nut and P/N MS24665-132 cotter pin, torqued to the value specified in the latest revision of TCM SB96-7.

Warning

If the hardware listed in (a) of note 6 or note 7 is not available, the connecting rod must be changed to a serviceable later configuration rod with the appropriate P/N hardware.

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