Due to a continuous program of research and development, some procedures, specifications and parts may be altered in a constant effort to improve our products.

When changes and improvements are made in our products, periodic revisions may be made to this manual to keep it up-to-date. It is suggested that customers contact their dealer for information on the latest revision.

ENGINE & FUEL SYSTEM
C-123, C-135, C-146 & C-153
Engines

GSS-1295-J W/Revision 2
March, 1977

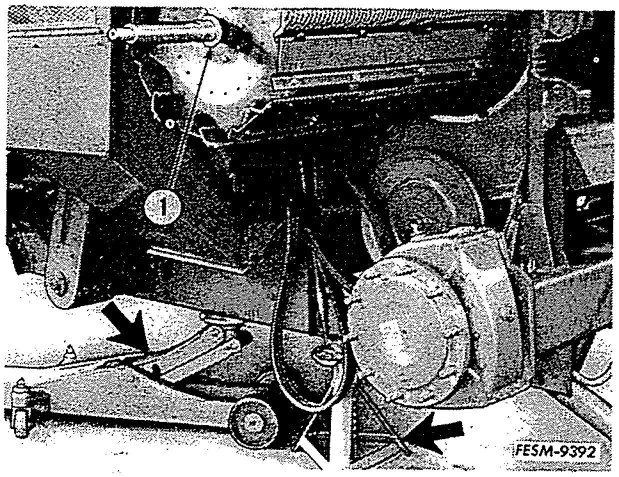
General Contents

GSS-1295-J (Rev. No. 2)

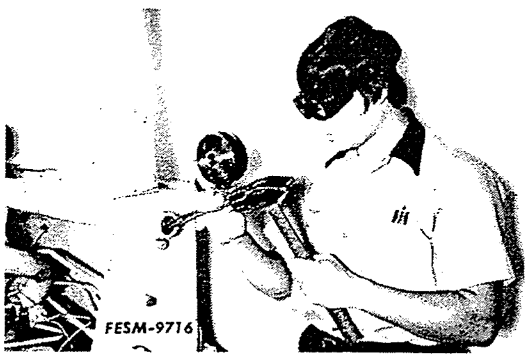
Printed in United States of America

WORK SAFELY – FOLLOW THESE RULES

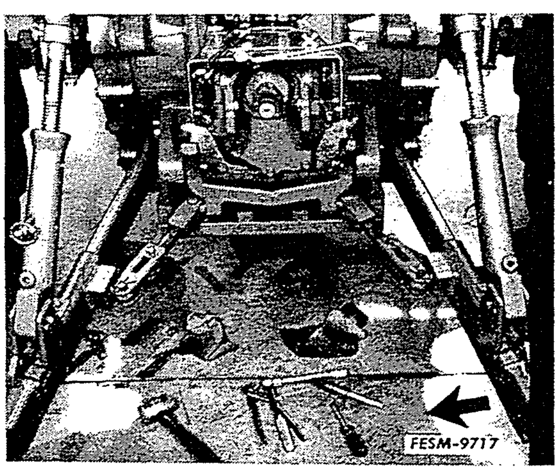
This symbol is used to call your attention to instructions concerning your personal safety. Be sure to observe and follow these instructions.



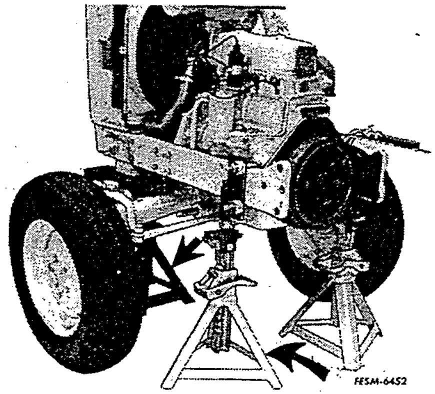
1. Always use safety stands in conjunction with hydraulic jacks or hoists. Do not rely on the jack or hoist to carry the load, they could fail.



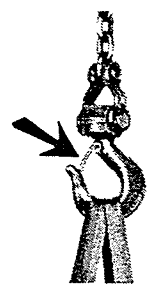
2. Always wear safety glasses when using a hammer, chisel or other tools that may cause chips to fly.



3. Keep work area organized and clean. Wipe up oil or spills of any kind. Keep tools and parts off of the floor. Eliminate the possibility of a fall which could result in a serious injury.



4. When splitting tractors, or disassembling machines, be sure to use safety stands and adequate supports to prevent tipping or roll-over.



FESM-9718

5. Use a safety catch on all hoist hooks. Do not take a chance, the load could slip off of the hook.

6. When using an acetylene torch always wear welding goggles and gloves. Keep a "charged" fire extinguisher within reach. Be sure the acetylene and oxygen tanks are separated by a metal shield and are chained to the cart. Do not weld or heat areas near fuel tanks or fuel lines and utilize proper shielding around hydraulic tanks or hydraulic lines.

7. Always use a safety bar to block hydraulic cylinders. Never rely on the machine hydraulic system to hold when working on loaders etc. A hydraulic line or cylinder could fail or someone could accidently strike the control levers causing the loader to fall.

8. When reassembling subassemblies, parts, hoses, hydraulic lines, fuel lines, wiring etc., be sure they are positioned properly for alignment and clearance with related parts to their original setting and/or position.

9. Electrical storage batteries give off highly inflammable hydrogen gas when charging and and continue to do so for some time after receiving a steady charge. Do not under any circumstances allow an electric spark or an open flame near the battery. Do not lay tools across battery terminals as this may result in a spark or short circuit which may cause an explosion. Be careful to avoid spilling any electrolyte on hands or clothing.

10. Hydraulic fluid escaping under pressure can have enough force to penetrate the skin. Hydraulic fluid may also infect a minor cut or opening in the skin. If injured by escaping fluid, see a doctor at once. Serious infection or reaction can result if medical treatment is not given immediately.

Do not attempt to repair or tighten hoses that are under pressure, when the boom is raised, or with the tractor engine running. Cycle all hydraulic control valves to relieve all pressure before disconnecting the lines or performing other work on the hydraulic system. Make sure all connections are tight and hoses and lines are in good condition before applying pressure to the system. To locate a leak under pressure, use a small piece of cardboard or wood. Never use hands.

11. When refueling, keep the hose and nozzle or the funnel and container in contact with the metal of the fuel tank to avoid the possibility of an electric spark igniting the fuel. Do not overfill the fuel tank – overflow creates fire hazard. Do not smoke when refueling. Never refuel when engine is hot or running.

12. Always use a protective fixture when inflating tubeless tires that have been repaired or are loose on the rim. Do not inflate over 30 psi to seat the tire bead.

13. Use pullers to remove bearings, bushings, gears, cylinder sleeves etc. when applicable. Use hammers, punches and chisels only when absolutely necessary. Then, be sure to wear safety glasses.

14. Never use trouble lights or electric powered tools that have cut and/or damaged cords or plugs. Be sure all electric tools are properly grounded.

15. Be careful when using compressed air to dry parts. Use approved air blow guns, do not exceed 30 psi, wear safety glasses or goggles and use proper shielding to protect everyone in the work area.

16. Do not wear rings, wrist watches or loose fitting clothing when working on machinery, they could catch on moving parts causing serious injury.

17. Excessive or repeated skin contact with sealants or solvents may cause skin irritation. In case of skin contact, remove sealant or solvent promptly by washing with soap and water.

IMPORTANT: The above is only a partial list of safe work rules. In addition, always refer to the Operator's Manual for the specific machine for additional safe work rules regarding the machine operation.

STANDARD TORQUE DATA FOR NUTS AND BOLTS— FOOT POUNDS

Recommended torque for all Standard Application Nuts and Bolts, provided:

A. All thread surfaces are clean and lubricated with SAE-30 engine oil. (See NOTE.)

B. Joints are rigid, that is, no gaskets or compressible materials are used.

C. When reusing nuts or bolts use minimum torque values.

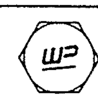
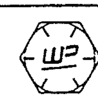
NOTE: Multiply the standard torque by:
- **.65 when finished jam nuts are used.**
- **.70 when Molykote, white lead or similar mixtures are used as lubricants.**
- **.75 when parkerized bolts or nuts are used.**
- **.85 when cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.**
- **.90 when hardened surfaces are used under the nut or bolt head.**

1 FOOT POUND = 1.355 NEWTON METERS

Bolt or Stud Diameter		Type 1 Studs Only		Type 1 Bolts 6" length or less		Type 1 Bolts longer than 6"		Type 5 (all lengths)		Type 8 (all lengths)			
										Only when used† in cast (gray) iron		All other applications	
Inches	MM	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1/4	6.4	5	6	5	6	3	3	9	10	11	13	12	14
5/16	8.0	12	13	12	13	6	7	19	21	24	27	27	30
3/8	9.5	21	24	21	24	11	13	33	37	43	47	45	50
7/16	11.1	35	38	35	38	19	21	53	60	69	76	75	85
1/2	12.7	52	58	52	58	29	32	80	90	104	117	115	130
9/16	14.3	70	80	70	80	41	46	115	130	150	170	165	185
5/8	15.9	98	110	98	110	57	63	160	180	210	230	220	250
3/4	19.0	174	195	174	195	100	112	290	320	350	390	400	450
7/8	22.2	300	330	162	181	162	181	420	470	570	630	650	730
1	25.4	420	470	250	270	250	270	630	710	850	950	970	1090
1-1/8	28.6	600	660	350	380	350	380	850	950	1200	1350	1380	1550
1-1/4	31.8	840	940	490	540	490	540	1200	1350	1700	1900	1940	2180
1-3/8	34.9	1100	1230	640	710	640	710	1570	1760	2300	2500	2600	2800
1-1/2	38.1	1470	1640	850	940	850	940	2000	2300	3000	3300	3300	3700
1-3/4	44.5	2350	2450	1330	1490	1330	1490	3300	3700	4700	5200	5300	6000
2	50.8	3500	3900	2000	2200	2000	2200	5000	5500	7000	7800	8000	9000

†When bolt penetration is 1-1/2 times the diameter of the bolt.

BOLT TYPE IDENTIFICATION CHART

IH TYPE	S.A.E. GRADE	DESCRIPTION	BOLT HEAD MARKING *
1	Equivalent 1 or 2	WILL HAVE A STANDARD MONOGRAM IN THE CENTER OF THE HEAD Low or Medium Carbon Steel Not Heat Treated	
5	5	WILL HAVE A AND 3 RADIAL LINES Quenched and Tempered Medium Carbon Steel	
8	8	WILL HAVE A AND 6 RADIAL LINES Quenched and Tempered Special Carbon or Alloy Steel	

*The center marking identifies the bolt manufacturer. The monogram is currently used. Some bolts may still have an IH or a raised dot which previously identified IH bolts.

STANDARD TORQUE DATA FOR NUTS AND BOLTS— NEWTON METERS

Recommended torque for all Standard Application Nuts and Bolts, provided:

A. All thread surfaces are clean and lubricated with SAE-30 engine oil. (See NOTE.)

B. Joints are rigid, that is, no gaskets or compressible materials are used.

C. When reusing nuts or bolts use minimum torque values.

NOTE: Multiply the standard torque by:

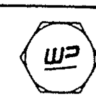
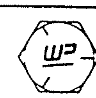
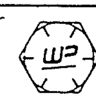
.65 when finished jam nuts are used.
.70 when Molykote, white lead or similar mixtures are used as lubricants.
.75 when parkerized bolts or nuts are used.
.85 when cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.
.90 when hardened surfaces are used under the nut or bolt head.

1 NEWTON METER = 0.738 FOOT POUND

Bolt or Stud Diameter		Type 1 Studs Only		Type 1 Bolts 6" length or less		Type 1 Bolts longer than 6"		Type 5 (all lengths)		Type 8 (all lengths)			
										Only when used† in cast (gray) iron		All other applications	
Inches	MM	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1/4	6.4	7	8	7	8	4	4	12	14	15	18	16	19
5/16	8.0	17	18	17	18	8	10	26	29	33	37	37	41
3/8	9.5	29	33	29	33	15	18	45	50	58	64	61	68
7/16	11.1	48	52	48	52	26	29	72	81	94	103	102	115
1/2	12.7	71	79	71	79	39	43	108	122	141	159	156	176
9/16	14.3	95	108	95	108	56	62	156	176	205	230	225	250
5/8	15.9	133	149	133	133	77	85	220	245	285	310	300	340
3/4	19.0	240	265	240	265	136	152	390	430	470	530	540	610
7/8	22.0	400	450	220	245	220	245	570	640	770	850	880	990
1	25.4	570	640	340	365	340	365	850	960	1150	1290	1300	1480
1-1/8	28.6	810	900	470	510	470	510	1150	1290	1630	1830	1870	2100
1-1/4	31.8	1140	1270	660	730	660	730	1600	1830	2300	2600	2600	3000
1-3/8	34.9	1490	1670	870	960	870	960	2100	2400	3100	3400	3500	3800
1-1/2	38.1	2000	2200	1150	1270	1150	1270	2700	3100	4100	4500	4500	5000
1-3/4	44.5	3200	3300	1800	2000	1800	2000	4500	5000	6400	7000	7100	8100
2	50.8	4750	5300	2700	3000	2700	3000	6800	7500	9500	10500	10800	12200

†When bolt penetration is 1-1/2 times the diameter of the bolt.

BOLT TYPE IDENTIFICATION CHART

IH TYPE	S.A.E. GRADE	DESCRIPTION	BOLT HEAD MARKING*
1	Equivalent 1 or 2	WILL HAVE A IH STANDARD MONOGRAM IN THE CENTER OF THE HEAD Low or Medium Carbon Steel Not Heat Treated	
5	5	WILL HAVE A IH AND 3 RADIAL LINES Quenched and Tempered Medium Carbon Steel	
8	8	WILL HAVE A IH AND 6 RADIAL LINES Quenched and Tempered Special Carbon or Alloy Steel	

*The center marking identifies the bolt manufacturer. The IH monogram is currently used. Some bolts may still have an IH or a raised dot which previously identified IH bolts.

CONVERSION TABLE
—inches to millimeters—

Inches	Millimeters	Inches	Millimeters	Inches	Millimeters	Inches	Millimeters
1	25.4	26	660.4	51	1295.4	76	1930.4
2	50.8	27	685.8	52	1320.8	77	1955.8
3	76.2	28	711.2	53	1346.2	78	1981.2
4	101.6	29	736.6	54	1371.6	79	2006.6
5	127.0	30	762.0	55	1397.0	80	2032.0
6	152.4	31	787.4	56	1422.4	81	2057.4
7	177.8	32	812.8	57	1447.8	82	2082.8
8	203.2	33	838.2	58	1473.2	83	2108.2
9	228.6	34	863.6	59	1498.6	84	2133.6
10	254.0	35	889.0	60	1524.0	85	2159.0
11	279.4	36	914.4	61	1549.4	86	2184.4
12	304.8	37	939.8	62	1574.8	87	2209.8
13	330.2	38	965.2	63	1600.2	88	2235.2
14	355.6	39	990.6	64	1625.6	89	2260.6
15	381.0	40	1016.0	65	1651.0	90	2286.0
16	406.4	41	1041.4	66	1676.4	91	2311.4
17	431.8	42	1066.8	67	1701.8	92	2336.8
18	457.2	43	1092.2	68	1727.2	93	2362.2
19	482.6	44	1117.6	69	1752.6	94	2387.6
20	508.0	45	1143.0	70	1778.0	95	2413.0
21	533.4	46	1168.4	71	1803.4	96	2438.4
22	558.8	47	1193.8	72	1828.8	97	2463.8
23	584.2	48	1219.2	73	1854.2	98	2489.2
24	609.6	49	1244.6	74	1879.6	99	2514.6
25	635.0	50	1270.0	75	1905.0	100	2540.0

1 inch = 25.4 millimeters

To convert inches to millimeters, the inch value to be converted should be written down, carried to as many decimal places as the desired accuracy requires. It should then be split into groups of not more than two figures each. The equivalent of each group should then be taken from the table, proper regard being given to the position of the decimal point in each case, and the equivalent of the inch value given.

For example, to convert 2.4635 inches to millimeters:

2.0000 inches	=	50.80000 millimeters
.4600 inches	=	11.68400
.0035 inches	=	.08890
2.4635 inches	=	62.57290 millimeters

Correct to 3 decimal places.

2.4635 inches = 62.573 millimeters

CONVERSION TABLE
—millimeters to inches—

Millimeters	Inches	Millimeters	Inches	Millimeters	Inches	Millimeters	Inches
1	0.03937008	26	1.0236220	51	2.0078740	76	2.9921260
2	0.07874016	27	1.0629921	52	2.0472441	77	3.0314961
3	.11811024	28	1.1023622	53	2.0866142	78	3.0708661
4	.15748031	29	1.1417323	54	2.1259842	79	3.1102362
5	.19685039	30	1.1811024	55	2.1653543	80	3.1496063
6	.23622047	31	1.2204724	56	2.2047244	81	3.1889764
7	.27559055	32	1.2598425	57	2.2440945	82	3.2283465
8	.31496063	33	1.2992126	58	2.2834646	83	3.2677165
9	.35433071	34	1.3385827	59	2.3228346	84	3.3070866
10	.3937008	35	1.3779528	60	2.3622047	85	3.3464567
11	.4330709	36	1.4173228	61	2.4015748	86	3.3858268
12	.4724409	37	1.4566929	62	2.4409449	87	3.4251968
13	.5118110	38	1.4960630	63	2.4803150	88	3.4645669
14	.5511811	39	1.5354331	64	2.5196850	89	3.5039370
15	.5905512	40	1.5748031	65	2.5590551	90	3.5433071
16	.6299213	41	1.6141732	66	2.5984252	91	3.5826772
17	.6692913	42	1.6535433	67	2.6377953	92	3.6220472
18	.7086614	43	1.6929134	68	2.6771654	93	3.6614173
19	.7480315	44	1.7322835	69	2.7165354	94	3.7007874
20	.7874016	45	1.7716535	70	2.7559055	95	3.7401575
21	.8267717	46	1.8110236	71	2.7952756	96	3.7795276
22	.8661417	47	1.8503937	72	2.8346457	97	3.8188976
23	.9055118	48	1.8897638	73	2.8740157	98	3.8582677
24	.9448819	49	1.9291339	74	2.9133858	99	3.8976378
25	.9842520	50	1.9685039	75	2.9527559	100	3.937008

1 mm = .03937008 inches

To convert millimeters to inches the millimeter value to be converted should be written down, carried to as many decimal places as the desired accuracy requires. It should then be split up into groups of not more than two figures each. The equivalent of each group should then be taken from the table, proper regard being given to the position of the decimal point in each case, and the equivalent of the several groups found by addition. This sum will be the inch equivalent of the millimeter value given.

For example to convert 75.384 millimeters to inches:

75.000 millimeters = 2.9527559 inches
.380 millimeters = .0149606
.004 millimeters = .0001574

75.384 millimeters = 2.9678739 inches
Correct to 5 decimal places.
75.384 millimeters = 2.96787 inches

SPECIAL SERVICE TOOLS REQUIRED

Section 1

FES 6-4	Valve guide driver (intake)
FES 6-5	Valve guide driver (exhaust)
FES 6-15	Oil seal retainer and seal installing tool (C-135, C-146 and C-153)
FES 22	Universal cylinder sleeve puller
FES 23-2	Pulling adapter plate (C-123 engine)
FES 23-3	Pulling adapter plate (C-135 engine)
FES 33-1	Fan drive puller (C-123 and C-135)
FES 33-4	Fan drive pulley wear sleeve installer
FES 52	Engine stand
FES 52-11	Attaching plate (C-123)
FES 52-12	Attaching ears, use with FES 52-11 (C-135, C-146 and C-153)
FES 101	Camshaft bearing puller and installing set
FES 108	Piston fitting set
SE 1721	Water pump seal installer

Section 2

FES 36	Fuel adjusting screw seat removal and installation tool
FES 36-1	Carburetor bushing remover for 1/4 inch bushings
FES 36-3	Carburetor liquid level hose assembly
FES 36-5	Screw starter
FES 36-6	1/4 inch adjustable bushing reamer
FES 36-8	Bushing driver for 1/4 inch bushing

Section 3

Ensign No. TSE-17885 - Bench Test Fixture

FES 36-1	Carburetor bushing remover for 1/4 and 5/16 inch bushings
FES 36-2	Bushing driver for 5/16 inch bushing
FES 36-4	Special plier for screw upsetting on throttle plate and choke shaft
FES 36-5	Screw starter
FES 36-7	5/16 inch adjustable bushing reamer

Refer to Agricultural Equipment Approved Service Tool Manual, GSS-1251-K for source and ordering proceedures.

Section 1

ENGINE

CONTENTS

SPECIFICATIONS

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
General					
Number of cylinders	4	4	4	4	4
Bore and stroke - inches	3-1/8 x 4	3-1/4 x 4-1/16	3-1/4 x 4-1/16	3-3/8 x 4-1/16	3-3/8 x 4-1/4
Displacement - cubic inches	123	135	135	146	153
Engine RPM (Governed)					
Low Idle					
F-140, I-140	425 ± 25	------	------	------	------
F-240, I-240	425 ± 25	------	------	------	------
F-340, I-340	------	425 ± 25	------	------	------
F-404, I-404	------	------	425 ± 25	------	------
I-424, 2424	------	------	------	425 ± 25	------
I-444, 2444	------	------	------	------	425 ± 25
F-504, I-504, 2504	------	------	------	------	425 ± 25
3514 Loader (w/s.n. 1705 and below)	------	------	------	------	650 ± 25
56, 57 Balers	425 ± 25	------	------	------	------

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
91 Combine	------	425 ± 25	------	------	------
93 Combine	------	------	------	------	425 ± 25
105 Combine	------	------	------	------	650 ± 25
203 Combine	------	------	------	------	650 ± 25
201 Windrower	------	425 ± 25	------	------	------
210 Windrower	------	------	------	------	650 ± 25
225 Hay Swather	------	------	------	------	650 ± 25
275 Windrower	------	------	------	------	650 ± 25
375 Windrower (w/s.n. H-200 and below)	------	------	------	------	650 ± 25
500 Crawler	------	------	------	425 ± 25	------
500 Series C Crawler ...	------	------	------	450 ± 25	------
2500 Constructall Tractor............	------	------	------	------	425 ± 25
4000 Series Forklift	------	------	------	------	425 ± 25
5000 Series Forklift	------	------	------	------	425 ± 25
High Idle					
F-140, I-140	1575 ± 25	------	------	------	------
F-240, I-240	2200 ± 25	------	------	------	------

* Includes gasoline and distillate unless otherwise designated.

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
General -- Continued					
High Idle - Continued					
F-340, I-340	------	2200 ± 25	------	------	------
F-404, I-404	------	------	2320 ± 25	------	------
I-424, 2424	------	------	------	2200 ± 25	------
I-444, 2444	------	------	------	------	2200 ± 25
F-504, I-504, 2504	------	------	------	------	2420 ± 25
3514 Loader (w/s.n. 1705 and below)	------	------	------	------	2570 ± 25
56, 57 Balers	2060 ± 25	------	------	------	------
91 Combine	------	2200 ± 25	------	------	------
93 Combine	------	------	------	------	2150 ± 25
105 Combine	------	------	------	------	2570 ± 25
203 Combine	------	------	------	------	2570 ± 25
201 Windrower	------	2200 ± 25	------	------	------
210 Windrower	------	------	------	------	2570 ± 25
225 Hay Swather	------	------	------	------	2570 ± 25
275 Windrower	------	------	------	------	2570 ± 25
375 Windrower (w/s.n. H-200 and below)	------	------	------	------	2570 ± 25
500 Crawler	------	------	------	2200 ± 25	------
500 Series C Crawler . . .	------	------	------	2730 ± 25	------

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
2500 Constructall Tractor	------	------	------	------	2420 ± 25
4000 Series Forklift . . .	------	------	------	------	2200 ± 25
5000 Series Forklift . . .	------	------	------	------	2420 ± 25
Rated Load					
F-140, I-140	1400 ± 10	------	------	------	------
F-240, I-240	2000 ± 10	------	------	------	------
F-340, I-340	------	2000 ± 10	------	------	------
F-404, I-404	------	------	2000 ± 10	------	------
I-424, 2424	------	------	------	2000 ± 10	------
I-444, 2444	------	------	------	------	2000 ± 10
F-504, I-504, 2504	------	------	------	------	2200 ± 10
3514 Loader (w/s.n. 1705 and below)	------	------	------	------	2380 ± 10
56, 57 Balers	1800 ± 10	------	------	------	------
91 Combine	------	2000 ± 10	------	------	------
93 Combine	------	------	------	------	2000 ± 10
105 Combine	------	------	------	------	2380 ± 10
203 Combine	------	------	------	------	2380 ± 10

* Includes gasoline and distillate unless otherwise designated.

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
General—Continued					
Rated Load - Continued					
201 Windrower	------	2000 ± 10	------	------	------
210 Windrower	------	------	------	------	2380 ± 10
225 Hay Swather	------	------	------	------	2380 ± 10
275 Windrower	------	------	------	------	2380 ± 10
375 Windrower (w/s.n. H-200 and below)	------	------	------	------	2380 ± 10
500 Crawler	------	------	------	2000 ± 10	------
500 Series C Crawler ...	------	------	------	2500 ± 10	------
2500 Constructall Tractor............	------	------	------	------	2200 ± 10
4000 Series Forklift	------	------	------	------	2000 ± 10
5000 Series Forklift	------	------	------	------	2200 ± 10
Horsepower (Rated) @ PTO Shaft (Rated eng. speed)					
F-140, I-140	23.7	------	------	------	------
F-240, I-240	31	------	------	------	------
F-340, I-340	------	36			
F-404, I-404					
Gas	------	------	36.7	------	------
LPG	------	------	33	------	------

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
I-424, 2424	------	------	------	35	------
I-504, 2504					
Gas	------	------	------	------	46.2
LPG	------	------	------	------	44.4
3514 Loader (w/s.n. 1705 and below)	------	------	------	------	46
500 Crawler	------	------	------	36	------
500 Series C Crawler ...	------	------	------	44	------
Compression ratio:					
Gas	7.3:1‡	7.6:1	7.5:1	7.6:1	7.5:1
LPG	------	------	7.8:1	------	7.8:1
** Compression pressure at cranking speed (150 rpm) with a motorite tester - psi:					
Gas	175#	180	180	180	180
LPG	------	------	185	------	185

* Includes gasoline and distillate unless otherwise designated.

** Compression pressures are based on the following conditions: Engine warmed up, battery fully charged, throttle wide open and all spark plugs removed.

Compression gauge readings given will apply at sea level barometric pressure. For each 1000 feet above sea level deduct 3-1/2 percent. For engines with high altitude pistons, the readings given will apply at 5000 feet. Deposits in combustion chambers will increase readings to some extent.

‡ Distillate - 4.8:1

Distillate - 95

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
General—Continued					
Crankcase refill capacity - quarts	5	5	5	5	5
Firing order	1-3-4-2	1-3-4-2	1-3-4-2	1-3-4-2	1-3-4-2
Crankcase					
Cylinder bore dia. - inches	------	------	------	3.3750-3.3775	3.3750-3.3775
Maximum allowable diametrical wear (at top of ring travel) - inch	------	------	------	.006	.006
Depth of cylinder sleeve flange bore - inches	.222-.224	.222-.224	.222-.224	------	------
Tappet bore, I.D. - inches	.5615-.5630	.5615-.5630	.5615-.5630	.5615-.5630	.5615-.5630
Crankshaft and Main Bearings					
Type	Counterbalanced	Counterbalanced	Counterbalanced	Counterbalanced	Counterbalanced
Number of main journals	3	3	3	3	3
Main journal diameter - inches	2.124-2.125	2.244-2.245	2.6235-2.6245	2.6235-2.6245	2.6235-2.6245
Maximum allowable out-of-round - inch	.003	.003	.003	.003	.003

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Maximum allowable taper - inch	.003	.003	.003	.003	.003
Crankpin diameter - inches	1.749-1.750	1.809-1.810	2.059-2.060	2.059-2.060	2.059-2.060
Maximum allowable out-of-round - inch	.003	.003	.003	.003	.003
Maximum allowable taper - inch	.003	.003	.003	.003	.003
Main bearings, type	Precision	Precision	Precision	Precision	Precision
Main bearings, running clearance - inch	.0009-.0039	.0009-.0039	.0009-.0039	.0009-.0039	.0009-.0039
Maximum allowable main bearing running clearance - inch	.0055	.0055	.0055	.0055	.0055
Thrust bearing location. . . .	Rear main bearing	Rear main bearing	Rear main bearing	Rear main bearing	Rear main bearing
Thrust bearing end clearance - inch	.004-.010	.004-.010	.004-.010	.004-.010	.004-.010
Maximum allowable end clearance - inch	.012	.012	.012	.012	.012

* Includes gasoline and distillate unless otherwise designated.

NOTE: For Ignition Timing Specifications, Refer to Page 1-26.

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Camshaft					
Drive	Helical gear	Helical gear	Helical gear	Helical gear	Helical gear
Cam lobe lift (total) - inch					
Intake	.2400 ± .0020 †	.2400 ± .0020	.2740 ± .0020	.2740 ± .0020	.2740 ± .0020
Exhaust	.2400 ± .0020 †	.2400 ± .0020	.2780 ± .0020	.2780 ± .0020	.2780 ± .0020
Maximum allowable camshaft lobe wear - inch	.020	.020	.020	.020	.020
Front bearing journal diameter - inches	1.8110-1.8120	1.8110-1.8120	1.8110-1.8120	1.8110-1.8120	1.8110-1.8120
Center bearing journal diameter - inches	1.5770-1.5780	1.5770-1.5780	1.5770-1.5780	1.5770-1.5780	1.5770-1.5780
Rear bearing journal diameter - inches	1.4990-1.5000	1.4990-1.5000	1.4990-1.5000	1.4990-1.5000	1.4990-1.5000
Thrust taken by	Thrust plate	Thrust plate	Thrust plate	Thrust plate	Thrust plate
Number of bearings	3 (one replaceable two integral)	3 (one replaceable two integral)	3 (one replaceable two integral)	3 (one replaceable two integral)	3 (one replaceable two integral)
Bearing running clearance - inch	.0009-.0054	.0009-.0054	.0009-.0054	.0009-.0054	.0009-.0054
Maximum allowable running clearance - inch . .	.006	.006	.006	.006	.006
Camshaft end play	.003-.012	.003-.012	.003-.012	.003-.012	.003-.012

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Connecting Rods					
Type	I - Beam	I - Beam	I - Beam	I - Beam	I - Beam
Side clearance - inch	.005-.014	.005-.014	.005-.014	.005-.014	.005-.014
Bearing running clearance - inch	.0009-.0034	.0009-.0034	.0009-.0039	.0009-.0039	.0009-.0039
Maximum allowable bearing running clearance - inch	.006	.006	.006	.006	.006
Bearing type	Precision	Precision	Precision	Precision	Precision
Bearing O.D. and spread . . .	1.876 + .030	1.9375 + .020	2.1875 + .020	2.1875 + .020	2.1875 + .020
Pistons					
Type	Cam ground	Cam ground	Cam ground	Cam ground	Cam ground
Material	Aluminum alloy	Aluminum alloy	Aluminum alloy	Aluminum alloy	Aluminum alloy
Overall length (std. alt.) - inches:					
Gasoline	3-47/64	3-31/64	3-45/64	3-31/64	3-31/64
Distillate	3-31/64	-------	-------	-------	-------

* Includes gasoline and distillate unless otherwise designated.

† Engines with serial number 95097 and up: Intake $.2740 \pm .0020$
Exhaust $.2780 \pm .0020$

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Pistons—Continued					
Diameter - inches	3.1232-3.1257	3.2482-3.2507	3.2482-3.2507	3.3735-3.3760	3.3735-3.3760
Skirt clearance, bottom - inch .... (measured at 90° from pin hole) (Refer to instructions on page 1-39)	.0011-.0019	.0011-.0019	.0011-.0019	.0010-.0020	.0010-.0020
Number of rings per piston	3	3	3	3	3
Piston pin hole bore - inch	.9195-.9198	.8593-.8596	.8593-.8596	.8593-.8596	.8593-.8596
Width of ring groove:					
Top compression - inch	.0965-.0975	.0965-.0975	.0965-.0975	.0965-.0975	.0965-.0975
Second compression - inch	.095-.096	.095-.096	.095-.096	.095-.096	.095-.096
Oil control - inch.......	.2505-.2515	.1880-.1890	.1885-.1895	.1885-.1895	.1885-.1895
Ring clearance in groove:					
Top compression - inch	.0030-.0045	.0030-.0045	.0030-.0045	.0030-.0045	.0030-.0045
Second compression - inch	.0015-.0030	.0015-.0030	.0015-.0030	.0015-.0030	.0015-.0030
Oil control - inch........	.0015-.0030	.0015-.0030	.0015-.0030	.0020-.0035	.0020-.0035

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Piston Pins					
Type	Full floating	Full floating	Full floating	Full floating	Full floating
Diameter - inch.	.9192-.9195	.8591-.8593	.8591-.8593	.8591-.8593	.8591-.8593
Length - inches	2.483-2.493	2.738-2.753	2.738-2.753	2.738-2.753	2.738-2.753
Clearance between end of pin and retainer ring - inch	.005-.039	.005-.039	.005-.055	.005-.055	.005-.055
Maximum allowable clearance in rod bushing - inch	.004	.004	.003	.003	.003
Maximum allowable clearance in piston - inch	.0025	.0025	.0025	.0025	.0025
Piston Rings					
Compression:					
Number of rings per piston	2	2	2	2	2
Type:					
Top	Chrome, thickwall	Chrome, thickwall	Chrome, thickwall	Chrome, thickwall	Chrome, thickwall
Second	Plain	Plain	Plain	Plain	Plain

* Includes gasoline and distillate unless otherwise designated.

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Piston Rings—Continued					
Width of ring:					
Top	.0930-.0935	.0930-.0935	.0930-.0935	.0930-.0935	.0930-.0935
Second	.0930-.0935	.0930-.0935	.0930-.0935	.0930-.0935	.0930-.0935
Oil Control Rings					
Type	Chrome wide slot	Chrome wide slot	Chrome wide slot	Chrome wide slot	Chrome wide slot
Number per piston	1	1	1	1	1
Width - inch	.2485-.2490	.1860-.1865	.1860-.1865	.1860-.1865	.1860-.1865
Ring gap	See Note	See Note	See Note	See Note	See Note
Cylinder Sleeves					
Type	Wet, replaceable	Wet, replaceable	Wet, replaceable	------	------
Diameter, inside - inches	3.1252-3.1272	3.2502-3.2522	3.2502-3.2522	------	------
Length - inches	7.000	7.000	7.000	------	------

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Flange thickness - inch....	.227-.229	.227-.229	.227-.229	------	------
Depth of cylinder sleeve flange bore in crankcase - inch	.222-.224	.222-.224	.222-.224	------	------
Maximum allowable diametrical sleeve wear (at the top of ring travel) (out-of-round) - inch	.006	.006	.006	------	------
Top surface of cylinder sleeve flange extends above top surface of crankcase - inch........	.003-.007	.003-.007	.003-.007	------	------
Cylinder sleeve taper (top to bottom of piston travel) - inch	.005	.005	.005	------	------
Valves					
Head diameter:					
Intake:					
Gasoline - inches......	1.495-1.505	1.495-1.505	1.495-1.505	1.495-1.505	1.495-1.505
Distillate - inches	1.337-1.347	------	------	------	------
Exhaust					
Gasoline - inches......	1.307-1.317	1.307-1.317	1.307-1.317	1.307-1.317	1.307-1.317
Distillate - inches	1.151-1.161	------	------	------	------

* Includes gasoline and distillate unless otherwise designated.

NOTE: Chrome rings must not be filed to increase the gap since the chrome will chip.

Ring gaps are checked by inserting the ring into the bore and measuring the gap with a feeler gauge. The minimum permissible gap is .010". Maximum gap in a new sleeve or bore (except .010" O.S. bore) should not exceed .035". On sleeveless engines a standard ring in a .010" O.S. bore should not exceed .065" gap.

Each .001" of bore wear will increase the ring gap about .0032".

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Valves—Continued					
Face angle - degrees	45-1/2	45-1/2	45-1/2	45-1/2	45-1/2
Stem diameter:					
Intake and exhaust - inch	.3405-.3415	.3405-.3415	.3405-.3415	.3405-.3415	.3405-.3415
Clearance in guide:					
Intake and exhaust - inch	.0015-.0035	.0015-.0035	.0015-.0035	.0015-.0035	.0015-.0035
Maximum allowable stem clearance in guide - inch	.006	.006	.006	.006	.006
Valve Seats					
Seat angle - degrees	45	45	45	45	45
Seat width:					
Intake and exhaust - inch	.070-.080	.070-.080	.070-.080	.070-.080	.070-.080
Valve Guides					
Length - inch	2-11/16	2-11/16	2-11/16	2-11/16	2-11/16
Inside diameter - inch	.343-.344	.343-.344	.343-.344	.343-.344	.343-.344
Maximum allowable flat on ends - inch	.010	.010	.010	.010	.010
Installed height above cylinder head surface - inch	13/16	13/16	13/16	13/16	13/16

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Valve Springs					
Free length - inches:					
Gasoline (Note 1)	2-13/32	2-47/64	2-13/32	2-13/32	2-13/32
Distillate	2-47/64 ± 3/64	------	------	------	------
Test length - inches					
Gasoline (Note 1)	1-11/16	1-11/16	1-11/16	1-11/16	1-11/16
Distillate	1-43/64	------	------	------	------
Test load - pounds:					
Gasoline (Note 1)	73-81	49-54.6	73-81	73-81	73-81
Distillate	40-44	------	------	------	------
Springs used with roto cap:					
Free length - inches	2-1/4	2-1/4	2-1/4	2-1/4	2-1/4
Test length - inches	1-29/64	1-29/64	1-29/64	1-29/64	1-29/64
Test load - pounds	80-87	80-87	80-87	80-87	80-87

* Includes gasoline and distillate unless otherwise designated.

NOTE 1: C-123 w/serial number 120979 and below, C-135 w/serial number 120229 and below, C-146 w/serial number 015949 and below and C-153 w/serial number 042264 and below use springs with a free length of 2-47/64 inches, test length of 1-11/16 inches and test load of 49 to 54.6 pounds.

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Valve Tappets					
Diameter - inches	.560-.561	.560-.561	.560-.561	.560-.561	.560-.561
Length - inches	2-5/16	2-5/16	2-5/16	2-5/16	2-5/16
Tappet clearance in guide - inch	.0005-.0030	.0005-.0030	.0005-.0030	.0005-.0030	.0005-.0030
Push rod diameter - inch	9/32	9/32	9/32	9/32	9/32
Push rod (bottom of cup to ball tip) length - inches	10-19/32- 10-41/64	10-19/32- 10-41/64	10-19/32- 10-41/64	10-19/32- 10-41/64	10-19/32- 10-41/64
Valve Lever and Shaft					
Valve lever shaft diameter - inch	.748-.749	.748-.749	.748-.749	.748-.749	.748-.749
**Valve lever bushing inside diameter - inch	.751-.752	.751-.752	.751-.752	.751-.752	.751-.752
Valve lever clearance on shaft - inch	.002-.004	.002-.004	.002-.004	.002-.004	.002-.004
Maximum allowable valve lever clearance on shaft - inch	.006	.006	.006	.006	.006
Tappet clearance (engine warm, not running) - inch	.014†	.014	Int. .014 Exh. .020	Int. .014 Exh. .020	Int. .014 Exh. .020

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Valve Timing					
NOTE: Tolerance for valve time is $\pm$ 8°. Valve clearance <u>MUST</u> be set to the specified clearance.					
Intake opens - degrees	15 before TDC	15 before TDC	15 before TDC	15 before TDC	15 before TDC
Intake closes - degrees	45 after BDC	45 after BDC	45 after BDC	45 after BDC	45 after BDC
Exhaust opens - degrees ...	45 before BDC	45 before BDC	45 before BDC	45 before BDC	45 before BDC
Exhaust closes - degrees ..	10 after TDC	10 after TDC	10 after TDC	10 after TDC	10 after TDC
Timing Gears					
Backlash - inch	.003-.006	.003-.006	.003-.006	.003-.006	.003-.006
Maximum allowable backlash - inch.........	.009	.009	.009	.009	.009

* Includes gasoline and distillate unless otherwise designated.

** Valve lever bushing is not replaceable.

† Engines with Serial Number 95097 and up: .014 int. .020 exh.

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Lubrication System					
Oil pressure at rated rpm - psi	45-55	45-55	45-55	45-55	45-55
Oil pump					
Type	Spur gear	Spur gear	Spur gear	Spur gear	Spur gear
Oil intake	Floating screen	Floating screen	Floating screen	Floating screen	Floating screen
Drive from	Camshaft	Camshaft	Camshaft	Camshaft	Camshaft
End clearance between gear and end plate - inch	.0035-.0060	.0035-.0060	.0035-.0060	.0035-.0060	.0035-.0060
Clearance, gear to housing - inch	.007-.013	.007-.013	.0068-.0108	.0068-.0108	.0068-.0108
Backlash - inch	.004-.006	.004-.006	.004-.006	.004-.006	.004-.006
Drive shaft diameter - inch	.4885-.4890	.4885-.4890	.4885-.4890	.4885-.4890	.4885-.4890
Drive shaft running clearance - inch	.0010-.0025	.0010-.0025	.0010-.0035	.0010-.0035	.0010-.0035
Idler gear running clearance, in on shaft - inch	.0015-.0030	.0015-.0030	.0015-.0030	.0015-.0030	.0015-.0030
Clearance between body and drive pinion - inch	.002-.004	.002-.004	.002-.004	.002-.004	.002-.004

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Oil filter (engine)					
Number used	1	1	1	1	1
Oil pressure valve location	Oil pump body	Oil pump body	Oil pump body	Oil pump body	Oil pump body
Oil pressure valve regulating spring					
Free length - inches	2.398	2.398	2.398	2.398	2.398
Test length - inches	1.674	1.674	1.674	1.674	1.674
Test load - pounds	24.2	24.2	24.2	24.2	24.2
Pressure regulating valve					
Valve diameter - inch	.743-.745	.743-.745	.743-.745	.743-.745	.743-.745
Valve clearance in bore - inch	.003-.007	.003-.007	.003-.007	.003-.007	.003-.007
Water Pump					
Type of seal	Packless	Packless	Packless	Packless	Packless
Rotation, drive end	Clockwise	Clockwise	Clockwise	Clockwise	Clockwise
Clearance from shaft to face of impeller hub - inch	.112 $\pm$ .005	.112 $\pm$ .005	.112 $\pm$ .005	.112 $\pm$ .005	.112 $\pm$ .005
Drive	Fan belt	Fan belt	Fan belt	Fan belt	Fan belt
Shaft bearing lubrication . . .	Sealed	Sealed	Sealed	Sealed	Sealed

* Includes gasoline and distillate unless otherwise designated.

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Thermostat					
Number used	1	1	1	1	1
Open at, degrees F	167-172	167-172	167-172	167-172	167-172
Wide open at, degrees F	192	192	192	192	192
Engine Governor					
Governor pin to weight clearance - inch	.001-.003	.001-.003	.001-.003	.001-.003	.001-.003
Spring Number					
140 Tractor series	389 987 R1	------	------	------	------
240 Tractor series	369 686 R2	------	------	------	------
56 and 57 Balers	46 944 DA	------	------	------	------
340 Tractor series, 91 Combine and 201 Windrower	------	369 686 R2	------	------	------
404 Tractor series	------	------	46 944 DA	------	------
424 and 2424 Tractor series and 500 Crawler Tractor	------	------	------	389 452 R1 (1)	------
444 and 2444 Tractor series and 4000 series Forklift	------	------	------	------	389 452 R1
500 series C Crawler Tractor	------	------	------	381 242 R1	------

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
504 and 2504 Tractor series, 3514 Loader Tractor, 5000 series Forklift, Constructall 2500 Loader-Backhoe	------	------	------	------	369 686 R2
93 Combine	------	------	------	------	69 235 D
105 and 203 Combine, 210, 275 and 375 Windrowers and 225 Hayswather.	------	------	------	------	381 242 R1
Outside diameter - inch					
No. 46 944 DA	.5625	------	.5625	------	------
No. 389 987 R1	.8125	------	------	------	------
No. 369 686 R2	.6875	.6875	------	------	.6875
No. 389 452 R1	------	------	------	.865	.865
No. 381 242 R1	------	------	------	.707	.707
No. 69 235 D	------	------	------	------	.5625

* Includes gasoline and distillate unless otherwise designated.

(1) High speed spring part number and spring specifications are shown. Low speed spring part number is 389 451 R1. Refer to page 1-46 and Illust. for correct spring installation procedure.

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Engine Governor—Continued					
Wire size - inch					
No. 46 944 DA	.080	------	.080	------	------
No. 389 987 R1	.0915	------	------	------	------
No. 369 686 R2	.092	.092	------	------	.092
No. 389 452 R1	------	------	------	.110	.110
No. 381 242 R1	------	------	------	.105	.105
No. 69 235 D	------	------	------	------	.080
Number of coils					
No. 46 944 DA	15	------	15	------	------
No. 389 987 R1	11	------	------	------	------
No. 369 686 R2	9	9	------	------	9
No. 389 452 R1	------	------	------	7	7
No. 381 242 R1	------	------	------	10	10
No. 69 235 D	------	------	------	------	13

	C-123 Serial Number 65001 and Up*	C-135 Below Serial Number 100,501	C-135 Serial Number 100,501 and Up Gas and LPG	C-146	C-153 Gas and LPG
Electrical	Refer to Electrical Specifications Manual GSS-1308-C				
Nut and Bolt Torque Data (Foot-pounds torque)					
Cylinder head	80-90	80-90	80-90	80-90	80-90
Connecting rod	43-49	43-49	43-49	43-49	43-49
Crankcase oil pan	11-19	11-19	11-19	11-19	11-19
Crankshaft pulley nut	130-150	130-150	130-150	130-150	130-150
Main bearing...........	75-80	75-80	75-80	75-80	75-80
Flywheel	37-45	45-52	45-52	45-52	45-52
Manifold..............	33-37	33-37	33-37	33-37	33-37
Spark plugs............	30-35	30-35	30-35	30-35	30-35

* Includes gasoline and distillate unless otherwise designated.

Ignition Timing (BTDC unless otherwise specified)	At Low Idle	*At High Idle
C-123 (w/s.n. 65001 and up)		
F-140, I-140 (up to s.n. 103556)	1^{o}	22^{o}
F-140, I-140 (s.n. 103557 and up)	1^{o} ATDC	14^{o}
F-240, I-240	1^{o}	30^{o}
56, 57 Balers	1^{o}	30^{o}
C-135 (w/s.n. 100,500 and below)		
F-340, I-340 (w/fire crater pistons)	1^{o} ATDC	25^{o}
F-340, I-340 (w/flat top pistons)	1^{o}	30^{o}
91 Combine (w/fire crater pistons)	1^{o} ATDC	25^{o}
91 Combine (w/flat top pistons)	1^{o}	30^{o}
201 Windrower	1^{o}	30^{o}
C-135 (w/s.n. 100,501 and above)		
F-404, I-404 (Gas and LPG)	0^{o}	20^{o}
C-146		
I-424, 2424	0^{o}	17^{o}
500 Crawler	0^{o}	17^{o}
500 Series C Crawler	2^{o}	20^{o}
C-153		
I-444, 2444	0^{o}	17^{o}
F-504, I-504, 2504 (Gas)	1^{o}	21^{o}
F-504, I-504, 2504 (LPG)	0^{o}	25^{o}
3514 Loader (w/s.n. 1705 and below)	1^{o}	21^{o}
93 Combine	0^{o}	17^{o}
105 Combine	1^{o}	21^{o}
203 Combine	1^{o}	21^{o}
210 Windrower	1^{o}	21^{o}
225 Hayswather	1^{o}	21^{o}
275 Windrower	1^{o}	21^{o}
375 Windrower (w/s.n. H-200 and below)	1^{o}	21^{o}
Constructall 2500 backhoe-loader	1^{o}	21^{o}
4000 Series fork lift	0^{o}	17^{o}
5000 Series fork lift	1^{o}	21^{o}

* Proper ignition timing at high idle is essential for best performance and engine life. Therefore, the distributor should be set to give the exact timing at high idle. Any variance that may exist then will occur at the low idle end of the advance curve.

SERVICE PROCEDURE

Valve Timing

Valve timing can be determined by checking only one valve. If the timing on the valve is within specification the other valves, barring extreme camshaft lobe wear or poor adjustment, will be in time.

The procedure for checking valve timing is as follows:

NOTE: The point of valve opening obtained here will not correspond with the specified valve opening. This checking procedure is used only to determine if valve timing is correct.

1. Adjust the No. 1 intake valve, with the engine set at No. 1 top dead center compression stroke to .021 inch valve lash.

2. Turn the engine forward to approximately bottom dead center.

3. Place a .004 inch feeler gauge between the valve lever and valve stem of the No. 1 intake valve and slowly rotate the engine <u>forward</u> until the feeler gauge becomes tight. This is the point at which the No. 1 intake valve starts to open which should be 11 degrees $\pm$ 4 degrees before top dead center.

NOTE: One tooth "out of time" equals approximately 11 degrees.

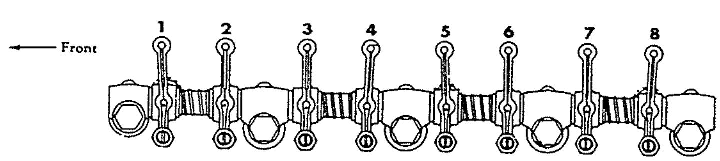
4. Readjust the No. 1 intake valve to its proper lash of .014 inch.

Valve Lash Adjusting Procedure

By referring to the chart below and using the simplified procedure outlined, all valves can be adjusted by cranking the engine only twice. The valve lash is adjusted with the engine warm which means any temperature above freezing. Valve lash can be adjusted while the engine is hot - however the quality of workmanship usually suffers due to the heat.

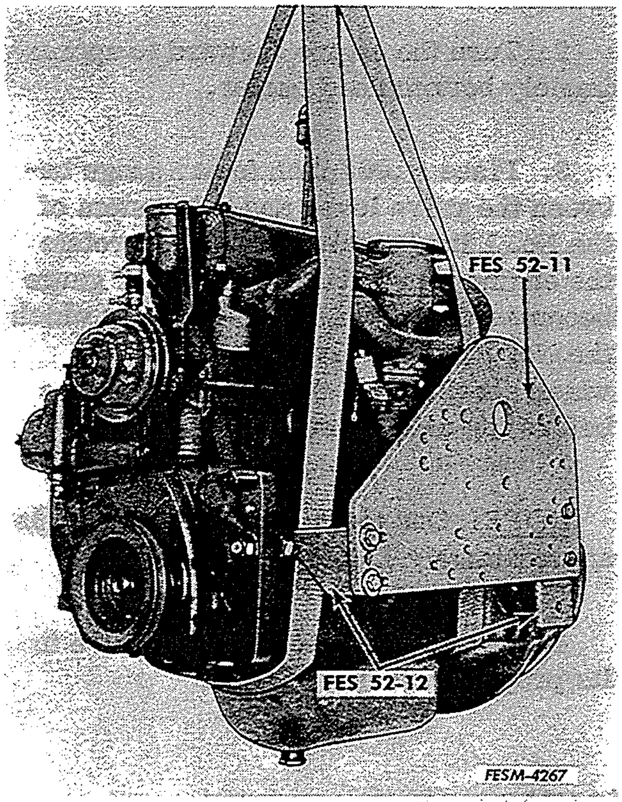
Four valves are adjusted when the No. 1 piston is at T.D.C. (Compression) and the remaining four are adjusted when the No. 4 piston is at T.D.C. (Compression). The following chart shows the numbering sequence of the valves which correspond to the chart. Refer to "Specifications" for specified clearance.

WITH	ADJUST VALVES (Engine Warm)							
No. 1 Piston at T.D.C. (Compression)	1	2	3		5			
No. 4 Piston at T.D.C. (Compression)				4		6	7	8



FESM-2324

Mounting the Engine to the Stand

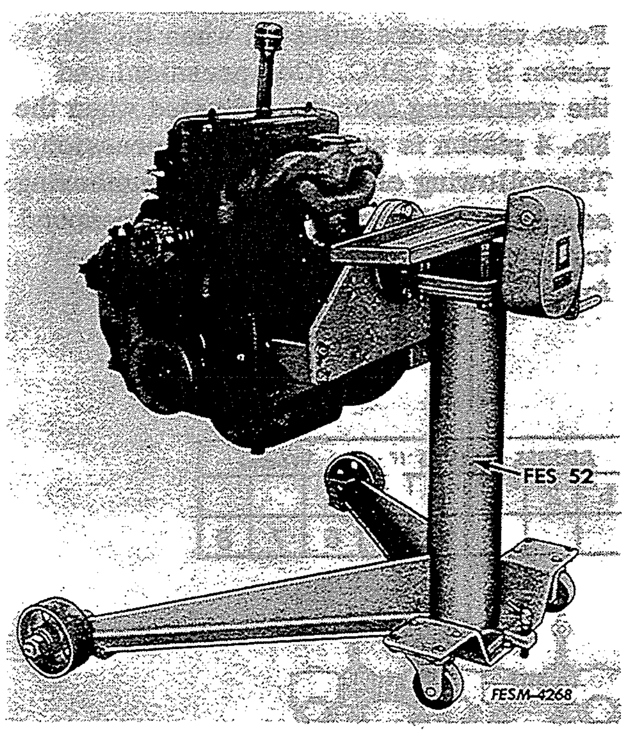


Install engine attaching plate FES 52-11 as follows:

Remove the starter, generator and generator bracket from the engine.

C-123: Install attaching plate FES 52-11.

C-135, C-146 and C-153: Install attaching plate FES 52-11 with attaching ears FES 52-12 as shown.



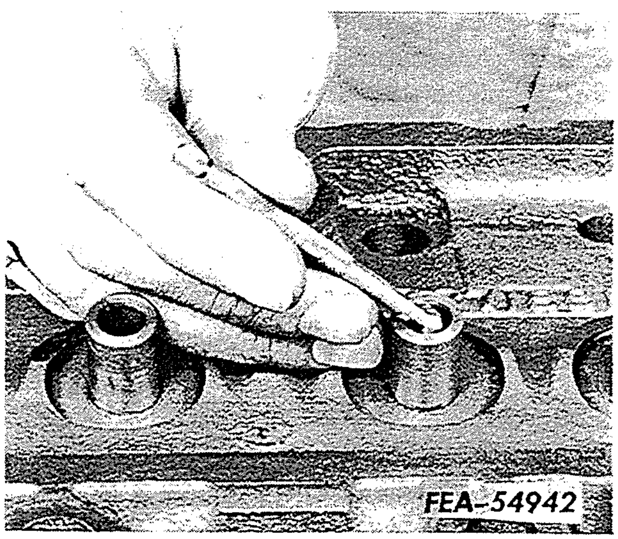
Mount the engine to engine stand FES 52.

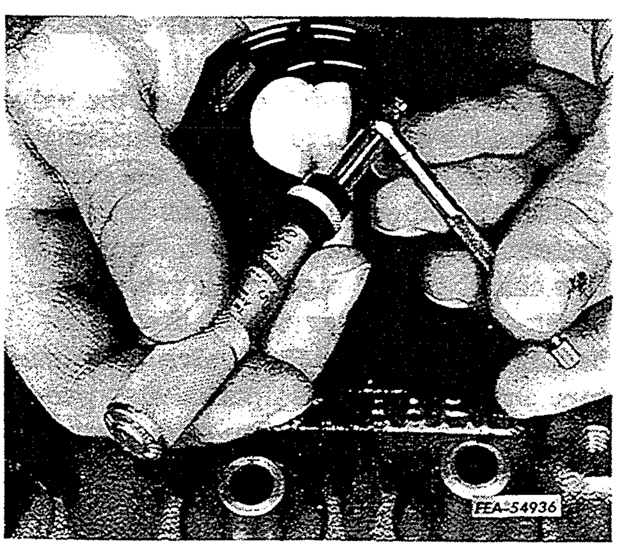
Cylinder Head and Valves

Cylinder Head

With the valves installed to protect the seats, clean the carbon deposits from the combustion chambers and valve heads with a wire brush and scraper.

Wash the head in cleaning solvent to remove dirt and grease from all surfaces and dry thoroughly. Check all water passages to make sure they are clear and open.





Examine the cylinder head for water leaks or cracks in the combustion chambers, exhaust ports, or around the valve seats. Inspect the machined or gasket surfaces for scratches or mars which may cause leakage after assembly.

Check the gasket surface of the cylinder head for trueness with a straightedge. Test by attempting to insert a .003" feeler gauge ribbon between the straightedge and cylinder head. If this is possible, either resurface or replace the cylinder head.

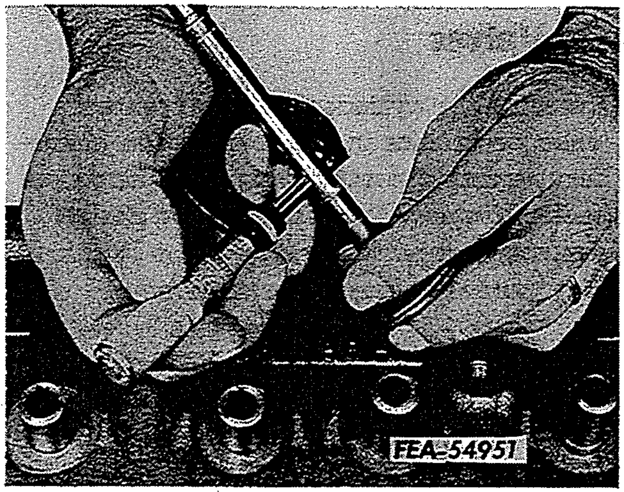
NOTE: When resurfacing the cylinder head do not remove more than .005" material, otherwise, contact between top of piston and head of valve may result.

Valves and Valve Guides

Discard valves which are obviously burned. Valves which are "necked" or "cupped" or which obviously will not have sufficient margin after refacing should be discarded. Valves with worn keeper grooves or badly worn tips should also be discarded. Clean the remaining valves on a brass wire brush.

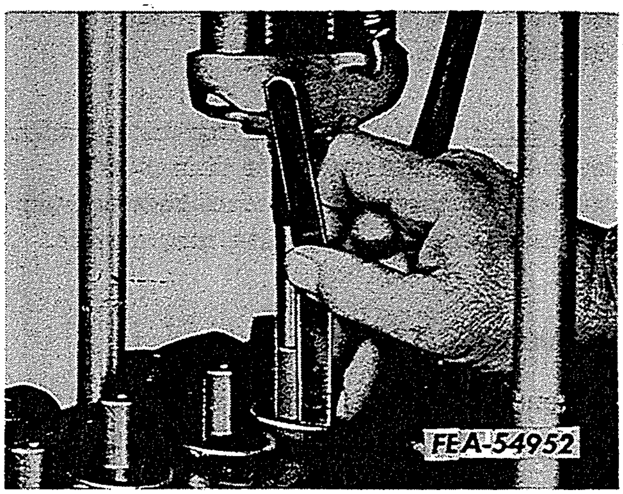
Use a valve guide cleaning brush in an electric drill to clean the I.D. of the valve guides. A cleaning solvent should be used on the brush.

Check valve guides and valve stems for excessive wear. Measure valve guides with a telescoping gauge and a micrometer as shown. Pay particular attention to guide wear at right angle to the valve lever shaft at the top of the valve guide.



FEA-54951

After the size of the valve guides has been determined, measure the valve stems at both top and bottom of the stem bearing area.

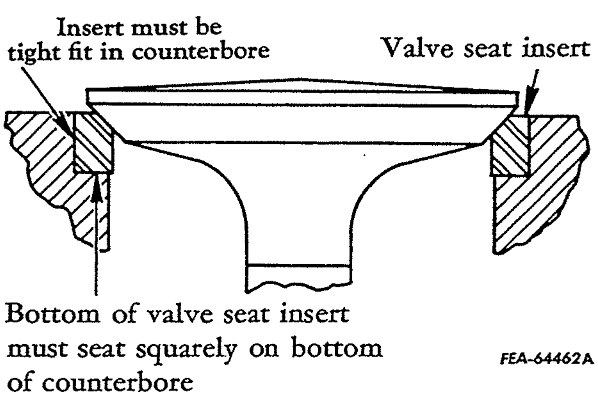


FEA-54952

If valve guides require replacement, use valve guide tools FES 6-4 (intake) and FES 6-5 (exhaust) with a press to remove the old guides and to install the new guides as shown. Use of these tools allow for guide installation from the top of the cylinder head without damage to the guide, thus facilitating checking of valve guide height during installation. Specified installed height is 13/16 inch. Valve guides installed with these tools will not require reaming. Check, however, to be sure that any burrs are removed from the upper and lower ends of the guide.

Valve Seats and Valve Seat Inserts

The primary purpose of a valve seat is to seal the combustion chamber against pressure losses and to provide a path to dissipate the heat accumulated in the valve head so as to prevent burning of the seat and warping of the valve head.

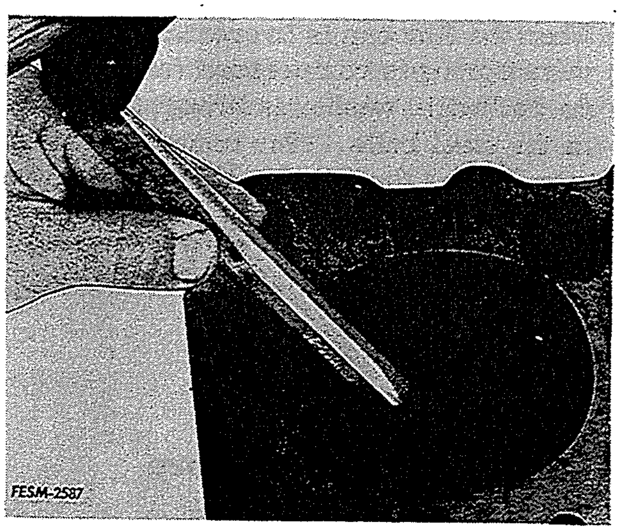


FEA-64462A

The location of the valve seat on the valve face and its width, controls the amount of valve head that protrudes into the combustion chamber. It is obvious that the greater the exposure within the combustion chamber, the higher the valve temperature; or in other words, the more heat it will collect. High valve temperature and poor heat dissipation also produce excessive valve stem temperatures. This will hasten the accumulation of carbon on the stems, causing them to stick in the guides.

Valve seat inserts should seldom need replacement. However, if a replacement is made, it is important that new inserts be peened securely in place by using either an insert peening tool or a dull pointed chisel, 1/4 inch wide, to peen cylinder head metal over the outer edge of the valve seat.

Valve seat inserts which are not fitted sufficiently tight, work loose, permitting carbon formations to collect on the outer surface of the insert, thus insulating the exhaust heat within the insert ring, preventing proper heat dissipation through the cylinder head.


FESM-2587

To assure maximum valve and valve seat insert life, it is essential that the valve insert be installed to obtain maximum contact with the bottom and sides of the counterbore in the head. Proper exhaust heat dissipation through the valve seat insert can only be accomplished by the insert being a tight fit in the cylinder head with the bottom of the insert squarely seated on the bottom of the counterbore as shown.

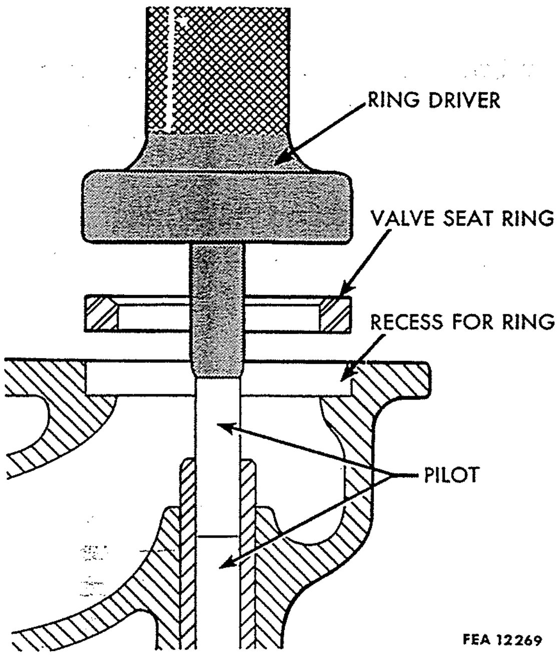
Removal

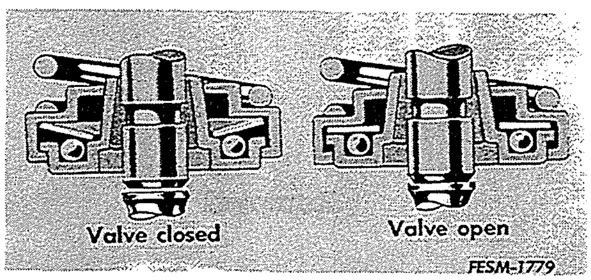
If necessary, remove valve seats with valve seat puller or use the large end of a punch to pry out old valve seat. Put the punch under valve seat and tap with hammer. Do not use the sharp end of a chisel as there is the danger of damaging the underside of the seat area, causing a poor contact around the insert or premature cylinder head failure.

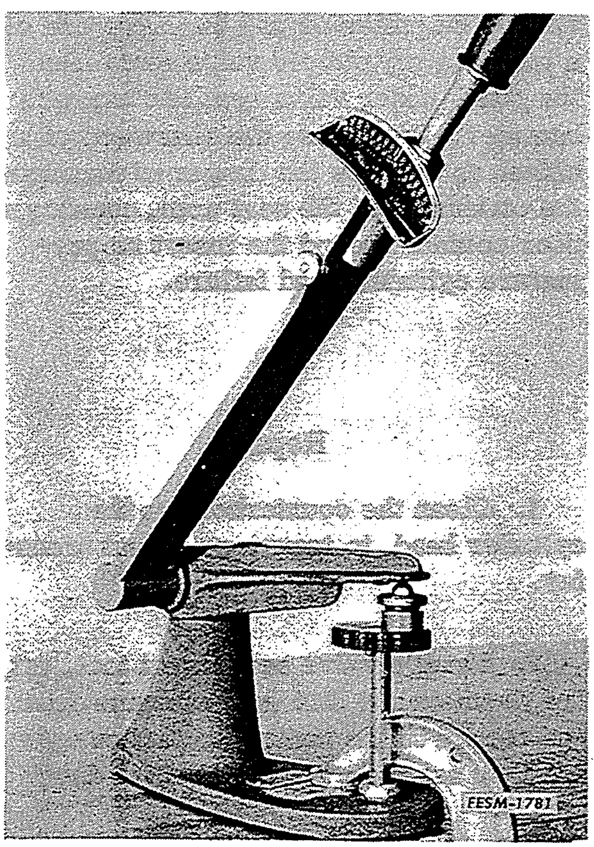
Repair

1. Clean the counterbore in the cylinder head, to insure good heat transfer.

2. Using a valve seat insert tool, cut the counterbore .010 inch oversize from the bottom of the insert counterbore (in head) to assure a square seat for the insert.







Installation

1. Chill the new valve seats with Liquid Freon or in dry ice before installation. This prevents metal scraping from the side of the counterbore, insuring full contact of the insert on the bottom and sides of the counterbore.

2. Install new insert using an insert driver as shown. Only two or three light blows with a hammer will be required to set the ring in place.

3. Properly seated, the insert should be recessed into the head from .008 to .030 in.

4. Using a suitable peening tool, peen the head metal over the edge and around the entire circumference of the insert.

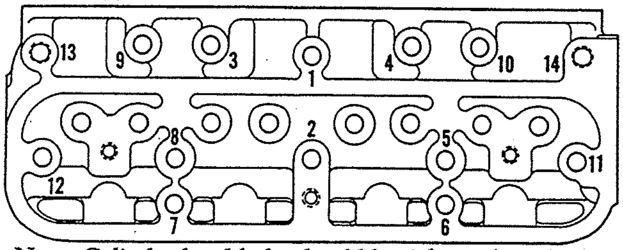
Rotocap

When the Rotocap is in operation, the valve spring is compressed (valve opened), the belleville washer is brought to bear on the steel balls. This causes the balls to roll down the ramp in the retainer thus rotating the valve.

Testing Rotators

Use any valve spring tester and a steel ball placed on an inner sleeve, then rapidly oscillate the load.

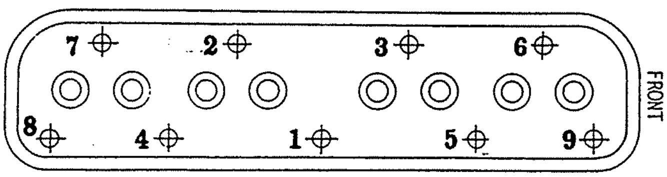
You should perform this oscillation up to the test load indicated in "Specifications". Be sure the rotator is lubricated internally. The rotators should be cleaned, checked and reinstalled at each overhaul period.



Note: Cylinder head bolts should be tightened gradually and alternately in the sequence shown.

FEA-64468

135 series serial number 100, 501 and up, 146 series and 153 series.



FEA-59140

123 series and 135 series below serial number 100, 501.

Cylinder Head Installation

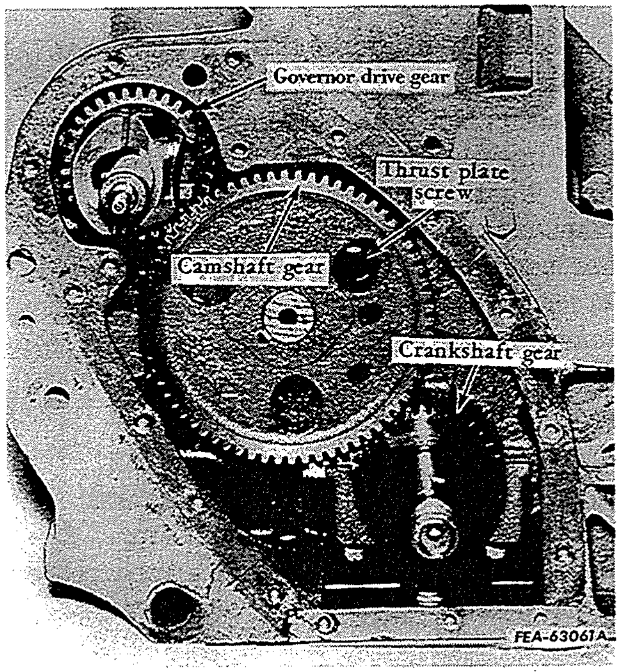
1. Apply a light coating of lubricant to the top of the crankcase, and install the cylinder head gasket. The gasket is suitably marked to prevent incorrect assembly. Position the cylinder head on the crankcase. Install and tighten the cylinder head nuts to 80 to 90 ft. lbs. torque. Torque must be applied to the nuts with a torque wrench. Torque the nuts in correct sequence as shown.

NOTE: Do not tighten to the full torque immediately; it is advisable to tighten to full torque in three steps. Retighten the cylinder head after the engine has been operated for 50 to 100 hours.

IMPORTANT: When retorquing cylinder head nuts, only those below proper torque are to be retorqued to specifications. The remaining nuts, complying with, or above torque specifications are to remain untouched.

2. Start engine and operate it until normal operating temperature is obtained. Check the ammeter and the engine oil pressure gauge as soon as engine is started. Listen for sounds or appearances indicative of faulty engine operation. Also recheck the cylinder head nut torque and tighten to 80 to 90 foot-pounds where necessary.

Timing Gear Train and Front Cover

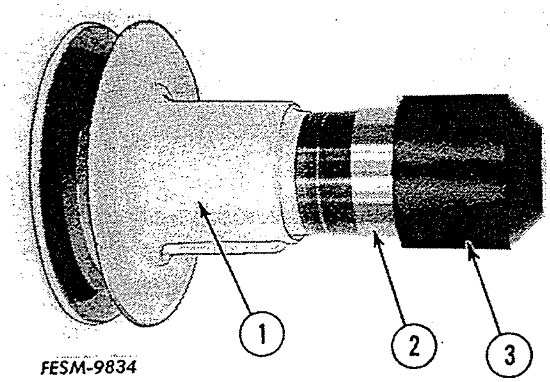


Crankshaft Pulley Removal

Remove the crankshaft pulley nut if present. Remove the crankshaft pulley using a suitable puller if necessary. C-123 and C-135 engines require a puller and special tool FES 33-1.

Front Cover

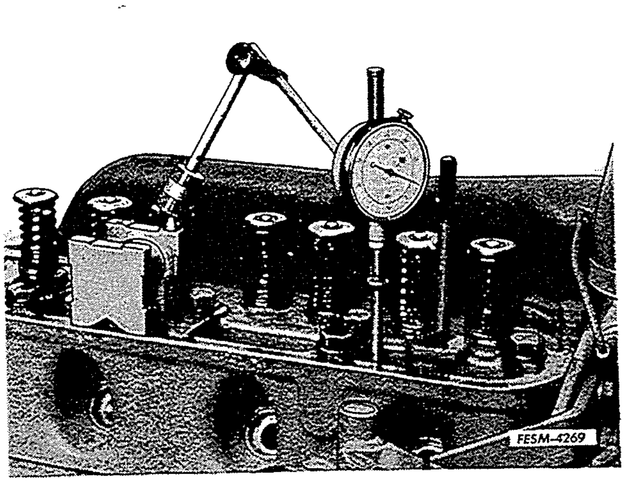
Remove the engine governor. Remove the cap screws securing the front cover and remove the cover. Shown is the complete timing gear train with timing gear marks aligned.



NOTE: Install a new wear sleeve onto the crankshaft pulley using the FES 33-4 fan drive pulley wear sleeve installer as shown. Be sure to apply a sealer onto the pulley O.D. or the I.D. of the wear sleeve before installing the wear sleeve onto the pulley.

1. Crankshaft pulley
2. Wear sleeve
3. FES 33-4 Fan drive pulley wear sleeve installer

Camshaft



Checking Camshaft Lobe Lift (Camshaft in Engine)

Preferred Method

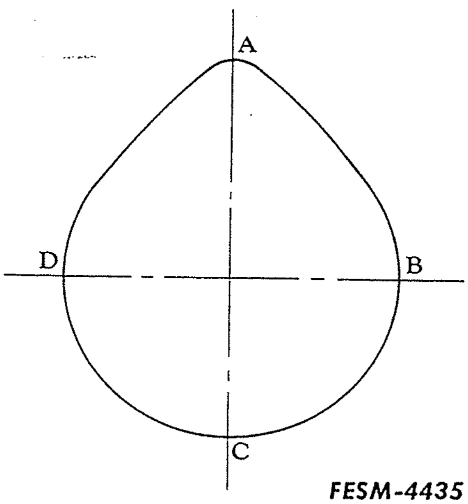
Camshaft lobe wear can be checked by the use of a dial gauge as shown.

Record the lift reading of each lobe and compare these readings with those listed in specifications. The camshaft must be replaced when .020 inch wear is indicated.

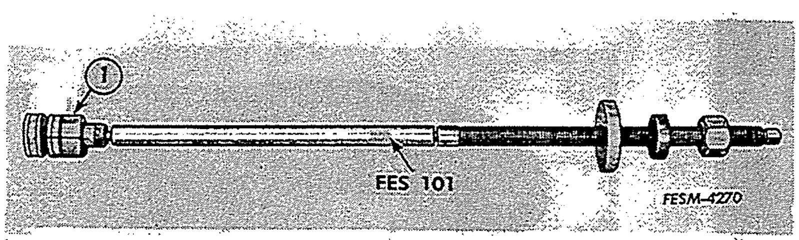
Checking Camshaft Lobe Wear (Camshaft Removed from Engine)

Alternate Method

Inspect the camshaft for indication of excessive lobe wear. If the lifting areas of the cam lobes, when compared with new camshaft, show amount of wear exceeding .020 inch, the camshaft must be replaced. If a new camshaft is not available for comparison, the cam lobe wear can be measured with a micrometer in the following manner. Take a reading across A-C and deduct the reading B-D; the difference should be the specified cam lift (refer to "Specifications"). The camshaft must be replaced when .020 inch wear is indicated. Inspect the camshaft journals and the oil pump drive gear for wear.



FESM-4435



1. Collet 817-9

Inspection and Repair

Measure camshaft bearings and camshaft journals to determine clearance. Maximum allowable running clearance is .006 inch.

Check the camshaft lobe wear and replace if necessary. (Refer to "Checking Camshaft Lobe Wear.")

Check for specified camshaft end play of .003 to .012 inch. Replace the thrust plate if necessary.

Installation

Camshaft bearing puller and installer set FES 101 (collet assembly 817-9) is used to remove the old bearing and install the new one.

NOTE: No reaming is required, therefore, be sure to prevent damage to bearing surface. Install camshaft bearing as follows:

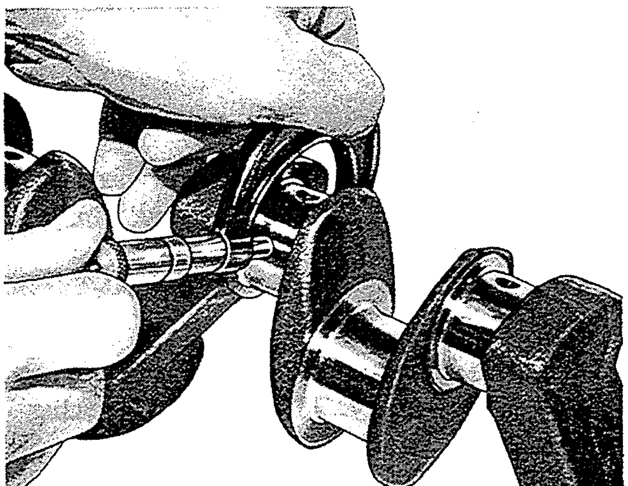
Front Bearing

Press in the front bearing with 20 degree chamfered edge to the rear. Align the bushing hole with the hole in the crankcase. The bushing must be pressed in until flush with the face of the crankcase.

Crankshaft

Inspection and Repair

1. Inspect the bearings for wear and evidence of uneven bearing support. Examine the bearing caps and supporting surfaces of the crankcase for high spots and burrs.



FEA-36204

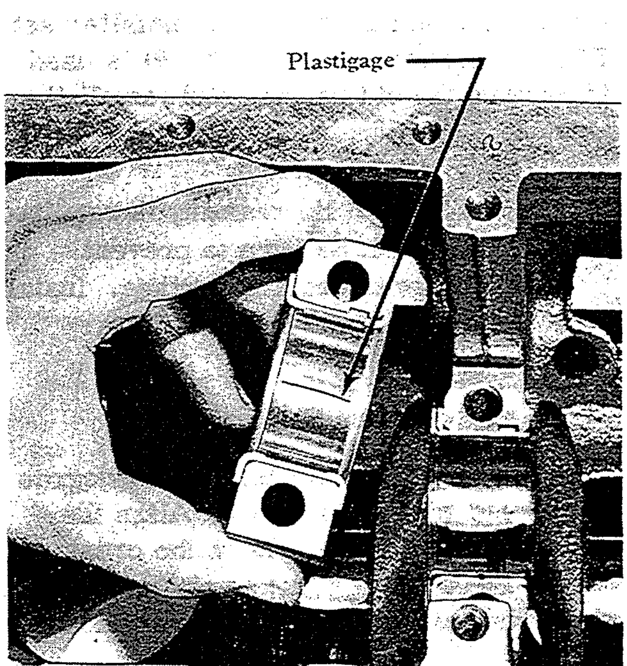
2. Inspect the crankshaft journals for scoring and measure the diameter of each journal with a micrometer. Refer to "Specifications" for specified journal diameter. Measure each journal at two points, one at right angles to the other, in order to detect any out-of-roundness.

Move the micrometer over the entire width of the journal.

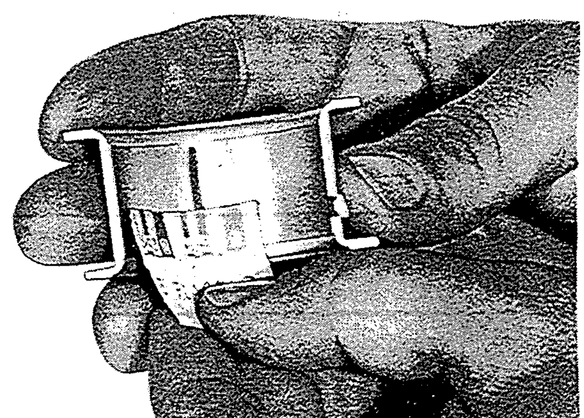
3. Check the connecting rod journals for out-of-round condition. Use a micrometer and take measurements at least three places around the journals. (Refer to "Specifications".)

4. Inspect the crankshaft gear teeth for excessive wear and chipping. If necessary to replace it, pull the gear with a puller.

5. Inspect the main bearing clearances using Plastigage or virgin lead. Specified bearing running clearance is .0009 to .0039 inch.



FESM-3273



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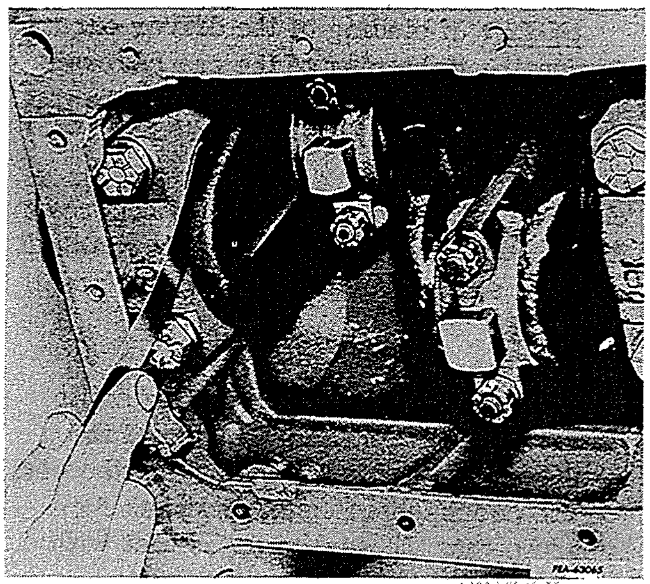


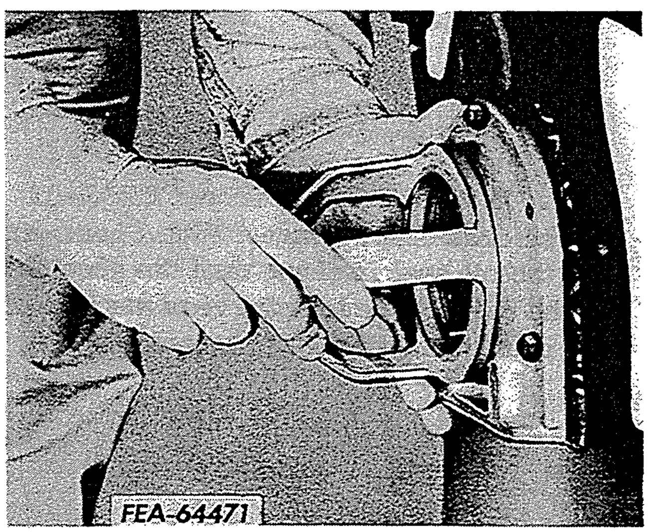
6. Check the crankshaft thrust bearing side clearance with a feeler gauge at the front side of the rear bearing on both upper and lower thrust faces. Specified side clearance is .004 to .010 inch.

While making this check, be sure the crankshaft is held against the rear thrust face of the bearing to show total clearance at front side.

7. Check the crankshaft end clearance with a feeler gauge. Maximum allowable end clearance is .012 inch.

Crankshaft Rear Oil Seal Installation

One Piece Oil Seal Retainer

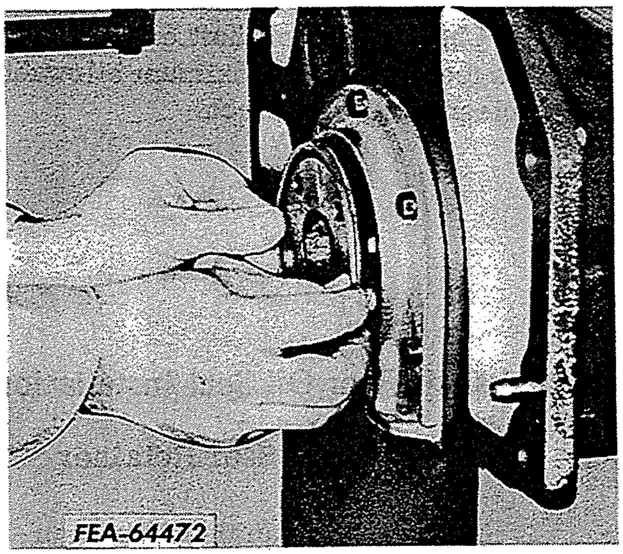


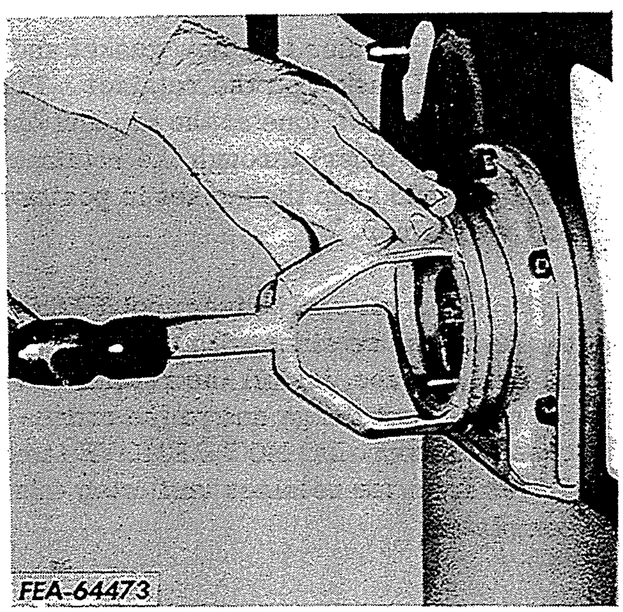
1. Thoroughly clean the gasket surfaces of the crankcase and the oil seal retainer.

2. Apply sealer to a new gasket and position the gasket on the retainer. Place three cap screws (one at the top and one opposite the other) through the retainer and gasket to keep the gasket in position on the retainer.

3. Using oil seal driver tool FES 6-15 to line up the retainer with the crankshaft oil seal surface, install the retainer over the crankshaft flange and to the crankcase as shown. DO NOT REMOVE the driver from the retainer until step 4 is completed.

4. With the driver remaining in position on the crankshaft and in the retainer, install the cap screws. Tighten the cap screws in sequence (one across from the other) rotating the driver in the retainer at the same time. Remove the driver after all the cap screws have been tightened.


FEA-64472


FEA-64473

NOTE: If binding of the driver occurs during the tightening of the cap screws the cap screws must be loosened and the tightening procedure repeated.

A freely rotating driver after the screws have been tightened means the crankshaft oil seal surface is aligned with the retainer.

5. Apply a film of lubricating oil to the oil seal, crankshaft flange and the seal bore in the retainer. Install the seal on the crankshaft flange, and push forward so that the seal is in contact with the retainer.

6. Push the seal forward by hand to insure that the sealing lip on the O.D. of the seal has entered the chamfer on the retainer around the entire circumference of the seal.

7. Position oil seal driver FES 6-15 on the crankshaft flange. With a hammer, tap the oil seal in place until the shoulder of the driver contacts the rear surface of the crankshaft flange.

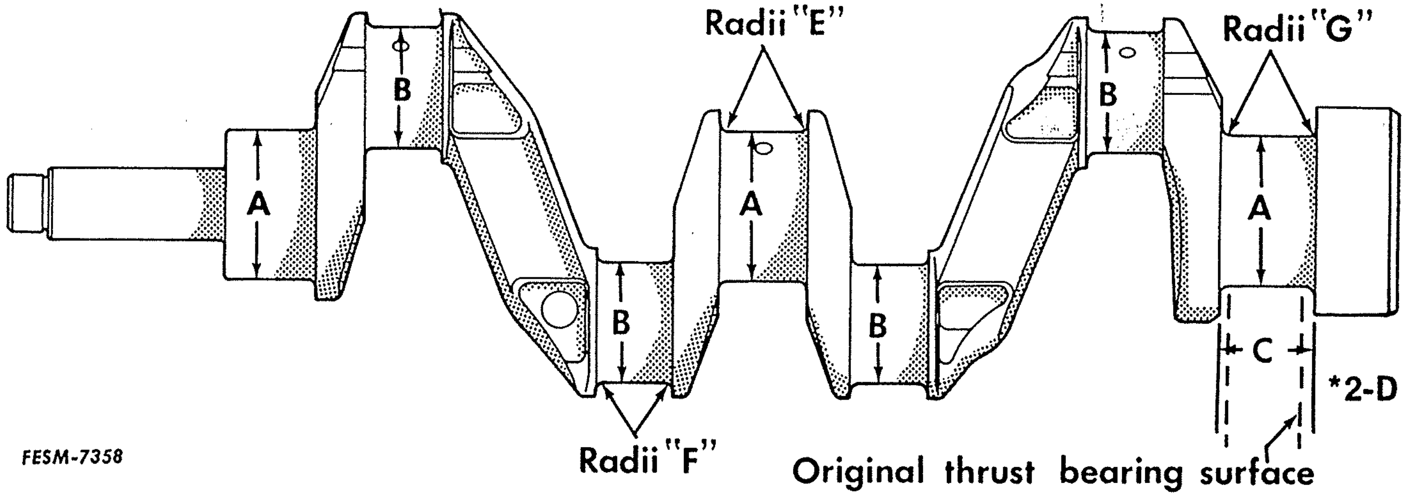
Split Type Retainers

(C-123 and C-135, with serial number 100,500 and below)

1. Install new rear oil seal felts in the oil seal retainer.

2. Install the retainer halves and tighten the cap screws.

Grinding Limits — Maximum allowable taper on crankpins and journals. .00015 per inch of length. Crankpins and journals must be polished, and must not be over .0005 out of round.



Engine	Undersize - inch	Main journal and thrust bearing journal A	Connecting rod journal B	Width for thrust bearing C	Distance from basic surface D*	Main brng. journal radius E	Connecting rod journal radius F	Thrust bearing journal radius G
C-123	.010	2.114-2.115	1.739-1.740	1.8495-1.8515	.002 *2-D	.039-.069	.100-.133	.118-.149
	.020	2.104-2.105	1.729-1.730	1.8535-1.8555	.004 *2-D			
	.030	2.094-2.095	1.719-1.720	1.8555-1.8575	.005 *2-D			
C-135	.010	2.6135-2.6145	2.049-2.050	1.636-1.638	.002 *2-D	.110-.130	.135-.155	.118-.149
C-146	.020	2.6035-2.6045	2.039-2.040	1.640-1.642	.004 *2-D			
C-153	.030	2.5935-2.5945	2.029-2.030	1.644-1.646	.006 *2-D			

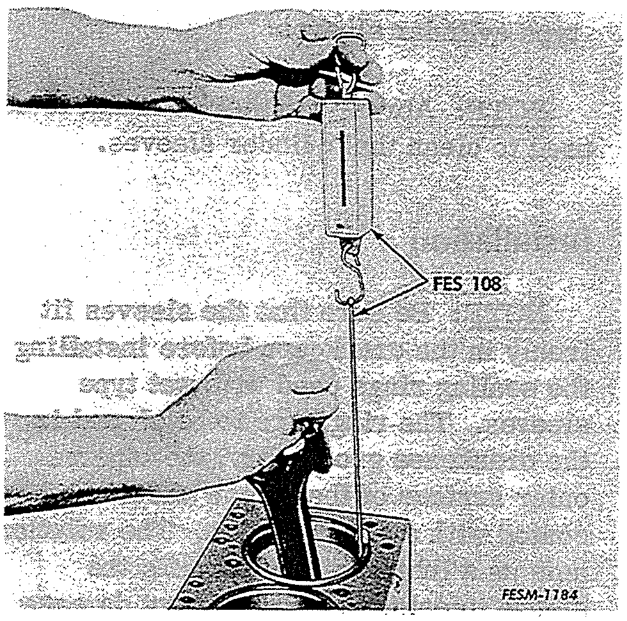
*Distance from original surface: *2-D = Remove specified material from thrust surface on rear side of crankshaft.

NOTE: Except for the thrust bearing width, all other journal widths must remain standard.

Piston Fit in Bore

Piston-to-bore clearance can be determined using a 1/2 inch wide feeler gauge and a spring-type tension scale (FES 108). Refer to "Specifications" for specified piston to bore clearance.

The thickness of the feeler gauge that can be removed with a 2 to 8 pound pull represents the piston-to-bore clearance as outlined in the "Piston Clearance Chart." Clearances should conform to specifications.



The chart at right shows the relationship between the feeler gauge thickness and pounds pull in measuring piston-to-bore clearance. Note that with a given feeler gauge thickness the actual clearance is less than the feeler gauge used when the pound pull is towards the high side of the pound pull range. This is especially true with the thinner feeler gauges.

To determine piston-to-bore clearance proceed as follows:

1. Select a feeler gauge (free of dents or burrs) of one of the thicknesses listed in the chart. Position the feeler gauge in the cylinder bore so that it extends the entire length of the piston 90° from the piston pin location.

2. Invert the piston and install it in the bore so that the end of the piston is about 1-1/2 inches below the top of the cylinder block and the piston pin is parallel to the crankshaft axis.

3. Hold the piston and slowly pull the scale in a straight line with the feeler gauge noting the pull required to remove the feeler gauge. Check three times and record the average of the three readings obtained. Do not bend or kink the feeler gauge.

4. Refer to the chart to determine the actual clearance. The clearance is shown where the horizontal column indicating pounds pull and the vertical column indicating the thickness of the feeler gauge used intersect.

EXAMPLE: If a .0015 inch feeler gauge is used and it takes 4 pounds pull to remove the feeler gauge, the clearance is .0013 inch.

5. Repeat step 3 with the piston at right angles to the crankshaft axis. Determine the clearance as instructed in step 4.

6. Measuring piston-to-bore clearance with the piston pin parallel and at right angles to the crankshaft axis will reflect any "out-of-round" in the bore.

PISTON CLEARANCE CHART

Feeler Gauge Thickness						
	.0015	.002	.003	.0035	.004	.0045
Pull in Lbs.	Clearance in Inches					
2	.0016	.0022	.0033	.0039	.0044	.005
4	.0013	.0018	.0029	.0035	.004	.0046
6	.001	.0015	.0026	.0031	.0036	.0042
8	.0008	.0013	.0023	.0028	.0033	.0038

Cylinder Sleeves

Description

The C-123 and C-135 engines use cylinder sleeves of the replaceable, wet liner type. When furnished as service parts, the cylinder sleeves cannot be obtained separately but only in combination with matched pistons. When installing a new set of sleeves and pistons, do not interchange the pistons and sleeves, or the piston pins, between the pistons.

Removal, Inspection and Repair

1. Each cylinder sleeve should be checked with an inside reading micrometer to determine taper, out-of-round or worn condition. Measure the diameter of the cylinder sleeve, at the top of the piston ring travel, at a right angle to the centerline of the crankshaft. Record the readings. Next, measure each bore so the gauge reading coincides with the centerline of the crankshaft. The difference between the readings is the out-of-round condition at the top of the bore. Repeat this same procedure at the bottom of the ring travel. The difference between the diameters measured at the top and bottom of the bore is the taper of the bore. Replace sleeves if worn beyond a serviceable clearance or taper. Refer to "SPECIFICATIONS."

2. Cylinder sleeve puller FES 22 with adapter plates FES 23-2 (C-123) and FES 23-3 (C-135) is used to remove cylinder sleeves. If difficulty is encountered, use dry ice packed in the sleeve around the puller to cold-shrink the sleeve.

3. Clean the sleeves in a cleaning solvent, and dry them with compressed air. Clean out the water jacket in the crankcase, and clean out the cylinder sleeve sealing ring grooves on the wet type cylinder sleeves.

NOTE: Abrasive material is not to be used to clean the cylinder sleeves.

Installation

NOTE: Be sure that the sleeves fit freely in the crankcase before installing the sealing rings used with wet type sleeves. The rings are to be placed in the crankcase groove dry; the tapered outer surface of the sleeve should be coated with a soap solution. The solution acts as a lubricant and permits the sleeve to enter the ring without damage to it.

1. Install the sealing rings in the crankcase grooves.

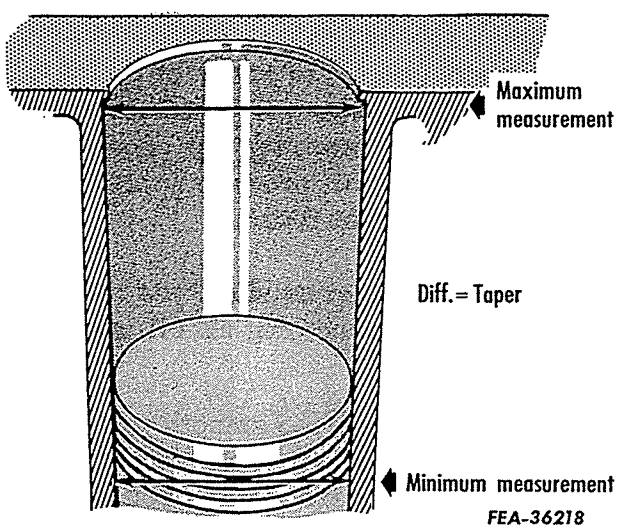
2. Insert the cylinder sleeves into the crankcase and hand-push them into position. If the rubber sealing ring is accurately installed and not pinched, the sleeve should enter easily into its position.

3. Install the connecting rods and pistons. Install the bearing caps.

Crankcase Cylinder Re-Boring Procedure

This section covers re-boring of the cylinder bore with the engine disassembled. However, if re-boring is the only service to be performed on the engine, the crankshaft need not be removed.

NOTE: When the crankshaft is not removed, cover the crankshaft and plug all oil passages.



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When to Re-Bore

Replacement piston ring kits may be used to extend the life of the piston if cylinder wear has not been excessive. Inspect cylinder bores for scoring and roughness which indicate excessive wear. Check cylinder bores for taper and out-of-round by the use of a cylinder gauge placed at the top, middle, and bottom of bores, both parallel and at right angle to the centerline of crankshaft. To be within safe limits, the taper from top to bottom of the ring travel area must not exceed 0.005 in. and the out-of-round (egg-shape) condition must not exceed .005 in. in the cylinder bores. If the bore is worn beyond these limits, a re-boring job is required. It is advisable to re-bore for the smallest possible oversize pistons and rings. If only one or two bores require correction, it is not necessary to re-bore all cylinders to the same oversize.

Preparing the Block

Clean the water jackets with materials that will remove rust and scale and then flush thoroughly. Degrease the crankcase so that the abrasive material from the boring operation may be completely removed before reassembly.

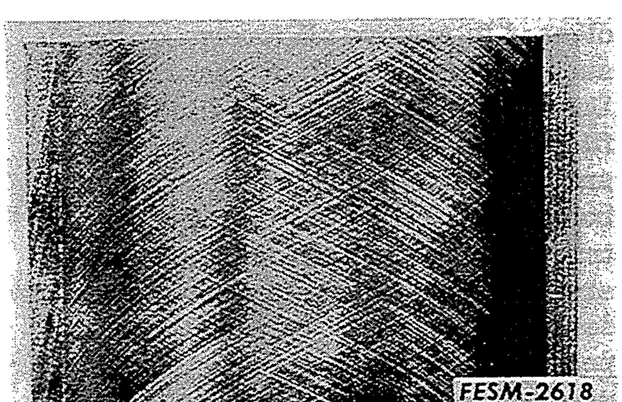
Before setting up a boring machine on the block, the top of block must be carefully cleaned to remove all foreign materials, such as carbon, rust, or gasket cement. Use a 14 in. fine-cut, mill file to draw-file the block for removal of all burrs and high spots around the top edge and bolt holes. This will provide a smooth, true working surface for the boring operation. This is very important because the alignment of the cylinder bores depends entirely on the trueness of this working surface.

Re-Boring

When re-boring cylinders, all crankshaft bearing caps must be in place and torqued to specifications to avoid possible distortion of bores in final assembly. If all bores require the same correction, to save time, bore the cylinder having the greatest amount of wear and taper first. If this cylinder cleans up to the smallest desired oversize, you can be sure that the remaining, smaller cylinder bores will clean up to the same size. Oversize pistons normally furnished for service are .010 in., .020 in., .030 in., and .040 in. oversize. No attempt should be made to cut down oversize pistons to fit cylinder bores.

To center the boring machine on each cylinder, follow closely the instructions of the boring machine manufacturer.

NOTE: If the crankshaft has not been removed, be sure the crankshaft is out of the way of the boring cutter when boring each cylinder.



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Use a good single point boring bar with a sharp tool and bore all cylinders the same size, to within .002 to .001 in. of the desired finished oversize to permit finishing honing operations.

Honing

For best results, hone the cylinders to the finished size. This operation must remove all boring tool marks. Final finish should be in the range of 20 to 35 micro-inches. If you have no means for measuring the finish, the use of about 120 grit stones will produce approximately the correct finish.

NOTE: If the crankshaft was not removed, cover it and plug all oil passages.

Cylinders that are too smooth will retard run-in and may result in ring scuffing. When cylinders are too rough, rapid ring wear will result. A rigid type wet hone is preferred for the final sizing operation, but a spring hone of the glaze-breaking type may be used if the other is not available. Spring hones should be equipped with 220 grit stones and stock removal should not exceed 0.003 in. This type of hone should be dipped into SAE 10 or 20 lubricating oil before beginning the operation. Dull or dirty stones cut unevenly and generate excessive heat. Keep honing equipment sharp and clean. When finished honing, pass the hone through the entire cylinder bore at a rate of 60 cycles per minute or as necessary to provide a 30 degree (relative to the top of the sleeve) cross-hatch pattern on cylinder walls. This will insure maximum ring life and minimum oil consumption.

Cleaning

The success of any re-boring job depends on the accuracy and smoothness of the finished bores, the amount of piston clearance, and the thoroughness with which you clean the block and crankcase of all cuttings and abrasive materials resulting from boring and honing. The best re-boring job will be a total loss unless the crankcase is thoroughly cleaned. Foreign material which remains causes rapid wear of pistons, rings, and cylinder walls, and will seriously damage engine bearings.

For thorough cleaning of the crankcase, washing in a tank of hot, agitated cleaning solution is the recommended procedure. If this cannot be done, use a good cleaning solution and air pressure blast followed by careful wiping with clean cloths and light lubricating oil. Surfaces should be wiped until a clean cloth shows no discoloration. Wash and blow out oil passages.

Checking Clearance

Refer to "Piston Fit In Bore".

Engine Governor

Principles of Operation

The governor is a fly-ball, variable speed type. It is designed to maintain a selected speed (rpm) within reasonably constant limits. The governor regulates the action of the carburetor by means of a balance between governor spring tension and weight force.

As the governor control handle is moved to increase engine speed, the tension of the governor spring is increased. The increased tension of the spring moves the rockshaft lever and, in turn, the carburetor control rod, which opens the throttle plate on the carburetor allowing more fuel to enter the engine.

As engine speed increases, the governor weights move outward by centrifugal force. The movement of the weights forces the thrust bearing sleeve and bearing against the rockshaft fork which, in turn, moves the rockshaft lever decreasing the throttle plate opening. The forces of the weights and spring tension will balance out maintaining the selected engine speed.

An increase in load causes a decrease in engine speed. Any speed variation on the engine activates the governor. As the speed decreases, the weights move in reducing thrust sleeve and bearing pressure against the rockshaft fork. This allows governor spring tension to move the rockshaft lever, opening the carburetor throttle plate, increasing the amount of fuel to the engine, thereby maintaining the selected engine speed.

To maintain a governed speed, all three factors (spring tension, centrifugal weight force and load) must remain balanced. A change in any one of these will cause the other two to react and restore the balance.

To insure smooth, surgeless, and prompt response of the governor, all of its moving parts and linkage must move freely to follow slight changes in engine load-speed. Should binding occur at any point, a greater change in speed will take place before sufficient centrifugal force or spring tension is built up to overcome the friction and move the throttle valve. Friction increases and binding often occurs because of wear and misalignment of the carburetor throttle shaft. Sludge deposits in the governor housings can cause sluggish or rough action of governor parts and linkage. Wear of governor weights, pins, sleeve, rockshafts, or rockshaft lever also result in surging and erratic governor action.

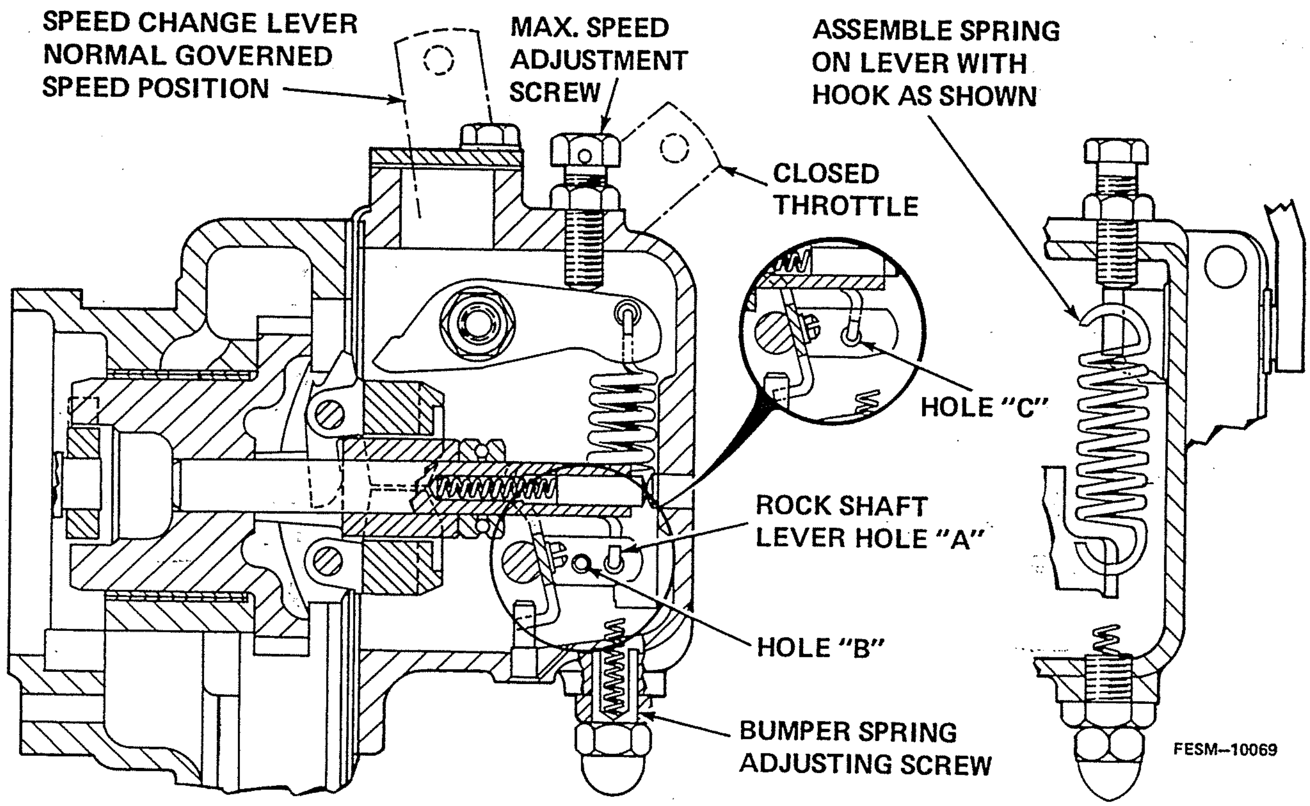
Removal, Inspection and Repair

Before removing any of the governor assemblies for inspection or repair, clean the surrounding area and the various connecting points to prevent entry of dirt into those parts which remain with the engine. After disassembly of the governor, start the cleaning of parts with a clean container of clean solvent. Wash ball bearings first. Do not spin bearings while washing. Turn them slowly back and forth while dipping the bearing up and down in the solvent to dislodge dirt. Blow out with compressed air, holding the parts to prevent the air blast from spinning them, to avoid possible scratching of balls and grooves. Flush again in clean solvent and blow-dry a second time. Examine under good light to determine if further cleaning is necessary. Add a few drops of oil to the balls and grooves, then, and only then, spin by hand to test for roughness and wear.

Wash and clean the remainder of the rotating parts in solvent, examining the weights, carrier and weight pins for damage or wear. Clearance between new weights and new pins for each governor are shown on specification page. Clearances found to exceed those specified by 0.003 inch or more would be considered excessive and parts should be renewed.

Wash and clean the housing and remaining parts and examine each for damage or excessive wear. No attempt should be made to salvage old gaskets or seals. They should be carefully removed from the assembly and replaced with new to insure an oil tight, dust proof operation.

Where sludge accumulations are found in the governor housing, corrosion of bearing surfaces may have occurred. These rough bearing surfaces and their increased frictional drag are responsible for poor governor action. Excessive bearing clearance also results from sludge corrosion.



NOTE: Moisture and sludge accumulations in the engine indicate that the engine has been running over long periods of time below normal operating temperature. Thermostat operation should be checked and the operator informed on his need to maintain operating temperature.

The decision on what new parts should be used to rebuild the governor assembly will be based upon the wear found and the condition of the following groups of parts:

1. Weights, pins, and weight carrier: Clearance in excess of 0.003 inch over that specified between pins and weights or carrier.

2. Governor shaft bearings and thrust bearing: Rough, pitted bearing surfaces of either plain or ball type bearings.

3. Rockshaft, rockshaft fork, bearings and levers: Worn or damaged rockshaft, rockshaft fork or spring levers. Rough, pitted bearings and bearing surfaces.

Where all three conditions are found, the use of new complete governor assembly should be considered, since the few parts which can be salvaged may not cover the labor cost of overhaul.

Where conditions 1 and 2 are involved, the rotating assembly, including new bearings, weights and pins, should be used.

Where only the governor weight and pin clearance is found questionable, only these individual parts need be replaced. In all cases new gaskets and new seals must be used to prevent entry of dirt and loss of oil.

Examine hook ends of governor springs and mating holes in spring levers for wear. Replace these parts where appreciable wear is found.

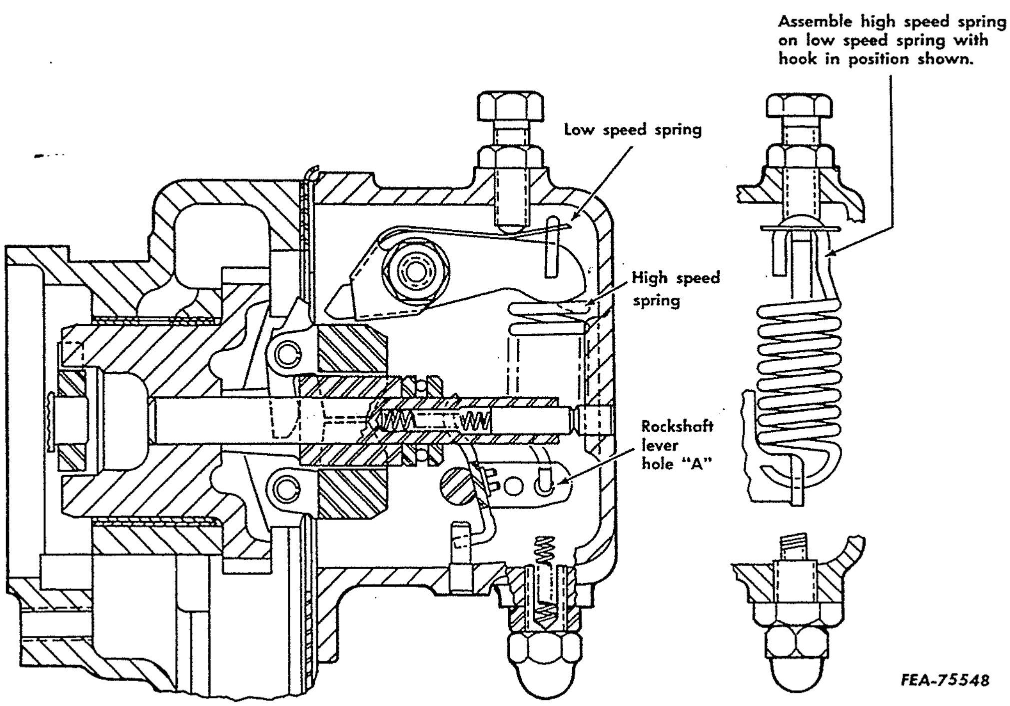
Care must be taken in the reassembly of the governor rockshaft, rockshaft fork, bearings and seal to insure uniformly smooth movement of the rockshaft from one extreme of movement to the other. Lubricate the rockshaft oil seal thoroughly upon installation. Some slight friction resulting from drag of the oil seal on the shaft is unavoidable, but friction from any other source must be held to a minimum. Any rough, jerking movement of the rockshaft must also be eliminated to prevent surging and erratic governor action.

The internal fit of the governor shaft ball bearing controls its end clearance. A new ball bearing will have end clearance in the range of 0.004 to 0.0065 inch. This bearing should be replaced when, after thorough cleaning, it is found rough.

Engine Governor High Speed and Low Speed Spring Installation

(Refer to Illust.)

Hook the upper end of the high speed governor spring through both holes of the low speed spring so that the open ends of the high speed spring will be toward the center of the governor housing. Hook the bottom end of the high speed spring into hole "A" of the rockshaft fork. Install the spring lever and low speed spring as a unit on the spring lever shaft.



Installation

Install the engine governor assembly using new mounting gaskets. The governor drive gear must be meshed in time with the camshaft gear in these engines, since the ignition unit is involved in the governor drive.

After installation of either new or overhauled governor assemblies in the engines covered in this manual section, it is important that a thorough check of all four adjustments be made. The basic governor assembly may be in perfect condition, but in order to insure its full range of control it must be adjusted to its individual engine.

Adjustments

Because of possible change in center-to-center distance between governor and carburetor, due to removal and replacement of manifold, carburetor or governor assemblies, the linkage between the governor and carburetor must be adjusted to establish the throttle position in relation to governor weight position. This adjustment insures the full power response of a wide open throttle when the governor weights are collapsed by reduction in rpm by application of heavy load. This governor-to-carburetor linkage must be free from binding throughout its range of movement.

1. Governor linkage adjustment procedure:

a. With the engine stopped, advance the speed change lever to about 3/4 speed position, sufficient to create tension on the governor spring.

b. Disconnect governor-to-carburetor control rod (either end). Hold carburetor throttle against its stop in wide-open position. Move governor rockshaft lever to rear of its travel and adjust length of governor-to-carburetor control rod so that it may be reconnected freely without moving throttle lever or governor lever.

c. Lengthen the control rod one turn from the above condition and reconnect.

d. After tightening the control rod clevis lock nut, check to be sure that both ends of the control rod are in the same plane to eliminate possibility of binding on levers.

e. Move the speed change lever a few times between half speed and low speed position, checking the governor-to-carburetor control rod in all positions for interference or binding.

2. Governor speed adjustment procedure:

a. After the engine has been started and the manifold is warmed up, the low idle speed setting should be made on the carburetor.

b. With the engine running, the governor speed change lever should be pulled back against its stop then the speed adjusting screw (the vertical screw on top of the governor housing) should be adjusted to obtain the specified high idle speed.

c. The governor action should be checked by moving the speed change lever back against the high idle stop suddenly. If the governor surges more than twice, screw in the bumper spring just enough to stop excessive surging.

d. After the bumper spring has been properly adjusted, lock it in place with a jam nut. Where use of the bumper spring is not required to control surging, it should be screwed in until it just touches the stop at low idle speed and then backed out 1/4 turn and locked.

NOTE: Excessive use of the bumper spring can cause an increase in low idle speed.

Lubricating Oil Pump

Description

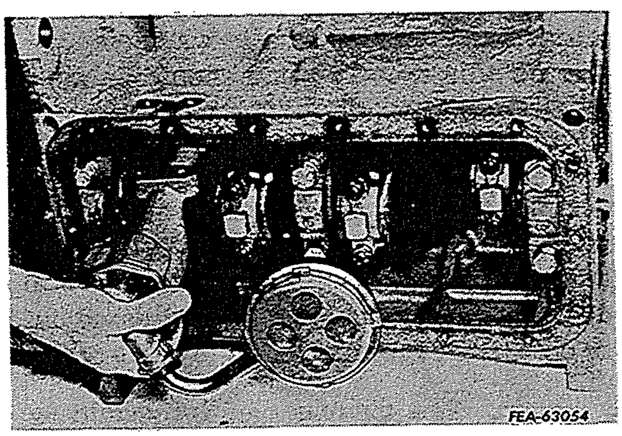
The engine lubricating oil pump is a gear type pump internally mounted to the bottom of the crankcase and is gear driven from the camshaft.

The lubricating oil is drawn from the oil sump through a screened intake to the oil pump.

The floating screened inlet is pivoted from the oil pump cover and must be free to move up and down.

From the oil pump, the oil is directed under pressure through rifle-drilled passages in the crankcase to the main bearings, camshaft bearings, timing gears, governor, valve lever assemblies and to the oil filter.

A plunger type, spring-loaded relief valve, located in the pump body, maintains the required circulating pressure. Should the oil pressure become excessive, the relief valve will by-pass the oil to the crankcase oil pan in sufficient amounts to reduce the pressure.



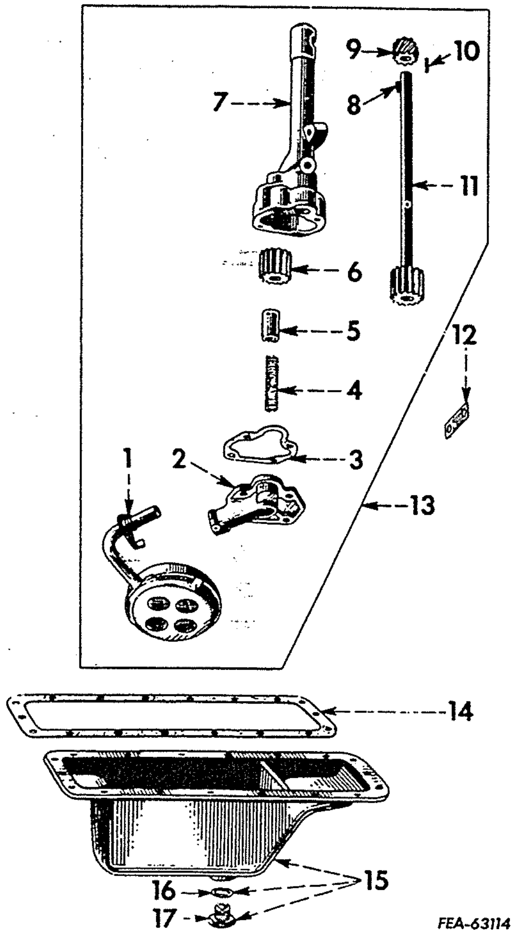
Removal

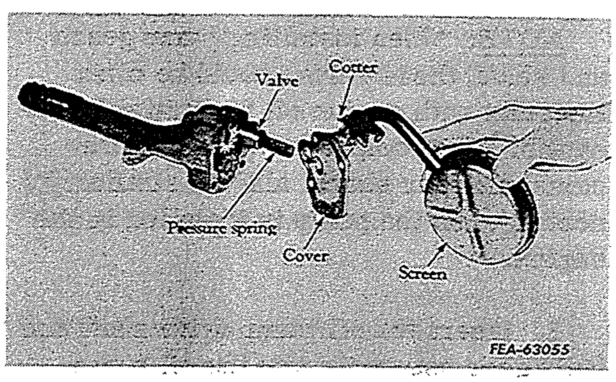
1. Drain the crankcase oil and remove the oil pan.

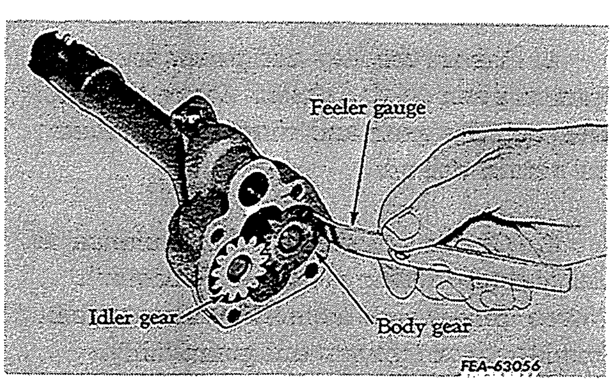
2. Remove the two cap screws that secure the oil pump to the crankcase. These cap screws are located on the outside of the crankcase on the right and toward the rear. Remove the pump, complete with screen, from the crankcase.

Disassembly

1. Remove the four cap screws securing the cover (2) to the oil pump body (7) and remove the cover and screen (1) as a unit. To separate the cover from the screen, remove the cotter pin.







2. Remove the pressure spring (4) and valve (5).

1. Screen	10. Pin
2. Cover	11. Gear and shaft
3. Gasket	12. Lock
4. Pressure spring	13. Pump assembly
5. Pressure valve	14. Gasket
6. Idler gear	15. Pan
7. Body	16. Gasket
8. Key	17. Plug
9. Gear	

3. Measure the clearance between the outside diameter of the gear and the bore of the housing. Clearance should be within the limits given in "Specifications".

4. Check backlash between the pump body gears. If this exceeds the figure shown in "Specifications" replace the gears.

5. Remove the oil pump idler gear (6) from the idler gear shaft.

6. Support the oil pump shaft (11) to prevent bending, and drive out the pin (10) from the oil pump spiral gear (9).

7. Press the spiral gear from the oil pump shaft using the proper support to avoid damaging the gear or bending the shaft.

8. Remove the Woodruff key (8) from the shaft.

9. Remove the oil pump drive gear and drive shaft assembly from the oil pump body. The shaft and gear are serviced as one part.

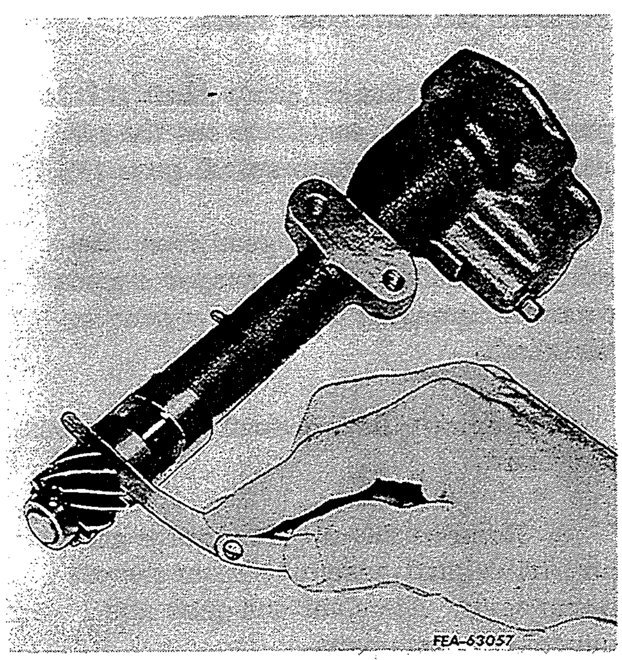
Inspection and Repair

1. Clean the pump parts thoroughly in cleaning solvent and dry with compressed air.

2. Inspect the gears for wear, scoring and chipped teeth. If either the body or idler gear is damaged, replace both.

3. Inspect the body and cover for traces of gear contact or other damage. Replace all worn or damaged parts. If the idler shaft is loose in the pump body, replace the body assembly as the idler shaft is not serviced separately.

4. Both the idler shaft and the drive shaft, when assembled, should be square with the face of the body within .001 inch.



5. Check the pump shaft clearance in the shaft bore. To correct for wear beyond limits given in "Specifications" replace the body and the shaft with gear.

6. The gasket is also a shim and should be replaced whenever a pump is serviced. If a replacement gasket is not available, do not use a makeshift gasket -- use the old one. When necessary, two gaskets are used to maintain the proper end clearance between the gears and the cover. Refer to "Specifications". It is important to maintain this clearance to prevent wear on the gears and cover.

7. Inspect the condition of the pressure valve. Be certain it slides freely and that the valve seat is not damaged.

8. Check the pressure valve spring (4) against the "Specifications". Replace the spring if it does not conform to specification.

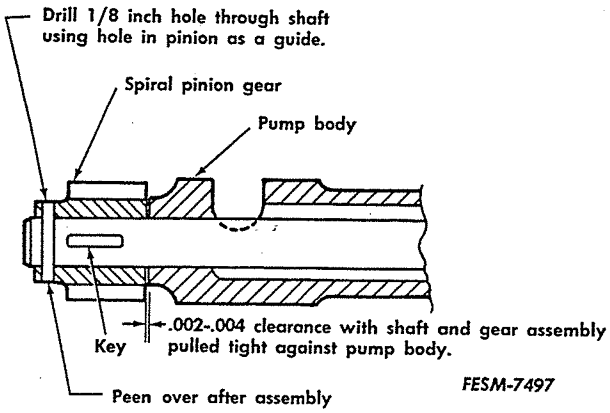
Reassembly

NOTE: When installing pump gears and shaft, these parts should be oiled liberally with engine oil for initial lubrication. The pump drive gear and the camshaft gear should also be similarly coated when the pump is installed in the engine.

1. Insert the oil pump drive shaft and body gear assembly into the oil pump body.

2. Insert the key and press the spiral pinion gear on the shaft. Drive the pin through the gear and shaft. Peen over to retain the pin.

3. Check the pinion end clearance as indicated. Refer to "Specifications". When clearances cannot be maintained, replace worn gears and pump body.



NOTE: Service pump shaft and gear assemblies are not drilled for the pump drive gear pin. A 1/8 inch hole must be drilled through shaft after the gear is assembled to the dimensions shown.

4. Install the pressure valve and pressure spring.

5. With the idler gear in place, put a thin coating of grease on the gasket surfaces of the body and cover. Install the gasket or gaskets and cover to the body with cap screws and lock washers.

6. Check the oil pump body gear end clearance using "Plastigage" or virgin lead as shown. If the end play is in excess of that shown in "Specifications" remove one gasket from the cover. If the end play is less than shown add one gasket. Always recheck the end play after adding or removing gaskets. Be sure that there is no binding in the pump assembly.

7. Install the screen if removed and secure with a cotter pin.

Installation

1. Lift the oil pump assembly into position and secure it to the crankcase with the cap screws and lock washers.

2. Install a new oil pan gasket and attach the oil pan to the crankcase. Tighten the cap screws to standard torque for size and class.

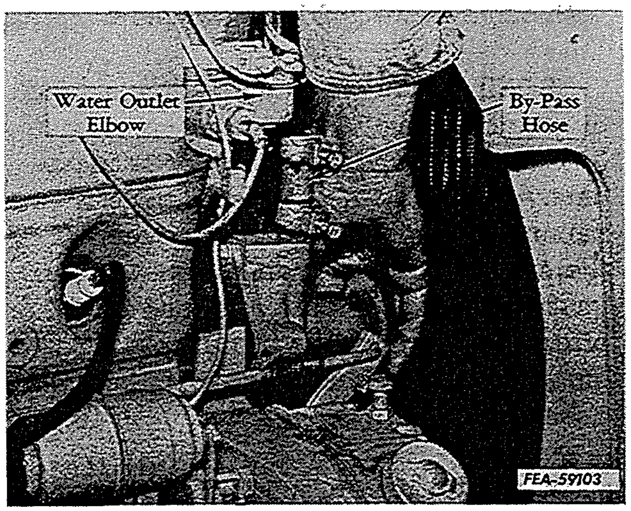
Water Pump

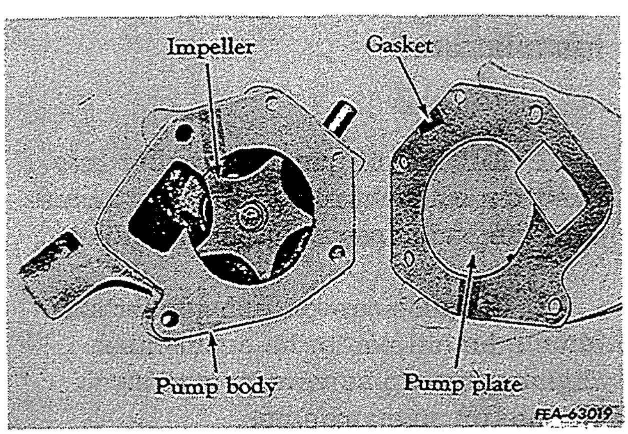
Description

The water pump assembly is composed of a body and a cover plate which houses a ball bearing mounted pump shaft and impeller. The pump is of the centrifugal packless type. It is bolted to the front end of the engine and is belt driven.

The pump, by means of centrifugal force developed by the impeller rotation, draws water from the lower part of the radiator into the water passages in the cylinder block and cylinder head. The water circulates through the cylinder block and out through the thermostat housing into the radiator upper tank.

If a water leak develops in the pump, it indicates that the sealing parts are worn. Disassembly of the pump is necessary to replace these parts.





Removal

1. Drain the cooling system.

2. Remove the fan, water pump pulley and fan belt.

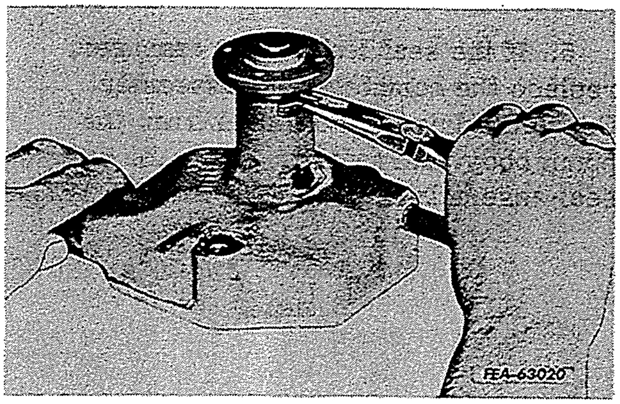
3. Disconnect the water pump inlet hose and slide it off of the water pump.

4. Disconnect the water by-pass hose from the water outlet elbow.

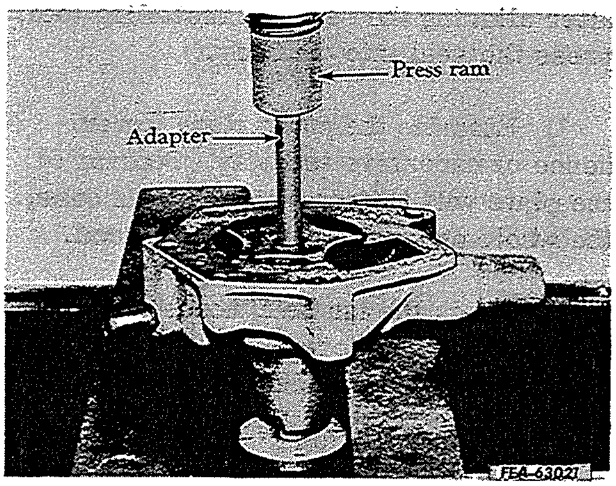
5. Remove the three cap screws securing the water pump to the crankcase and remove it from the engine.

Disassembly

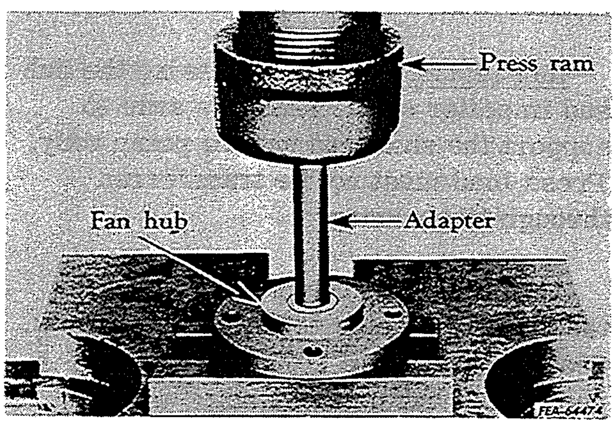
1. Remove the screws from the water pump plate. Remove the plate and gasket from the pump body.



2. Remove the front snap ring that retains the water pump shaft bearing. Support the water pump in an arbor press and push the shaft and bearing out as one assembly.



3. Place the shaft assembly in a press and press the shaft from the hub.



NOTE: Do not attempt to remove the bearing or slinger; they are factory installed in the proper location. The shaft, bearing and slinger are serviced as an assembly.

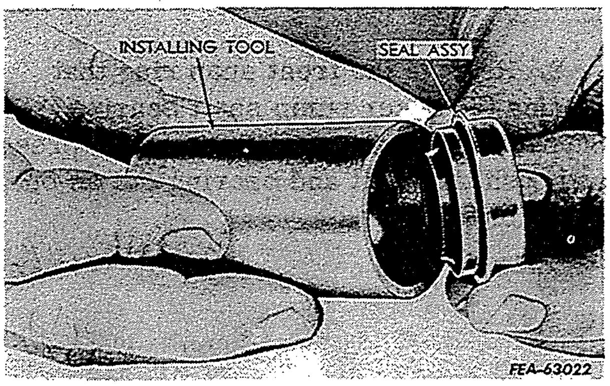
Inspection and Repair

1. Clean all parts (except pump shaft and bearing) in a cleaning solvent.

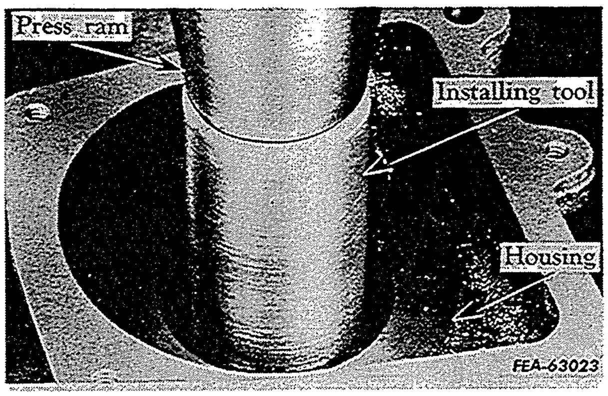
2. Examine the pump shaft and bearing for wear and damage. If necessary, replace the shaft, bearing and slinger as an assembly.

3. Replace the impeller if badly eroded.

4. Replace all gaskets.



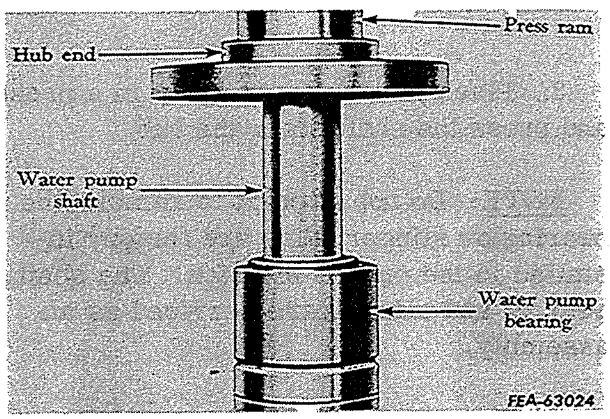
5. If the seal leaks or is damaged, replace the complete seal assembly. Carefully drive the old seal from the pump body with a drift. Place the new seal assembly on installing tool SE-1721.



6. Place the pump body in a press and, after aligning the seal and installing tool, press the seal into the body.

7. Examine the pump plate for evidence of excessive end play. Scoring of the plate will indicate this. In this case, the whole assembly must be replaced.

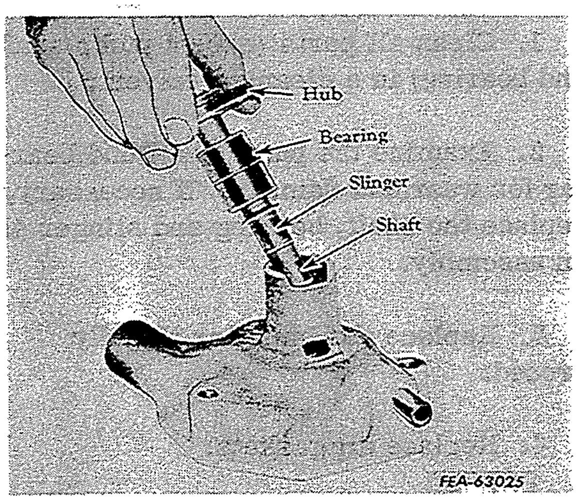
8. Check the fan belt, hoses and clamps. Cracked or oil soaked hoses and belt must be replaced. Make sure clamps have retained their strength.



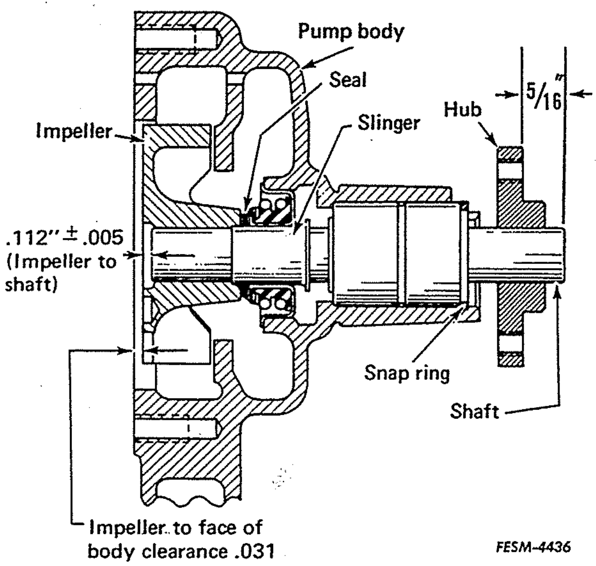
Reassembly

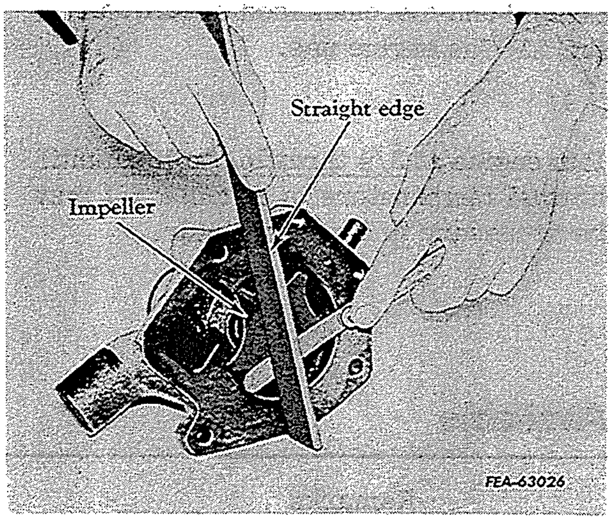
IMPORTANT: When pressing the hub and impeller on the shaft, be sure to support the shaft and not the pump body. Press load must not be transferred through the bearing.

1. Press the hub on the shaft with the small diameter of the hub facing out. See Illust. on page 1-55 for correct position of hub on the shaft.



2. Install the shaft, bearing and slinger assembly in the front end of the pump body. Tap the shaft into place so that the bearing is firmly seated and clears the front snap ring groove.





3. Install the snap ring in its groove at the front end of the pump body.

IMPORTANT: Be sure to support the shaft and not the pump body when pressing. Press load must not be transferred through the bearing.

4. Support the front end of the shaft, and press the impeller on the rear of the shaft so there is .031 inch clearance between the machined face of the pump body and the face of the impeller. Check the clearance with a straight edge and feeler gauge.

5. Install the water pump plate with a new gasket.

Installation

1. Secure the water pump to the crankcase with three cap screws and a new gasket.

2. Connect the water by-pass hose to the water outlet elbow.

3. Connect the water pump inlet hose to the water pump.

4. Install the water pump pulley, fan and fan belt.

BREAK-IN PROCEDURE OF REBUILT GASOLINE AND LPG ENGINES

Gas Engines

Fill crankcase with MIL-L-2104A or Service "MS" oil of SAE 30 weight to the proper level.

LPG Engines

Fill crankcase with a "Low Ash" engine oil of SAE 30 grade to the proper level.

"Low Ash" engine oils which do not contain barium or calcium additive compounds are recommended. These oils are usually designated as "Supplement 1" oils for API Service "MS" in LP Gas engines. Oils of this type are usually labeled and merchandised specifically for LP Gas engine use.

Run engine at 3/4 throttle, no load until normal temperature is reached. It may be necessary to cover radiator.

"Run-In" When Dynamometer is Not Available

Period	Engine RPM	Load	Remarks
15 Min.	3/4 of rated	None	Operate tractor in fourth gear on road.
45 Min.	3/4 of rated	Light	Operate tractor 2 full gear below normal for load connected to drawbar.
2 Hours	Full	Medium	Operate tractor 1 full gear below normal for the load connected to drawbar. *Retorque head and adjust valves.

*NOTE: When retorquing cylinder head bolts, only those below proper torque are to be torqued to specifications. Those within specified torque or above torque are to remain as they are.

"Run-In" When Dynamometer is Available

Period	Engine RPM	Load	Remarks
1/2 Hour	1/2 of rated	Set dynamometer to show 1/2 of rated hp.	Load on the engine will be about 1/4 of rated due to reduced rpm.
1/2 Hour	3/4 of rated	Set dynamometer to show 3/4 of rated hp.	Load on engine will be slightly over 1/2 of rated.
1/2 Hour	Full	3/4 of rated hp	Dynamometer will read correct hp.
*Retorque Head and Adjust Valves			
1 Hour	Full	3/4 of rated	Dynamometer will read correct hp.

*NOTE: When retorquing cylinder head bolts, only those below proper torque are to be torqued to specifications. Those within specified torque or above torques are to remain as they are.

Tractor is then ready for normal operation. After 100 hours, the cylinder head bolts should be retorqued and the valves adjusted.

If SAE weight is correct for prevailing temperature, oil used for break-in can be used for the duration of the normal change period, otherwise, recommendations in owner's manual as to SAE weight should be followed.

Section 2

GASOLINE FUEL SYSTEM

CONTENTS

CARBURETOR SPECIFICATIONS

	C-123				
IH part number	366 462 R94	366 463 R93	367 822 R91	372 095 R91	372 096 R93
Machine used on	F & I-140 w/s.n. 103, 556 and below	56, 57 Balers	F & I-240	F & I-240 (distillate)	F & I-140 (distillate)
Model	Zenith 68X7	Zenith 68X7	Zenith 68X7	Zenith 68X7	Zenith 68X7
Liquid level - inch	15/32	15/32	15/32	15/32	15/32
Float height - inch*	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32
Main metering jet	20-L†	21†	21†	20-L†	20-L†
Idle jet	11-S†	11-S†	11-S†	11-S†	11-S†
Discharge nozzle - drill size	45†	50†	50†	45†	45†
Venturi	15 m.m.	16 m.m.	16 m.m.	15 m.m.	15 m.m.
Needle valve seat	35†	35†	35†	35†	35†

	C-123			
IH part number	372 983 R91	372 984 R91	385 607 R91	385 608 R91
Machine used on	F & I-140 w/s.n. 103, 556 and below	F & I-240	F & I-140 w/s.n. 103, 557 and above	F & I-140 w/s.n. 103, 557 and above
Model	Marvel-Schebler TSX-730	Marvel-Schebler TSK-744	Marvel-Schebler TSX-864	Zenith 68X7
Liquid level - inch	1/2	1/2	1/2	15/32
Float height - inch *	1/4	1/4	1/4	1-5/32
Main metering jet	142 c.c.	184 c.c.	150 c.c.	19-L †
Idle jet.	85 c.c.	101 c.c.	85 c.c.	11-S †
Discharge nozzle - drill size . . .	#40 (.098")	#35 (.110")	#40 (.098")	45 †
Venturi	19/32 inch	11/16 inch	5/8 inch	15 m.m.
Needle valve seat.	.070 inch	.070 inch	.070 inch	35 †

* IH & Zenith: Measured from the top of the bowl gasket to the bottom of the float.

Marvel-Schebler: Measured from the bottom of the gasket to the top of the float.

† Figures shown are flow check numbers - not drill sizes. These figures are stamped on individual parts.

CARBURETOR SPECIFICATIONS – Continued

	C-135		
IH part number	367 700 R93	372 985 R92	396 478 R91
Machine used on	F & I-340, 404 & 91 Combine	F & I-340, 404 & 91 Combine	201 Windrower
Model	Zenith 68X7	Marvel-Schebler TSX-827	Marvel-Schebler TSX-926
Liquid level - inch	15/32	1/2	1/2
Float height - inch *	1-5/32	1/4	1/4
Main metering jet	24-L †	184 c.c.	218 c.c.
Idle jet	11-S †	101 c.c.	101 c.c.
Discharge nozzle - drill size	50 †	#35(.110")	#35(.110")
Venturi	17 m.m.	11/16 inch	11/16 inch
Needle valve seat	35 †	.070 inch	.070 inch

	C-146			
IH part number . . . . †	389 683 R94	397 341 R91	404 120 R91	404 140 R91
Machine used on	I-424, 2424	500 Crawler	500 Series C Crawler (G.D.)	500 Series C Crawler (P.S.)
Model	Marvel-Schebler TSX-896	Marvel-Schebler TSX-930	Marvel-Schebler TSX-948	Marvel-Schebler TSX-949
Liquid level - inch	1/2	1/2	1/2	1/2
Float height - inch *	1/4	1-1/2 (Note 1)	1-1/2 (Note 1)	1-1/2 (Note 1)
Main metering jet	242 c.c	260 c.c.	275 c.c.	307 c.c.
Idle jet.	85 c.c.	85 c.c.	85 c.c.	85 c.c.
Discharge nozzle - drill size	#35(.110")	#35(.110")	#31(.120")	#31(.120")
Venturi	25/32 inch	25/32 inch	7/8 inch	7/8 inch
Needle valve seat.	.082 inch	.070 inch	.070 inch	.070 inch

* IH & Zenith: Measured from the top of the bowl gasket to the bottom of the float.
Marvel-Schebler: Measured from the bottom of the gasket to the top of the float.

† Figures shown are flow check numbers - not drill sizes. These figures are stamped on individual parts.

Note 1: Measured from the bottom of the gasket to the bottom of the float.

CARBURETOR SPECIFICATIONS – Continued

	C-153				
IH part number	380 490 R94	381 945 R93	389 683 R94	396 738 R92	405 530 R91
Machine used on	Constructall 2500 Backhoe-Loader	F & I-504, I-2504, 3514 Loader Tractor, 93 Combine, 5000 Series Forklift, Constructall 2500 Backhoe-Loader	I-444, 2444 and 4000 Series Forklift	105, 203 Combine, 225 Hayswather, 210, 275, 375 Windrowers	105, 203 Combine, 225 Hayswather, 210, 275, 375 Windrowers
Model	Zenith 267X9	Marvel-Schebler TSX-857	Marvel-Schebler TSX-896	Marvel-Schebler TSX-925	Zenith 267X9
Liquid level - inch	15/32	1/2	1/2	1/2	15/32
Float height - inch*	1-5/32	1/4	1/4	1/4	1-5/32
Main metering jet	25 †	232 c.c.	242 c.c.	232 c.c.	25 †
Idle jet	14 †	101 c.c.	85 c.c.	101 c.c.	14 †
Discharge nozzle - drill size	70 †	#26(.147")	#35(.110")	#26(.147")	70 †
Venturi	21MM Offset	7/8 inch	25/32 inch	7/8 inch	21MM Offset
Needle valve seat	35 †	.101 inch	.082 inch	.070 inch	55 †

* IH & Zenith: Measured from the top of the bowl gasket to the bottom of the float.
Marvel-Schebler: Measured from the bottom of the gasket to the top of the float.

† Figures shown are flow check numbers - not drill sizes. These figures are stamped on individual parts.

CARBURETORS

General Description

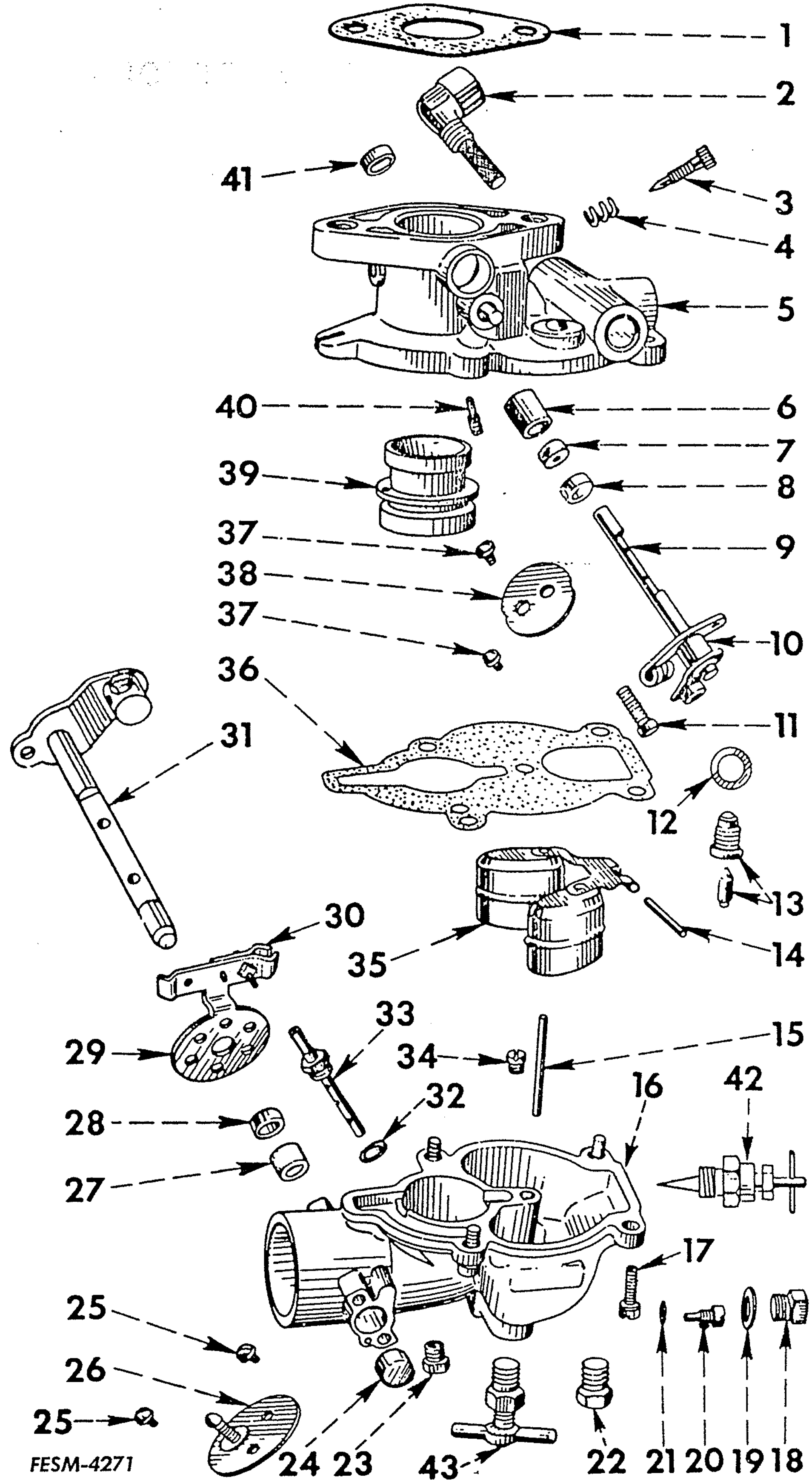
The fuel system consists, basically, of a fuel supply tank, fuel shut-off valve, fuel strainer, carburetor, intake-exhaust manifold, air cleaner and a variable speed governor.

Liquid fuel flows from the supply tank by gravity or by means of an electric fuel pump through the fuel strainer and sediment bulb to the carburetor. Air enters these naturally aspirated systems through the air cleaner, where dirt and abrasive material are removed.

Clean air and fuel is metered to the engine by the carburetor; in varying proportions to meet the changing demands of load and speed.

The variable speed governor controls the carburetor throttle to admit a greater or lesser volume of air-fuel mixture. This supports the operator's demand for engine speed, and provides power to maintain that speed, up to the capacity of the engine.

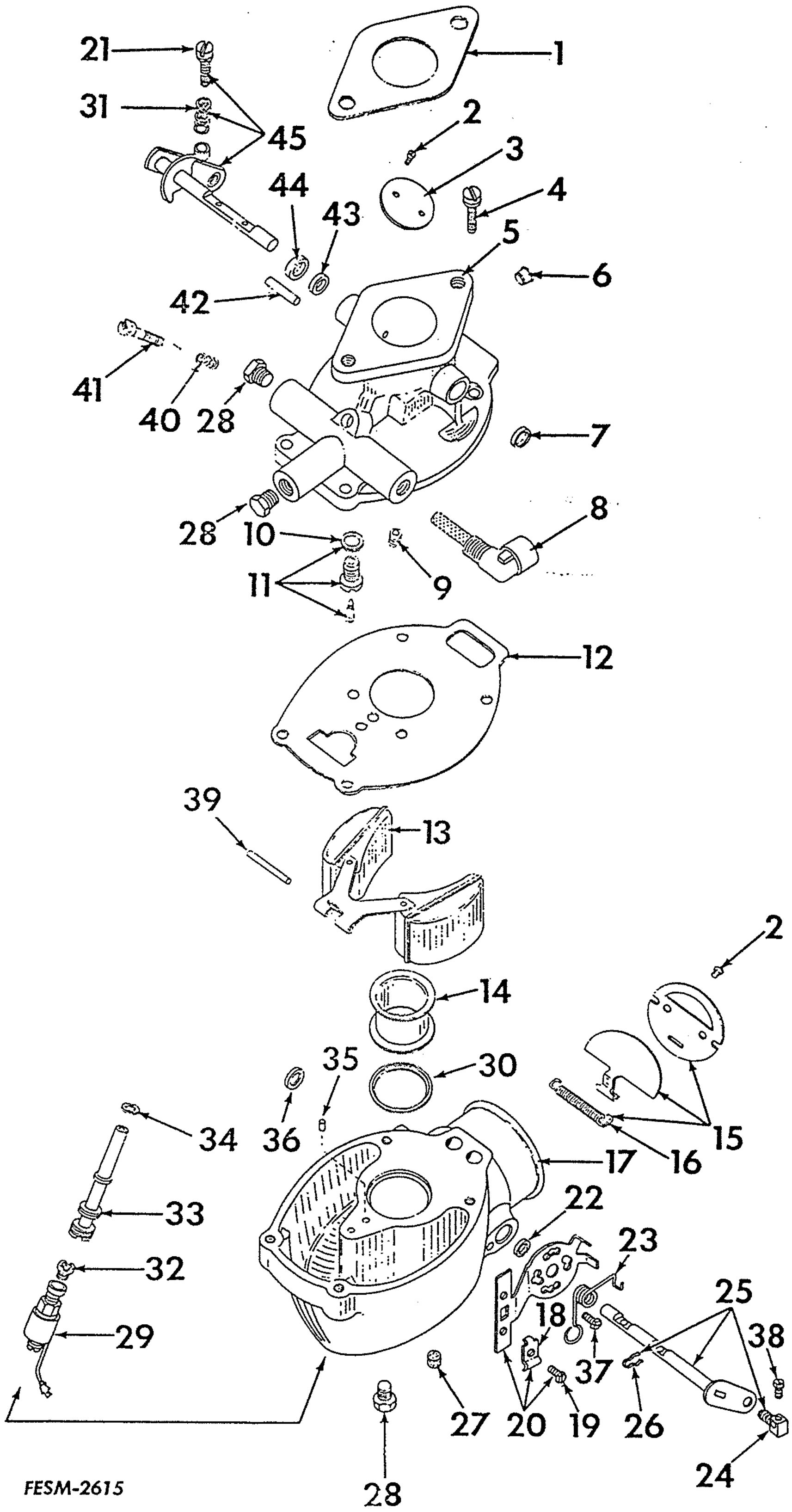
1. Gasket
2. Elbow and strainer
3. Idle adjusting needle
4. Spring
5. Throttle body
6. Throttle shaft bushing (if used)
7. Throttle shaft seal
8. Seal retainer
9. Lever and shaft
10. Taper pin
11. Throttle stop screw
12. Fuel valve washer
13. Fuel valve and seat
14. Float axle
15. Idle filler tube
16. Fuel bowl
17. Screw
18. Lower plug
19. Fibre washer
20. Main jet
21. Washer
22. Drain plug
23. Drip plug filter
24. Plug
25. Screw
26. Choke plate
27. Washer
28. Packing retainer
29. Choke valve bracket
30. Bracket clamp
31. Lever and shaft
32. Fibre washer
33. Main discharge jet
34. Well vent jet
35. Float assembly
36. Gasket
37. Screws
38. Throttle valve plate
39. Venturi
40. Idling jet
41. Plug
42. Not used
43. Not used



Exploded view of typical Zenith carburetor.

1. Gasket
2. Screw
3. Throttle plate
4. Screw
5. Throttle body
6. Plug
7. Cup
8. Strainer assembly
9. Idling jet
10. Gasket
11. Float valve assembly
12. Gasket
13. Float
14. Venturi
15. Choke plate assembly
16. Spring
17. Fuel bowl
18. Clip
19. Screw
20. Bracket
21. Stop screw
22. Packing
23. Return spring
24. Swivel
25. Choke shaft assembly
26. Retainer spring
27. Bowl strainer
28. Drain plug
29. Solenoid fuel shut-off valve
30. Venturi retainer
31. Spring
32. Power jet*
33. Nozzle
34. Gasket
35. Well vent
36. Cup
37. Screw
38. Screw
39. Float axle
40. Spring
41. Idle adjusting screw
42. Throttle stop pin
43. Packing
44. Packing retainer
45. Throttle shaft assembly

* Not part of carburetor assembly.



Exploded view of typical Marvel Schebler carburetor.

Operation

The function of the carburetor is to meter the required amount of fuel to meet varying demands of engine load and speed, and to discharge this fuel into the intake air stream in as fine a spray as possible.

The air-fuel ratio is not constant for all loads and speeds. Idle and low speeds require rich fuel mixture; full load, full speed operation requires the leanest fuel mixture. To simplify the explanation of how the carburetor functions, we will divide it into four systems and discuss each, separately.

- FUEL SUPPLY SYSTEM
- IDLING SYSTEM
- LOAD SYSTEM
- STARTING SYSTEM

Fuel Supply System

The fuel supply system is that portion of the carburetor consisting of the fuel inlet strainer, fuel needle valve and seat, fuel float, fuel bowl and the bowl air vent.

The function of the float and fuel needle valve is to maintain an even level of fuel in the bowl. The float assembly hinges on the float axle supported by a bracket on the bowl cover.

Fuel from the supply tank enters the bowl through the inlet strainer and the float needle valve. As the level of fuel rises in the bowl, the float is carried upward until the float lever forces the needle valve against its seat, stopping further flow of fuel.

While the engine is in operation, fuel flows from the bowl through the main metering jet to the load system or idling system and the float valve maintains just enough opening to keep a constant level of fuel in the bowl.

The bowl air vent passage is a drilling in the throttle body connecting the float chamber with an air vent channel surrounding the venturi.

Air for the bowl vent, the well bleed and the idling system is taken from this channel in the venturi which, in turn, is vented to the carburetor main air intake.

In this manner, all air taken into the carburetor is supplied through the air cleaner. This not only prevents entry of dirt and abrasives, but creates what is called a "balanced" vent.

The ratio of air and fuel mixture from a "balanced" carburetor will not be seriously affected by changes in condition of the air cleaner as it becomes restricted by accumulation of dirt. However, a power loss will be caused. A balanced type carburetor must have an airtight seal between the bowl and the bowl cover, since any air admitted into the bowl other than through the calibrated vent, will upset the ratio of air-fuel delivery and also allow entry of dirt.

In review, sustained constant level of fuel in the bowl, together with controlled venting of the bowl, insures a stable supply of fuel to the various metering systems and is unaffected by the height of fuel in the supply tank or normal operating changes in air cleaner condition.

Idling System

The idling system consists of idle discharge port, idle adjusting needle, idle jet and the connecting channels and air bleed. This system controls the mixture at partially opened throttle for idle and slow engine speeds, until the throttle is opened sufficiently to allow the load system to function.

Fuel for the idling system enters the well through the main metering jet and is drawn through the idle jet calibration into the idle passage where it is mixed with air from the idle air bleed.

The air-fuel mixture enters the air stream past the throttle plate, from the idle discharge port. The idle air adjusting screws on the carburetors are turned toward their seat to enrich the air-fuel mixture.

Load System

The load system consists of the venturi, discharge nozzle, well, well air bleed, and main metering jet. The load system as the name implies, controls the air-fuel mixture during the time the engine is loaded or is operating above idle speed.

When the throttle plate is opened a short distance beyond the idle port, a sufficient amount and velocity of air passes the venturi and discharge nozzle to draw fuel from this source. This condition starts the load system functioning.

Within a partial load-speed range of throttle plate movement, both the idling system and load system are delivering fuel. Further opening of the throttle plate, due to increased engine load-speed results in diminished delivery of fuel from the idling system. Ultimately, all delivery of fuel from the idling system is stopped and air is being drawn from this source into the well.

The main metering jet has a calibrated opening large enough to permit the flow of the maximum amount of fuel necessary for full load operation.

When the engine is stopped or idling, the level of fuel in the well and discharge nozzle is similar to the level in the fuel bowl.

As the load system goes into operation with increased load and throttle opening, the fuel is drawn from the discharge nozzle at a higher rate than supplied to the well by the main metering jet. This lowers the level of fuel in the well.

As the load and throttle opening is increased, the fuel level in the metering well drops below a series of air bleed holes in the discharge nozzle, admitting an increasing amount of air from the well air bleed. This metered addition of air to the discharge nozzle is necessary to compensate for the fact that the partial vacuum produced at the nozzle increases out of proportion with the increased velocity of air through the venturi.

Were it not for this well-air-bleed compensation, the proportion of fuel to air would rapidly increase with the throttle opening, producing an extremely "rich" mixture at full throttle, full load operation.

A small additional amount of fuel is necessary to insure prompt response for engine acceleration. When the throttle is suddenly opened, the resulting rush of air through the venturi picks up this necessary extra fuel which remains above the main metering jet in the metering well during part throttle operation.

Most carburetors are equipped with a main jet adjustment screw or an electric fuel shut-off valve which incorporates a main jet adjustment screw. The screw is used to limit the amount of fuel going into the engine.

The fuel adjusting screw must be set six turns off its seat. The fuel adjusting screw on carburetors with electric fuel shut-off should be set 4-1/2 turns off its seat.

The main metering jet in the carburetor has been calibrated to provide an economical, full-power mixture and must not be restricted by use of the adjusting screw when full power of the engine is required.

Starting System

The starting system consists of a manually operated choke valve mounted in the carburetor main air intake. When the choke valve plate is turned to the closed position, it restricts the air entering the carburetor. It does not, however, restrict the main air vent passage. This upsets the balance of the carburetor, allowing the increased suction to draw strongly upon the fuel discharge openings when starting the engine.

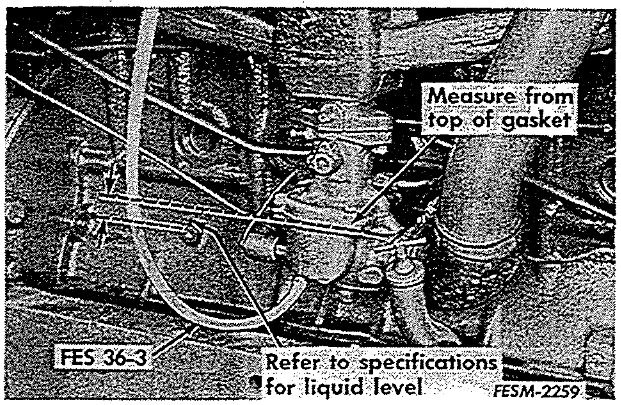
When the outside air, manifold, and engine combustion chambers are cold, it is necessary to supply a very "rich" starting mixture. Only the "light-ends" or more volatile portions of the fuel can be vaporized because of the low temperature and the slow movement of air past the discharge nozzle due to low cranking speed. The necessary large quantity of fuel is supplied by closing the choke valve during the cranking period.

As the engine fires and engine speed increases, a spring-loaded valve in the choke plate opens to let in more air and lean out the "rich" mixture. As the engine gathers speed and warms up, the choke valve is manually opened to further lean out the air-fuel ratio to a normal mixture.

An opening is provided in the bottom of the carburetor main air intake to drain off any excess unvaporized fuel which may return from the manifold. This opening is protected against the entry of dust and abrasives by a drop filter. Should this filter shrink and deteriorate from age, dirt may be drawn into the engine contributing to excessive engine wear. Should this opening be painted over or otherwise plugged, no drainage is possible and flooding with raw fuel can occur if the fuel float valve leaks.

Liquid Level Check
(Carburetor on Engine)

The liquid level in the carburetor can be checked with the carburetor on the engine using tool FES 36-3.



1. Close the fuel shut-off at the fuel tank.

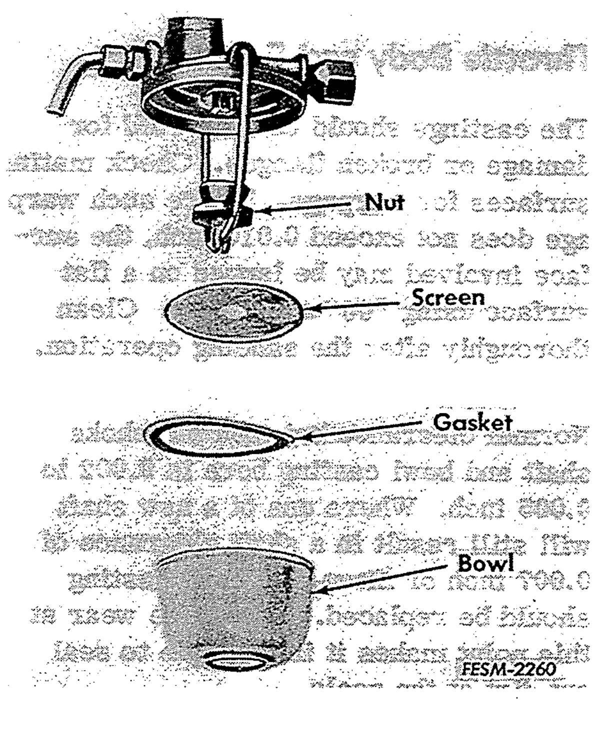
2. Remove the drain plug at the bottom of the carburetor. Attach the tool FES 36-3 as shown.

3. Open the fuel shut-off. Fuel will flow into the tube and seek the same level as the liquid level in the carburetor.

4. Measure the distance between fuel level in the tube to the top of the fuel bowl gasket. This will be the liquid level in the carburetor. Refer to specification for specified liquid level.

Removal and Installation

Before removing the carburetor from the engine for cleaning, inspection or repair, clean the area and various connecting points to prevent entry of dirt into those parts which remain with the engine. Failure to perform this simple operation may result in an ultimate condition much worse than that which made the carburetor removal necessary.



After the carburetor is removed, inspect the air cleaner pipe and hose for possible air leaks wherein dirt and abrasives could enter the engine. Discard the carburetor flange gasket. Clean manifold flange of any scraps of old gasket which may adhere and would prevent sealing of new gasket.

When reinstalling the carburetor, care must be used in securing air and dust tight connections of air cleaner pipe and hose. Renew if necessary. Before reconnecting the fuel line to the carburetor, remove and clean sediment bowl and screen. Use new bowl gasket in replacing sediment bowl. Open the fuel tank valve momentarily to flush line and observe for free flow of fuel.

After the carburetor is reinstalled on the manifold, recheck the adjustment of the governor-to-carburetor control rod to insure wide open throttle at full load demand of governor, as follows. With engine stopped, advance engine speed control hand lever to create tension on the governor spring. Adjust length of governor-to-carburetor control rod so that the rod slides freely into the throttle lever, when the throttle is wide open. Lengthen governor-to-carburetor control rod by one turn in its clevis to place spring load on throttle lever, insert cotter pin and tighten lock nut on clevis. Return the speed control hand lever to a position slightly advanced from low idle position. In this condition, check the governor-to-carburetor control rod for any tendency toward binding. It may be necessary to loosen the clevis lock nut and reposition the clevis slightly to insure both ends being in the same plane to eliminate binding (after which the lock nut is retightened). Refer to section 1 for governor adjustments.

Assemble the choke control wire and tube, being sure full movement of choke valve is assured with the full movement of choke control knob.

Inspection and Repair

Before disassembly of the carburetor, clean the outside surfaces of dirt accumulations so that the solvent used to clean the dismantled parts will not become contaminated.

In order that individual parts may be given a thorough inspection, cleaning is important. The use of a good carburetor cleaning solvent is necessary to dissolve gum and varnish-like coatings. The slow buildup of these coatings in jets and calibrated openings of the carburetor restricts the normal flow of fuel, and must be completely dissolved and removed to restore the original fuel flow characteristics. Where a good commercial carburetor cleaner is not available, equal parts of alcohol and benzol may be used.

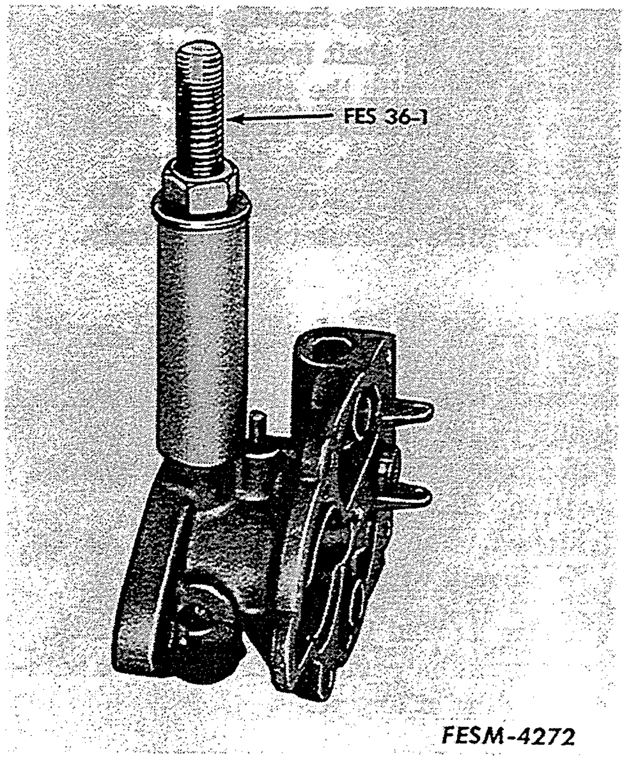
After the dismantled parts have remained in the solvent long enough to dissolve the coatings, remove and rinse in petroleum base cleaning solution. Dry all parts with compressed air, blowing through all jets and channels in both directions to assure that they are clear and clean.

IMPORTANT: Do not use drills or wires to clean calibrated openings; any slight enlargement of these jet openings will affect the operation. Use only gum solvent and compressed air for cleaning.

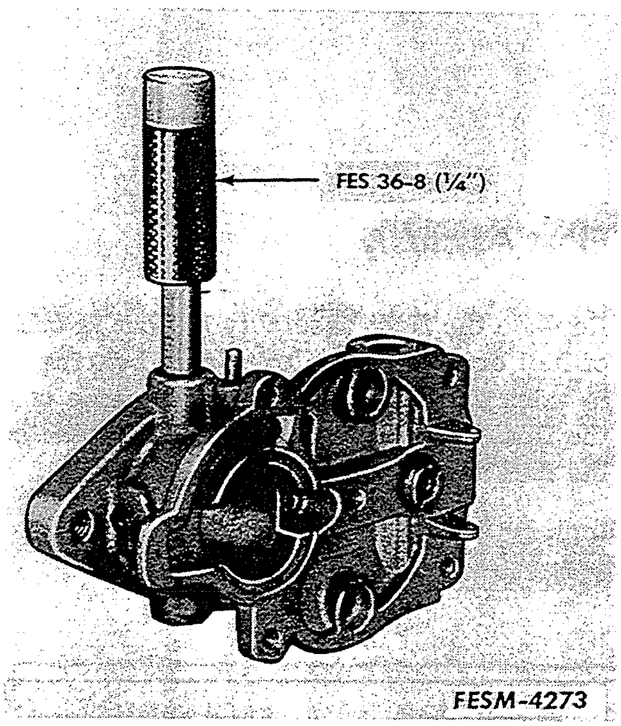
Throttle Body and Fuel Bowl

The castings should be inspected for damage or broken flanges. Check mating surfaces for warpage. Where such warpage does not exceed 0.010 inch, the surface involved may be lapped on a flat surface using "00" sandpaper. Clean thoroughly after the sanding operation.

Normal clearance between the choke shaft and bowl casting bore is 0.002 to 0.005 inch. Where use of a new shaft will still result in a shaft clearance of 0.007 inch or more, the bowl casting should be replaced. Excessive wear at this point makes it impossible to seal out dirt at the seals.

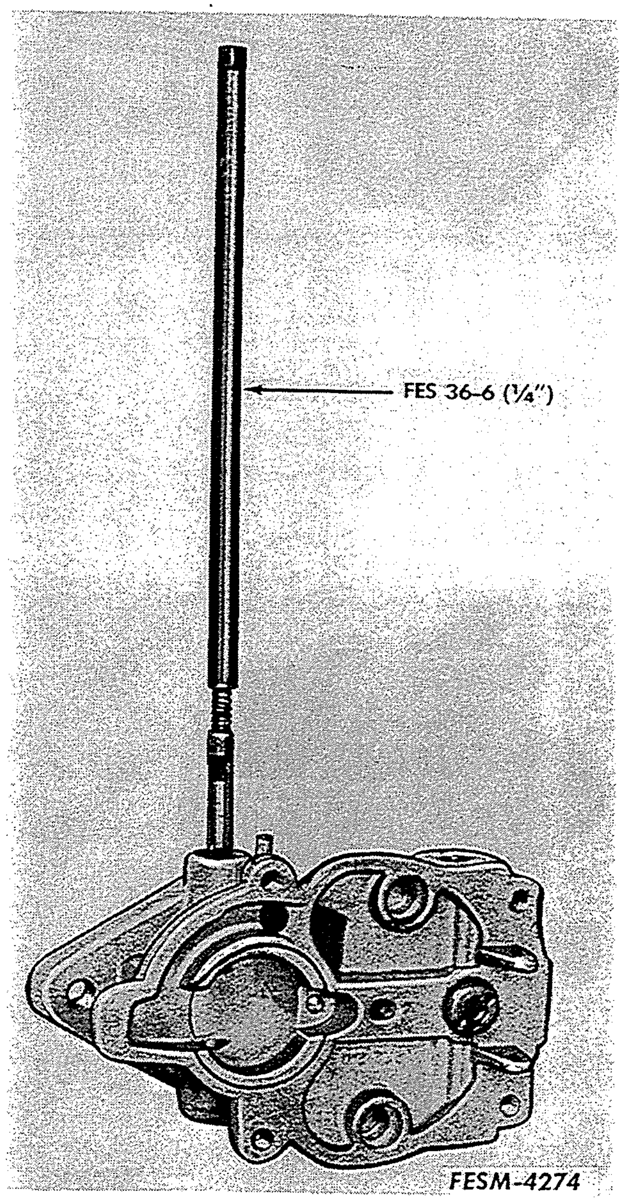


Removing throttle shaft bushing (Zenith).



Installing throttle shaft bushing (Zenith).

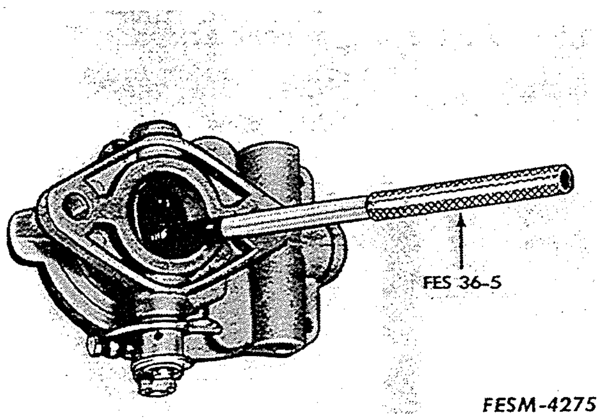
The normal clearance between the throttle shaft and throttle body bore is 0.001 to 0.003 inch. Where the use of a new throttle shaft will not hold the clearance below 0.005 inch, the throttle shaft bushings (Zenith) or body assembly (Marvel-Schebler) should be replaced. Excessive wear of this throttle shaft bore or bushings will result in dirt and air leakage past seals and poor alignment of the throttle plate, affecting engine idling and governor action. Bushings can be replaced using tools shown in Illusts. on this page.



Reaming throttle shaft bushing (Zenith).

Throttle Plate

The throttle plate should be inspected for burrs or damaged edges which would prevent good contact with the throttle body bore when fully closed. Never use a buffing wheel or wire brush to clean this plate, its sharp edges must not be deformed.

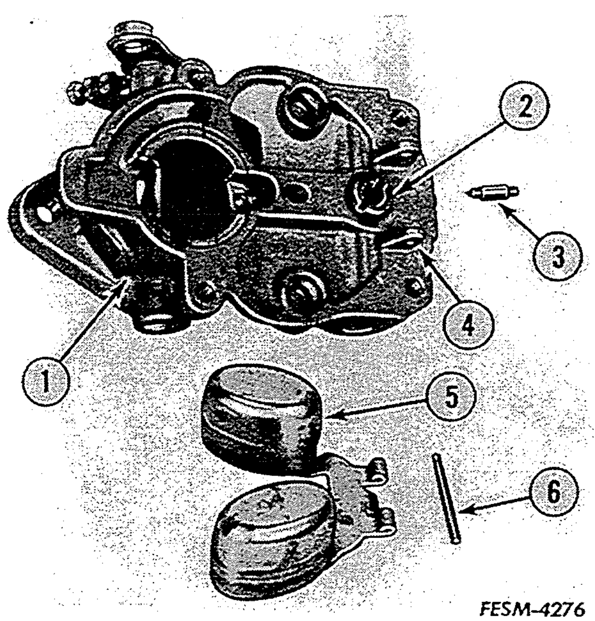


FESM-4275

When installing the throttle plate, insert it into the shaft from top of the throttle body with the short end of the plate down (measured from the holes). Insert screws from the top, using FES 36-5 but do not tighten until the throttle plate is centered in the body bore.

Unscrew the throttle stop screw until the plate is allowed to close fully. Holding the shaft lightly in the closed position, tap lightly on the face of the throttle plate with a brass rod to jar it into a centered position. The screws may then be tightened. The throttle plate must fit the bore closely with a minimum of light showing around its edges. The throttle shaft must be perfectly free to turn without binding at any point.

Flatten the exposed ends of the throttle plate screws to lock them in place. This must be done with care to prevent distortion of throttle shaft or plate.



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Float Assembly

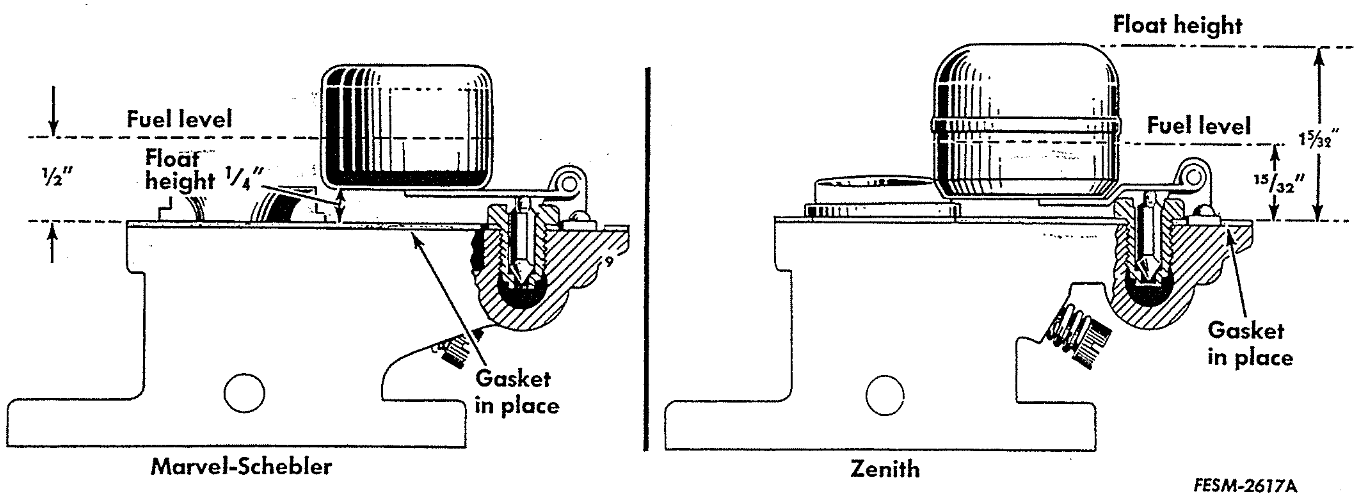
Replace the float assembly if float is full of fuel or if the float lever axle bearing is worn excessively. Inspect top side of the float lever for wear where it contacts the fuel needle valve.

Replace the float axle if any wear can be detected on its bearing surfaces.

1. Throttle body	4. Float axle support
2. Fuel valve seat	5. Float
3. Fuel valve	6. Float axle

Fuel Needle Valve and Seat

If any wear can be detected on the valve face, the needle valve and seat assembly should be replaced. The float assembly, its axle, and the fuel valve are responsible for maintaining a stable and correct fuel level; all parts must be maintained in good condition. Only slight bending of the float lever should be necessary to secure the correct float height. The float lever stop where used, should be adjusted to control float drop. Proper setting of float drop prevents the float from striking and wearing on the bottom of the bowl when operating over rough terrain.



Float measurement and liquid level.

Adjusting Screws

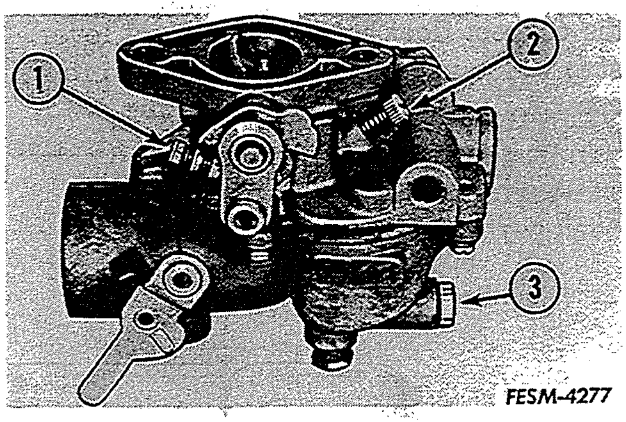
The idle adjusting needle point must be smooth and free from grooves, caused by being closed forcibly against its seat. Where this condition is found, a new screw should be used.

The main jet adjusting screw or adjusting screw in the electric fuel shut-off valve (where used) and seat should be inspected for damage caused by the screw having been forced against its seat. Where evidence of this is found, the screw should be replaced.

Venturi and Jets

Inspect the venturi, jets, main adjusting screw seat, and other calibrated openings for possible damage from improper probing in previous cleaning operations. Use the carburetor identifying part number to be found stamped on a metal disc riveted to the throttle body when selecting replacement parts. Make sure you are using the parts catalog for the particular unit and engine involved and that parts selected are from list headed with the carburetor identifying parts number. Failure to take this precaution when renewing parts could result in a carburetor completely out of calibration and an operation lacking power or economy.

Assembly and Adjustment



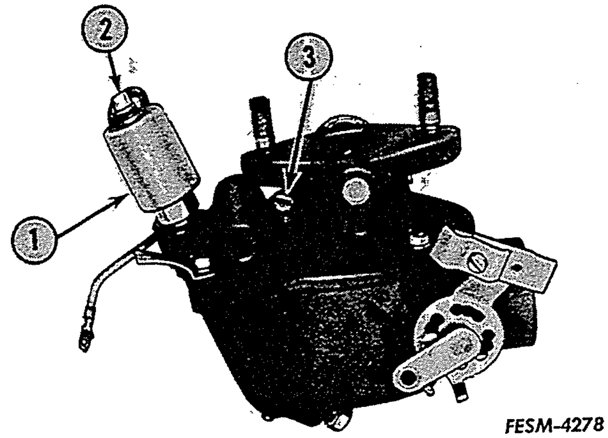
Zenith carburetor adjusting screws (not equipped with electric fuel shut-off).

1. Throttle idle stop screw 2. Idle adjusting screw 3. Main jet plug

Upon reassembly of the carburetor, be sure all new gaskets and seals are used throughout and are properly installed to insure gas tight connections. Use care when assembling fuel bowl to throttle body to prevent damage to the float assembly or the idle jet tube.

When replacing the idle adjusting screw and the main jet adjusting screw (if equipped), turn them down carefully until lightly seated. Forcible seating of these screws will result in damage to the tapered face of the screw and to its seat. Turn the idle screw out one turn. On carburetors with a main fuel adjustment screw, turn the screw six turns off its seat. On carburetors with electric fuel shut-off the adjusting screw must be set 4-1/2 turns off its seat. The throttle stop screw should be set to hold the throttle plate slightly open. These settings of the idle screw and the throttle stop screw serve only as a starting point for idle adjustment.

Adjustment of the carburetor should not be attempted until the engine has reached



Marvel-Schebler carburetor adjusting screws (equipped with electric fuel shut-off).

1. Electric fuel shut-off 2. Main fuel adjusting screw 3. Idle adjusting screw

normal operating temperature. Then adjust throttle stop screw for the specified low idle speed and set the idle adjusting screw for smoothest engine operation. Advance the engine speed control lever for a few seconds and again idle the engine, rechecking the idle adjustments for specified low idle speed and smoothest operation.

Where gasoline carburetor is equipped with a main fuel adjustment screw, its only function is to limit the fuel going to the engine. The main fuel adjusting screw must be set six turns off its seat. On carburetors with electric fuel shut-off the adjusting screw must be set 4-1/2 turns off its seat. The main metering jet which forms the fuel adjustment screw seat, has been calibrated to provide a full-power mixture and must not be restricted by use of the adjusting screw when the full power of the engine is required. The main fuel adjusting screw packing nut should be tightened sufficiently to prevent leakage and to hold screw firmly in position.

Section 3

LPG FUEL SYSTEM

CONTENTS

SPECIFICATIONS

Ensign LPG Carburetor Specifications

	C-135	C-153
IH part number	378 292 R93	377 641 R93
Ensign model number	CBM-100A121B	CBX-125A5412B
Machine used on	F&I-404	F&I-504
Venturi number	30	34
Delivery nozzle	Four - #10 drill	Two - .344 inch
Economizer bleed - drill size number	42	44
Economizer spring number	383 068 R1	359 622 R1
Starting adjustment screw - turns off seat	1-1/4	1-1/4
Main adjustment screw - turns off seat	1-5/8	2-5/8

Ensign LPG Regulator-Vaporizer Specifications

	C-135	C-153	
IH part number	377 640 R91	378 319 R91	382 494 R91
Ensign model number	RDG-55A5425A	RDG-55A5431B	RDG-55A5490A
Machine used on	I-404	I-504	F-504
Idle bleed - drill size	68	68	68
Idle adjustment - turns off seat	1-1/2	1-1/2	1-1/2

SAFETY PRECAUTIONS

CAUTION: Handling of equipment designed to use Liquefied Petroleum Gas fuel requires simply the exercise of common sense, based upon the knowledge of the nature of the fuel, and an understanding of the equipment in which it is handled and consumed.

The hazards of fire and explosion connected with leakage of Liquefied Petroleum Gas are similar to those which surround the leakage of gasoline. However, it is more difficult to detect dangerous accumulations of LP Gas. Escaping LP Gas is invisible and the volume of gas which has escaped cannot be determined by its odor in the area.

Leaking gasoline gives some visual evidence of its presence and volume, because it retains its liquid form for longer periods of time. Individuals are automatically on the alert when they smell the familiar gasoline odor and see the escaping fluid.

The vapors of both fuels are heavier than air. They are both able to disperse rapidly in moving air, which reduces them to a non-flammable mixture. But in still air, the vapors may accumulate in dangerous concentration, even flowing along the floor or ground into areas a considerable distance from the source, where they may lie as an explosive mixture for a considerable time.

No area in the vicinity of leaking gasoline or LP Gas may be regarded as safe until the leak is stopped and the concentration of vapors have been dispersed by a thorough ventilation. This ventilation must be accomplished without the production of sparks from electrical switches or other possible sources of ignition.

Safety precautions in the handling of Liquefied Petroleum Gas cannot be over emphasized. Sales and Servicing Organizations must familiarize themselves with City, County, and State regulations, governing the Sales and Servicing of LP Gas Equipment. Such laws, ordinance and fire regulations must be adhered to in addition to the following safety rules. Where local rules are more stringent than those given below, the local rules are to be given priority.

These rules apply to servicing any tractor or engine using Liquefied Petroleum Gas (butane-propane) for engine fuel, regardless of the nature of the service operations to be performed.

1. Select a position for servicing the machine with good air circulation. This is to avoid accumulation of gas-air mixture in and about the vehicle caused by undetected leaks.

2. Such location should be as far as possible from steam cleaners, hot water cleaners, hot dip tanks, etc., and any other device operating with open flame.

3. Shut off the main valves at fuel tank and allow engine to run. This is to exhaust all fuel in the system from the tank to the engine. In the event tractor is disabled and engine is inoperative, shut valve at tank. Bleed fuel system of LP Gas outside of building before towing unit into shop.

4. DANGER signs should be placed on both sides of the machine. There is to be no smoking in the vicinity. No work is to be performed on this unit or others in a nearby zone involving open flames such as cutting or welding, grinding, chiseling or any similar operation which may produce sparks.

5. In order to avoid possible accumulations of explosive gas-air mixtures, these machines, whenever possible, should be removed from the shop at the end of the working day.

6. A fire extinguisher (dry powder or carbon dioxide, CO^2) should be removed from its regular location and placed adjacent to mechanics working point . . . handy for immediate use. If LP Gas accidently ignites, it should be allowed to burn, if possible, until the source of fuel is shut off. Extinguishing the fire before this is accomplished can result in dangerous accumulations of gas which might cause a more serious flash or explosion.

7. Never use LP Gas from fuel tank for cleaning parts, blowing of horns, inflating tires, or other uses for which it is not intended.

NOTE: This is mentioned because inspections have revealed that operators have used it as a substitute for solvents and compressed air not realizing the extreme danger of this practice.

8. Whenever the nature of service work requires any operation on the fuel system, the following should be observed:

a. Any inspections, adjustments or operations on the fuel system which require venting or releasing gas from the system should be performed outside of the building, where the released gas may be dissipated harmlessly into the open air.

b. All pipe threads on LP Gas connection fittings are to be lubricated with a non-hardening compound, insoluble in petroleum, such as:

"Tite Seal" made by Radiator Specialty Co., Charlotte, N. C.

"Rectorseal #2" made by Rector Well Equipment Co., Houston, Texas.

"Plastic Lead Seal #2" made by Crane Packing Co., Chicago, Ill.

"Permatex #2" (made by Permatex Co., Inc., Brooklyn, N. Y. Permatex Aviation). Use compound sparingly on threaded portion only, to prevent forcing compound into the system.

Replace worn or defective fittings.

c. Synthetic rubber compounds are used in Fuel hose to resist the strong solvent action of LP Gas. Be sure hose of correct type and part number is used when replacement is necessary.

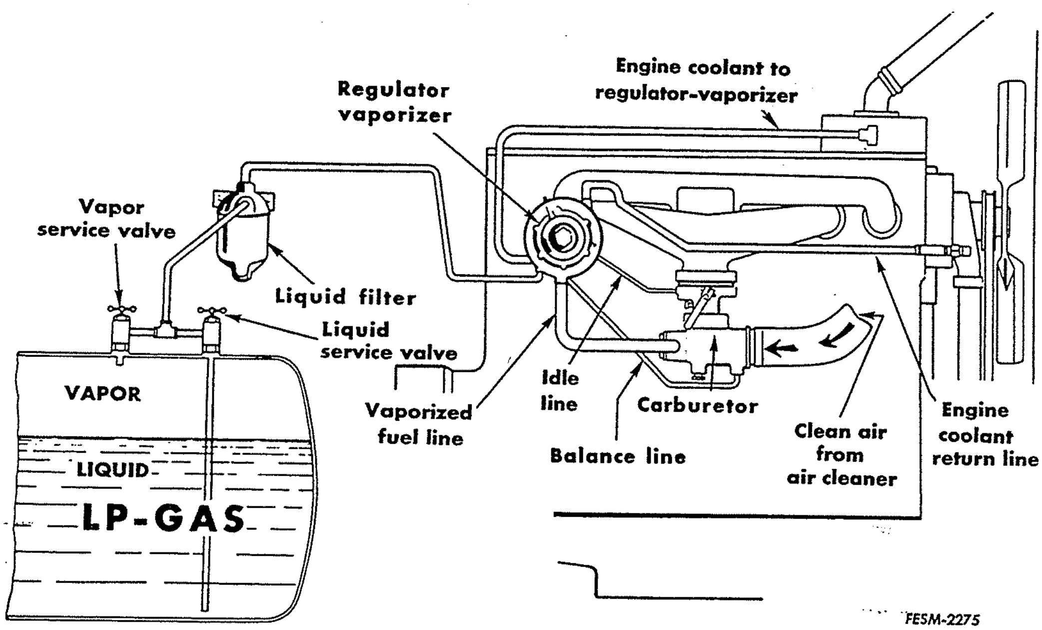
d. After connecting up fuel system, check for leaks. NO LEAKS ARE PERMISSIBLE. The appearance of frost at any point in the fuel system (when the engine is not running) is an indication of leakage. Strong smelling compounds are added to LP Gas to aid in leak detection. Household liquid soap of a foamy type should be applied to all fuel connections with a soft brush, leakage is indicated by forming bubbles. NEVER use open flame to check for leakage.

9. NO WORK WHATEVER IS TO BE PERFORMED ON THE FUEL TANKS OF LIQUEFIED PETROLEUM GAS FUELED VEHICLES. Any necessary work should be performed by qualified concerns who normally service such pressure vessels and are familiar with local regulations, inspection and approved tests after any repairs are made.

10. Vehicles of this type which have been involved in an accident should not be brought into the shop for repair until the shop foreman has checked the fuel tanks and fuel systems for possible leaks.

11. It is important to remember that all LP Gas systems are pressurized. Be sure the tank valves are tightly closed and all fuel is exhausted from lines before starting any repair work on the fuel system.

GENERAL DESCRIPTION



Typical LPG system schematic.

The Liquefied Petroleum Gas fuel system consists of the following basic parts:

- Fuel Supply Tank and Fittings
- Fuel Filter
- Regulator-Vaporizer Unit
- Carburetor
- Intake-Exhaust Manifolds
- Air Cleaner
- Variable Speed Engine Governor

The LP Gas fuel used must always have a boiling point temperature below the temperature of the surrounding atmosphere, which results in the fuel in the tank being under pressure at all times. Fuel from the supply tank passes through the fuel filter to the regulator-vaporizer unit. Here the varying pressure of fuel from the tank is stabilized and reduced to slightly below atmospheric pressure. With this reduction in pressure and the application of heat from engine coolant, the liquid fuel expands rapidly and is completely converted from a liquid to a gas.

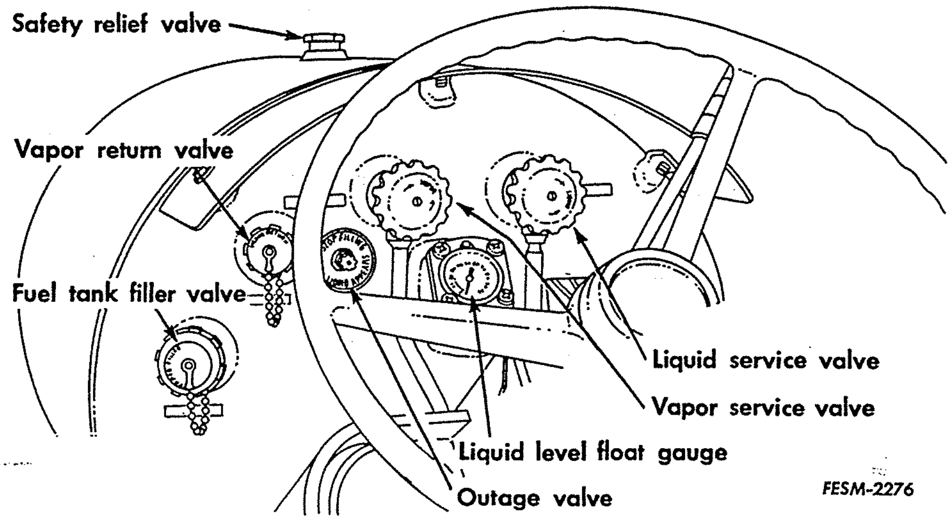
The vaporized fuel is drawn into the carburetor by a combination of pressure drop at the venturi and in the intake manifold. When the engine is stopped, no manifold vacuum exists and therefore the withdrawal of fuel from the regulator is stopped. Air enters these naturally aspirated systems through the air cleaner, where dirt and abrasive material is removed. Cleaned air and gaseous fuel is metered by the carburetor to the engine in varying proportions to meet the changing demands of load and speed.

A balance line connected between the atmospheric side of the low pressure diaphragm and the carburetor air horn provides further assurance that proper fuel-air ratio will be maintained even if airflow is restricted such as when the air cleaner accumulates dirt.

The variable speed engine governor controls the carburetor throttle to admit a greater or lesser volume of air-fuel mixture. This supports the operator's demand for engine speed, and provides power to maintain that speed up to the capacity of the engine.

Since all vaporization of the fuel takes place in the regulator-vaporizer, the intake manifold does not require heating, therefore, the intake and exhaust manifolds do not have a heat exchange feature.

OPERATION
Fuel Tank and Fittings



Typical LP gas fuel system controls.

Liquefied Petroleum Gas is exactly what its name implies. It is a petroleum gas (vapor) which for convenience in storing, transporting and handling, has been compressed into a liquid. This reduction in volume amounts to approximately 250 gallons of vapor to one gallon of liquid. Since LP Gas at mean temperatures can only be kept in liquid state under pressure, the fuel supply tanks and fittings are built to withstand a pressure of 500 pounds per square inch.

Actual saturated vapor pressure of the confined liquid will vary with its temperature and with the proportion of propane and butane it contains. The level of liquid in the fuel tank has no effect on pressure as long as vapor space is maintained and the tank is not overfilled. Under normal temperature range the gas in the tank will be under pressures ranging from a few pounds per square inch to 300 psi.

The fuel tank is of heavy, welded steel construction and is equipped with a safety relief valve, a filler valve, a vapor return valve, an outage valve, a liquid level float gauge and two service valves.

The safety relief valve protects the tank from excessive pressure by releasing vapor. It starts to open at 312 pounds per square inch and being spring loaded the valve closes with the reduction in pressure. A plastic cap is snapped into the outlet to exclude dust and the cap is displaced when the valve opens. Should tank be overfilled, resulting in too small an area above the liquid for expansion from temperature increase, the relief valve will open to prevent excessive pressure rise.

If tank is subjected to fire, the excessive temperature will result in a pressure increase above 300 psi. The relief valve will open allowing vapor to escape and burn. The fuel burns very fiercely, as in a blow torch, but since no air can enter the tank there is no explosion. With the reduction in temperature and pressure the relief valve will close preventing further loss of gas vapor.

The safety relief valve is serviced only by replacement of complete valve assembly. Adjustment or replacement of components must not be attempted.

The filler valve serves as a connection for the transfer of liquid fuel from storage. The filler valve is spring-loaded and automatically closes when pressure from the transfer hose connection is released. The valve is equipped with a screw cap which keeps out dust and forms an additional seal against leakage after transfer of fuel is completed. With the exception of the screw cap and its retaining chain, no components of this valve will be furnished for service. When damage or malfunction occurs, the complete valve must be replaced.

The vapor return valve is used to connect the vapor space in the tractor tank with the vapor space in the storage tank. This equalizes the pressure in the two tanks, permitting transfer of fuel by gravity or reducing the pump pressure required to transfer fuel. A built-in excess flow valve closes if the flow through the valve becomes excessive. A screw cap (with attached chain) is also provided to exclude dirt.

The outage valve is used to determine when the fuel tank is filled to the maximum permitted level. It is also a positive check on the accuracy of the float type gauge. The outage valve is opened by turning the thumb screw counterclockwise, venting vapor from the tank through a small opening. The moment liquid is ejected from this valve, the maximum permitted filling level has been reached. The filling operation should be stopped and the outage valve closed. The thumb screw is retained with a keeper ring to prevent its complete removal in normal use. This retainer ring and the valve stem are available for service.

The liquid level gauge is a float type gauge which rotates a small bar magnet as the liquid level in the tank carries the float up or down. The motion of this magnet moves another bar magnet mounted on the external portion of the gauge. The external magnet forms the gauge indicating needle. While these gauges are fairly accurate, some deviation will occur with various mixtures of butane-propane and because of the moving parts involved, the wear of certain parts effect the accuracy. The outage valve is fixed in its location in the tank and is always an accurate check on the float type gauge at maximum permitted liquid level. When damage or wear occurs to the liquid level gauge, the complete unit must be replaced.

The vapor and liquid service valves are well tagged for identification on the fuel tank. Except for their position in the tank, both valves are identical. Internal tank piping delivers vapor from the top of the tank to the vapor service valve. Liquid from the bottom of the tank is delivered to the liquid service valve. External tubing connects both valves to the inlet port of the fuel filter.

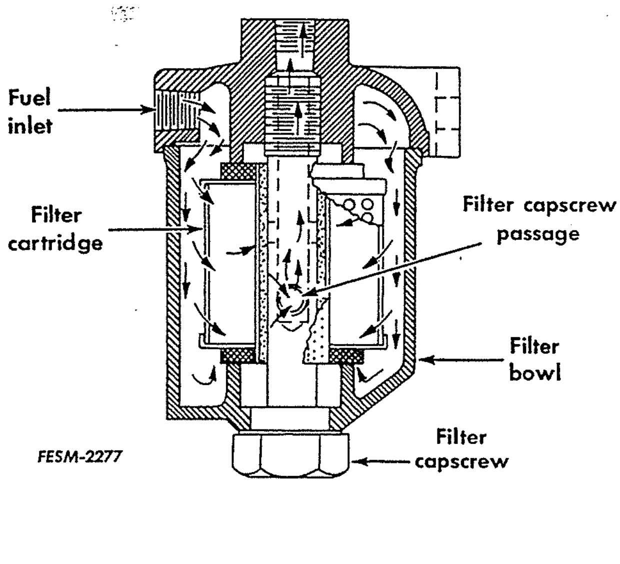
Both the liquid and vapor service valves are fitted with automatic excess flow check valves which close instantly whenever the flow exceeds the normal amount used to operate the engine. If a fuel line should accidentally be broken or a valve torn off the tank, the check valve located ahead of the mounting thread of the valve body, will close and stop the flow of gas, except for a small amount bypassed for valve relief purposes. Operator's instructions warn against opening these service valves too rapidly, because the resulting initial rapid surge of gas through the valve will cause the excess flow check valve to slam shut. Should this occur, about 50 seconds is required for pressures to equalize through a small bypass opening at which time the check valve will automatically reopen.

With the exception of the hand wheels and their retaining screws, no components of these valves are furnished for service. When damage or malfunction occurs, the complete valve is replaced.

CAUTION: The fuel tank must be empty and pressure reduced to atmospheric before removing any valve or the liquid level gauge assemblies.

Fuel Filter Assembly

The fuel filter is provided to stop the passage of scale, rust or other foreign solids that may be carried by the liquid fuel from any source. Such material must be prevented from reaching the regulator valves and orifices. These finely finished surfaces or edges may be easily damaged by grit or hard material that might lodge between the seats and the valves. Fuel from either the vapor or liquid service valves enters the fuel filter inlet, passing through the treated paper filter element to the outlet passage and then to the regulator-vaporizer unit.



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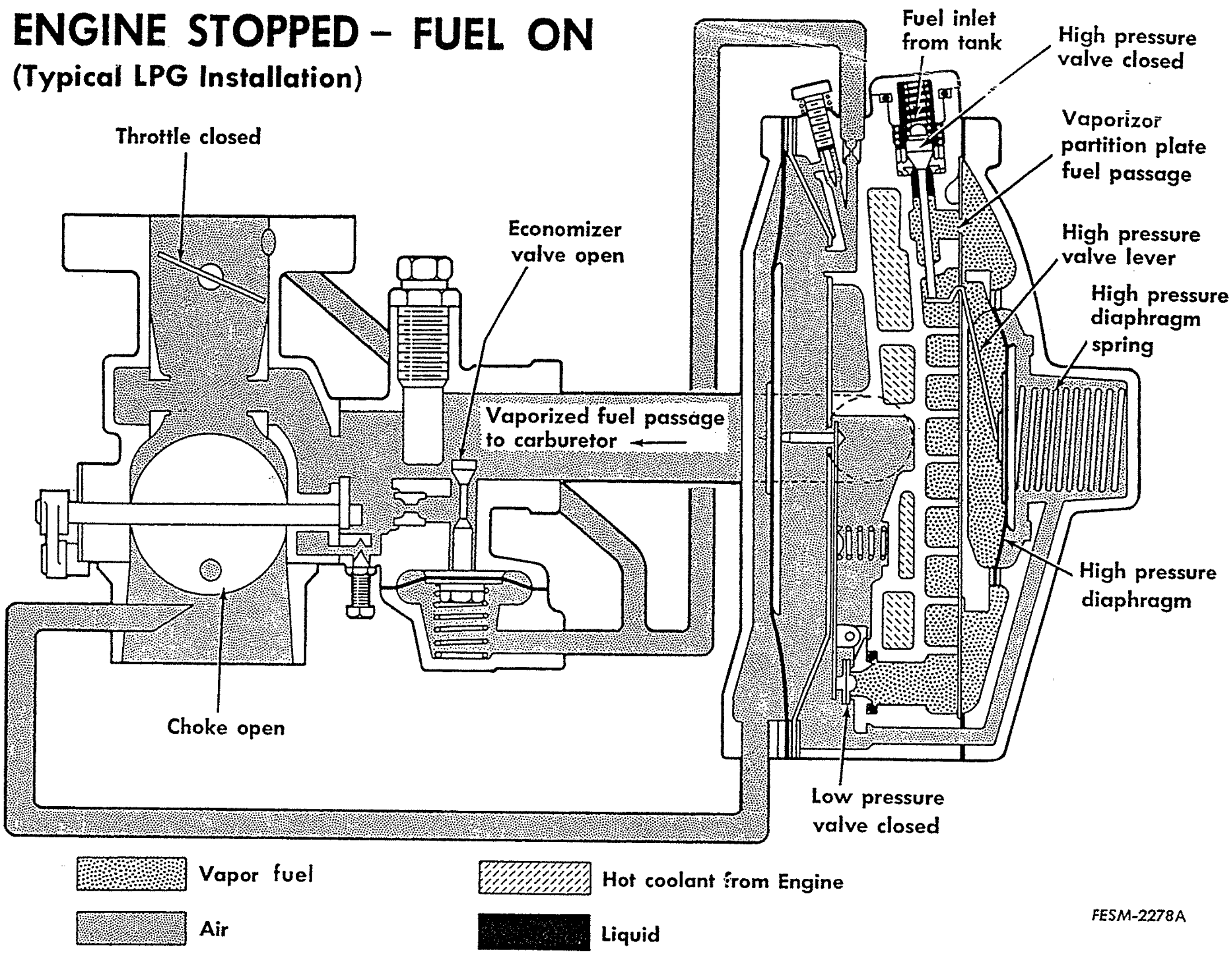
As the filter element loads up with foreign material sufficiently to restrict the flow of fuel, a pressure drop will occur within the filter. The resulting vaporization occurring in the filter will cause frost to form on the outside of the filter. If the filter is definitely cold to the touch when the engine is running under load, it indicates a need for cleaning or replacing the filter element.

Before opening the filter, close the service valves at the tank and continue to operate the engine to use up the fuel remaining in the lines, filter and regulator-vaporizer. If operation of the engine is not possible, the unit must be moved out into the open air where the system may be safely vented. Examine the filter element closely for damage which would allow dirt to pass, replace if badly loaded with dirt or damaged. Use new gaskets upon reassembly and check for possible leakage by opening the vapor service valve for a moment and applying liquid detergent to areas of fuel bowl gaskets. No leakage is permissible. Do not over tighten the cap screw as the gasket may roll-up and leak.

ENGINE STOPPED - FUEL ON
(Typical LPG Installation)

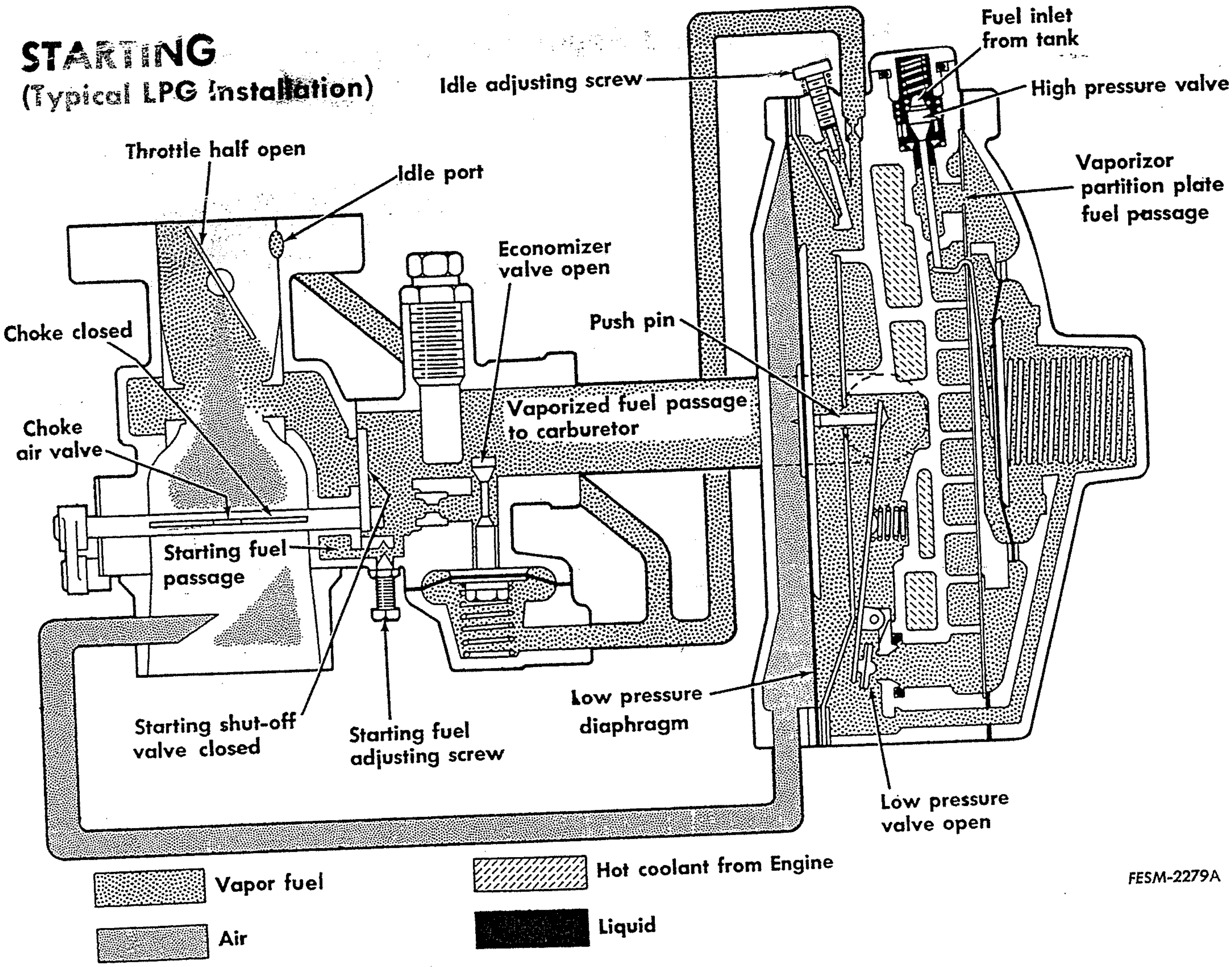


Engine Stopped — Fuel On

The Illust. shows the carburetor throttle closed and the choke open. The economizer valve is open. The regulator high pressure valve and the low pressure valve are both closed.

The regulator high pressure valve was open until vapor fuel forced the high pressure diaphragm against its spring. When the vapor fuel pressure reaches 3-1/2 to 5 psi, the high pressure diaphragm spring will have been compressed enough to allow the high pressure valve to close.

STARTING
(Typical LPG Installation)



Starting

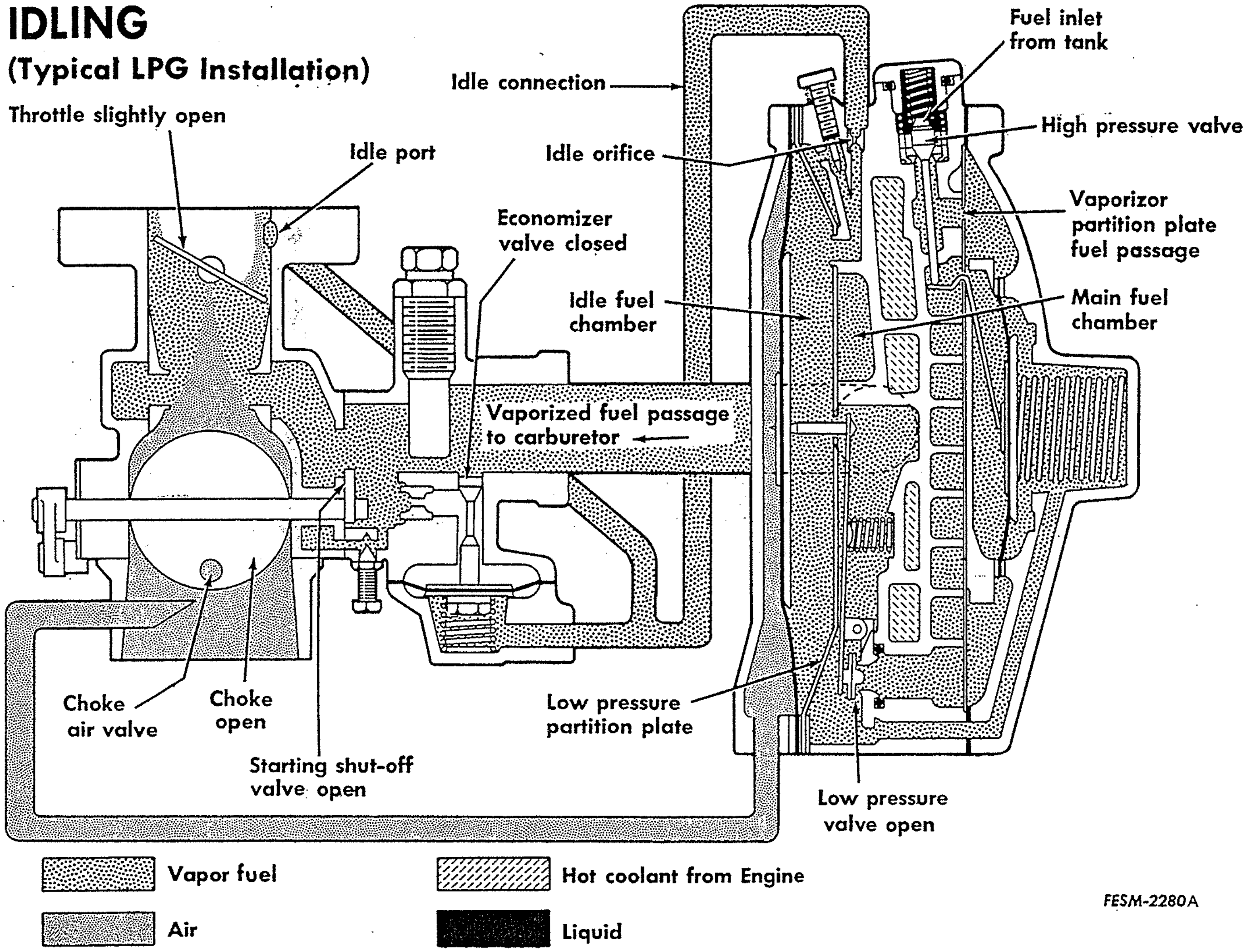
The Illust. shows the carburetor choke closed, starting shut-off valve closed (which is attached to the choke shaft), and the throttle half open. The economizer valve is open, regulator low pressure valve open and the high pressure valve maintaining a pressure of 3-1/2 to 5 psi as the engine is being cranked.

Vacuum developed (as the engine is being cranked) in the intake manifold, carburetor, vaporized fuel passage to carburetor and low pressure chamber has moved the low pressure diaphragm against the push pin with sufficient force to open the low pressure valve.

Vapor fuel is drawn past the vaporized fuel passage, the starting fuel adjusting screw, through the starting fuel passage of the carburetor where it is mixed with clean air, drawn through the choke air valve in the choke plate and on through the intake manifold to the engine cylinders.

IDLING

(Typical LPG Installation)



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Idling

The Illust. shows the carburetor choke open, starting shut-off valve open, and the throttle slightly open. The economizer valve is closed, regulator low pressure valve open and the high pressure valve continues to maintain a pressure of 3-1/2 to 5 psi.

With the engine running and the throttle valve slightly open, the vacuum in the idle connection is sufficient to close the economizer valve.

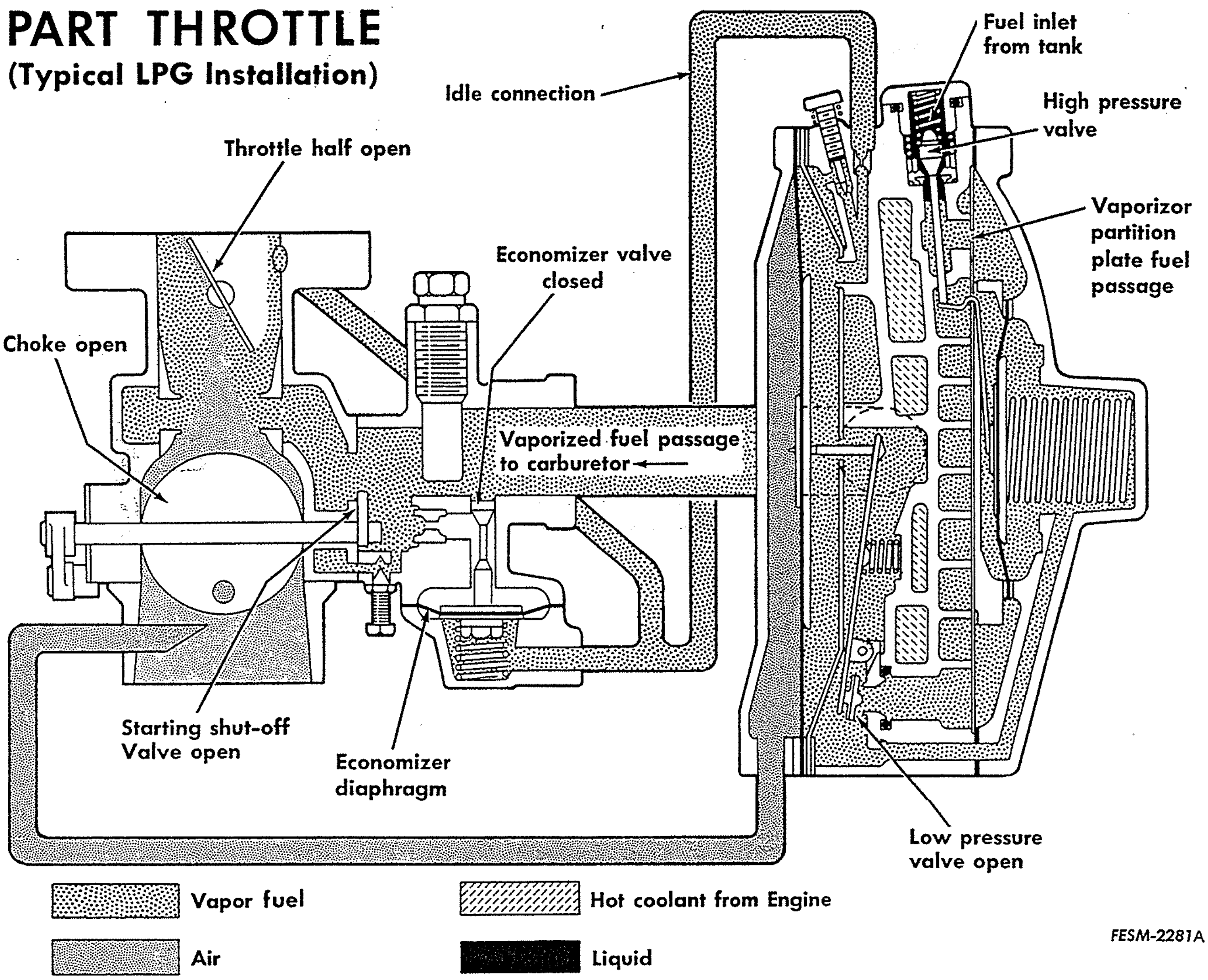
The low pressure partition plate separates the main fuel chamber from the idle fuel chamber.

The idle orifice provides a restriction between these two chambers, sufficient to make manifold vacuum, applied through the idle passageway in the regulator to be instantly effective on the low pressure diaphragm.

This causes the low pressure valve to open and vapor fuel is drawn from the main fuel chamber past the idle adjusting screw into the idle connection to the idle port in the carburetor.

The greater portion of the vapor fuel required for controlling the idle mixture is drawn through the idle connection from the main and idle fuel chambers of the regulator. The remainder is drawn through the vaporized fuel passage to the carburetor.

PART THROTTLE
(Typical LPG Installation)



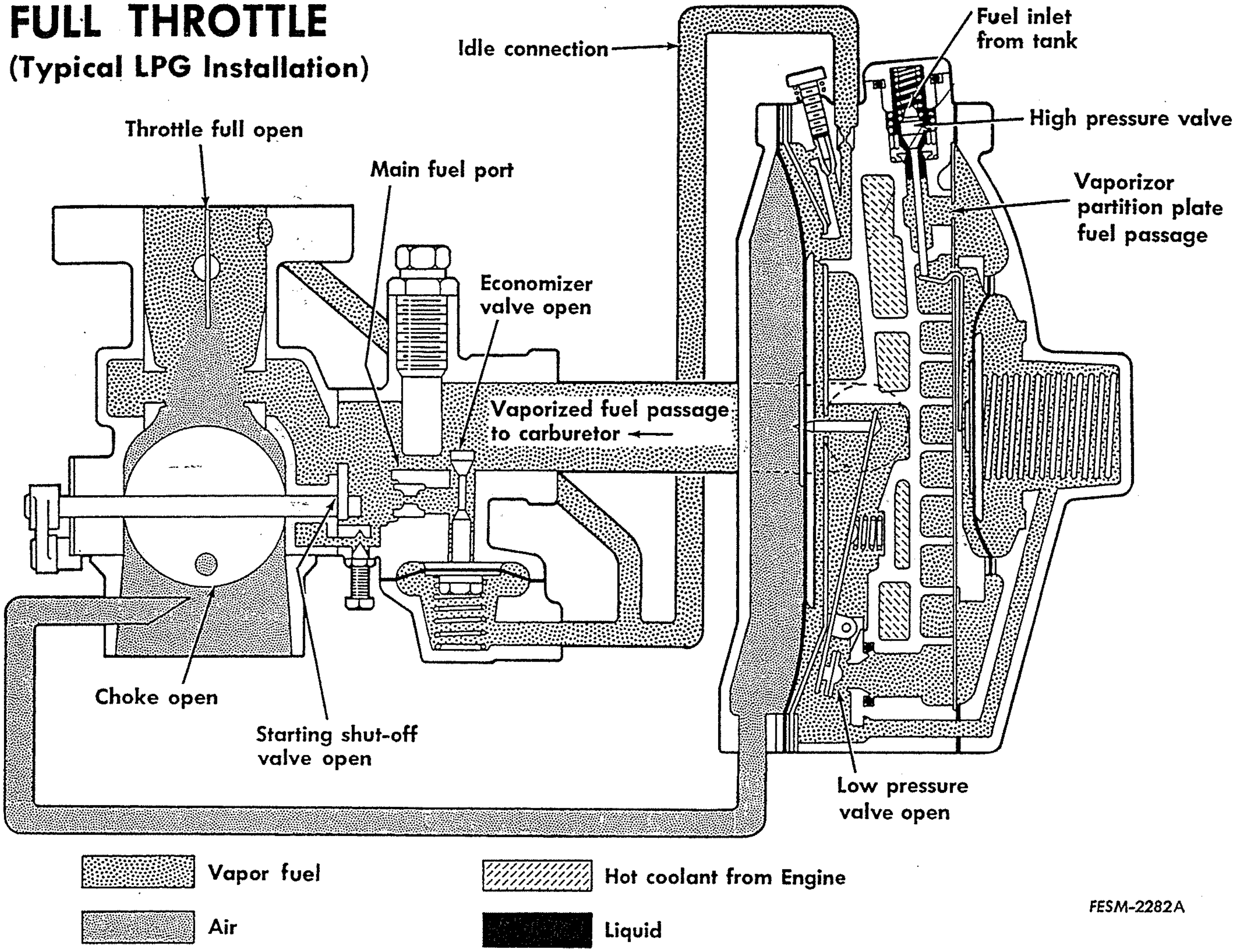
Part Throttle

The Illust. shows the carburetor choke open, starting shut-off valve open, and the throttle half open. The economizer valve is closed, regulator low pressure valve open and the high pressure valve continues to maintain a pressure of 3-1/2 to 5 psi.

Vapor fuel is drawn through the vaporized fuel passage and the idle connection to the carburetor.

The valve of the economizer, during part throttle operation, is normally held shut by manifold vacuum acting on the economizer diaphragm. This assures maximum economy. However, if the throttle is opened to provide for greater speed or load, the drop in manifold vacuum permits the spring to open the economizer valve and allow more vaporized fuel to flow into the carburetor.

FULL THROTTLE
(Typical LPG Installation)



Full Throttle

The Illust. shows the carburetor choke open, starting shut-off valve open, and the throttle full open. The economizer valve is open, regulator low pressure valve open and high pressure valve continues to maintain a pressure of 3-1/2 to 5 psi.

Vacuum in the idle connection is not high enough to close the economizer valve, therefore vapor fuel is being drawn through the vaporized fuel passage and economizer valve.

TROUBLE SHOOTING

Trouble shooting the LP Gas burning engines should follow the same general sequence as used with gasoline burning engines, since the same basic requirements are necessary to their continued good operation. However, the points of emphasis are changed somewhat due to operating characteristics of the LP Gas engine. Many of the common causes of trouble in the gasoline engine rarely occur in the operation of the LP Gas engine and visa versa.

LP Gas purchased from reputable producers and distributors will generally be free of harmful solids or moisture. Since LP Gas is, of necessity, handled and stored in closed systems and under pressure, it is not exposed to dirt contamination and moisture condensation which often cause plugged lines, strainers and jets in gasoline systems.

The metering of completely vaporized, dry gas is done through jets and nozzles which are many times larger than those required for liquid fuel. These jets and adjusted openings for dry gas do not become enlarged from wear and are not readily clogged by foreign material. Once properly adjusted, the LP Gas system will retain its calibration over long periods of time without need for service.

The range of air-fuel ratios of LP Gas which will ignite and support combustion is similar to that of gasoline but in somewhat narrower range. This means that excessively lean or excessively rich fuel mixtures will not ignite. An engine "flooded" with an excessively rich LP Gas mixture (from any cause) will remain in that condition until the combustion chambers, intake manifold and induction system are cleared of gas. LP Gas vapor does not condense and drain off like gasoline, the source of fuel must be shut off and the engine cranked with open throttle to expel the overrich mixture.

The LP Gas regulator unit is comparable to the diaphragm type fuel pump as used on some applications of gasoline burning engines. Both of these units control the volume and pressure of fuel as supplied to the carburetor. In service life, the LP Gas regulator unit has the advantage of a cleaner fuel and less inherent wear in a reduced number of working parts as compared to the gasoline unit.

In reviewing the above comparisons, it is evident that in trouble shooting the LP Gas burning engine, greater emphasis should be placed on condition of the engine and the electrical system than on the fuel system. Fuel system conditions which can affect fuel economy, loss of power, smooth engine operation and good starting characteristics, while important, are relatively few in number.

Before disturbing carburetor adjustments or removing LP Gas equipment for inspection, check the general condition of the engine with particular attention to the ignition and electrical system. Refer to Blue Ribbon Service Manual Section, Form GSS-1052-C, for full information on the Electrical System. Basic engine information will be found in Section 1, of this manual.

Problem	Cause
Fuel system conditions affecting Fuel Economy:	1. Poor setting of fuel adjustments to meet conditions of fuel and operation. 2. Leakage of fuel through regulator valves or high-pressure diaphragm. 3. Lack of economizer action, due to diaphragm leakage, valve damage, or vacuum line and connections leaking. 4. Low-pressure regulator valve opening at less than 3/8 inch water manometer, resulting in over-sensitive action or leakage. 5. Unbalanced regulator due to air leak in balance line or connections. 6. Plugged air intake and/or air cleaner.
Other factors that can influence fuel economy:	1. Loss of engine compression due to piston and ring condition or valve leakage. 2. Loss of valve lift due to cam wear or valve lever adjustment. 3. Valve timing error. 4. Ignition timing error. 5. Misfiring due to poor condition of ignition points, plugs and insulation. 6. High friction loss in engine, transmission or final drive due to improper lubrication. 7. Brakes dragging. 8. Excessive drive wheel slippage due to worn tire lugs or lack of sufficient wheel weight. 9. Improper adjustment of implement, resulting in excessive draft requirements. 10. Excessive drive belt slippage, in belt drive applications. 11. Excessive amount of tractor wheel weight used for field conditions, resulting in increased power requirement.

Problem	Cause
Fuel system conditions affecting Power Loss:	1. Excessively lean air-fuel settings of fuel adjustments. 2. Lack of regulator valves response to fuel demand of engine, due to gummy, sticky action of either valve and/or pressures out of range. 3. Plugged fuel filter or inlet screens. 4. Plugged regulator balance lines or connections. 5. Air leakage at throttle shaft, carburetor gaskets, intake manifold gaskets, fuel hose or idle tubing. 6. Poor governor action due to wear, misalignment, binding of moving parts, or failure of governor to fully open throttle, due to adjustment of governor linkage. 7. Plugged air intake or air cleaner. 8. Lack of fuel vaporizing capacity due to insufficient water circulation through regulator-vaporizer unit, from obstructed water lines or frozen water lines. Freeze-up may occur when cold engine is placed under full load before water temperature has approached normal range.
Other factors that can influence power output:	1. Loss of engine compression due to piston blow-by or valve leakage. 2. Loss of valve lift due to cam wear or valve lever adjustment. 3. Valve timing error. 4. Ignition timing error. 5. Excessive intake valve stem and guide clearance. 6. Misfiring due to poor condition of ignition points, plugs and insulation. 7. Obstruction in exhaust system, muffler or spark arrester.

Problem	Cause
Other factors that can influence power output: (Cont.)	8. Detonation (audible or inaudible) due to: a. "Hot Spots" in the combustion chambers, exposed sharp corners or projections or burned spark plug elements. Surface ignition. b. Use of LP Gas Fuel having <u>poor anti-knock characteristics.</u> c. Overadvanced ignition timing. d. Excessive combustion chamber deposits. <u>NOTE</u>: Detonation results in "blown" cylinder head gaskets, damaged pistons, shortened valve life and damaged spark plugs in addition to power loss. 9. High pressure loading of hydraulic power supply. 10. High friction losses in transmission of power. 11. Indicated power loss, due to excessive draft demand from improperly adjusted implement, or from use of excessive amount of tractor wheel weight. 12. Slippage of drive wheels or drive belt.
Fuel system-conditions affecting <u>Starting Characteristics</u>:	1. Poor adjustment of starting fuel screw and/or idle fuel screw. 2. Leakage of fuel through regulator valves or high-pressure diaphragm. 3. Failure of choke operating cable and/or choke lever to place choke valve and starting shut-off valve in starting position. 4. Leakage of fuel past starting shut-off valve in starting position. 5. Obstruction in starting gas passages in carburetor.

Problem	Cause
Fuel system conditions affecting Starting Characteristics: (Cont.)	6. Air leakage at throttle shaft, carburetor gaskets, intake manifold gaskets or idle fuel line and connections. 7. Plugged fuel filter, fuel intake screens, lines or fittings. 8. Excess flow check valve in tank service valve closed due to defect or from too rapid opening of service valve.
Other factors affecting starting characteristics:	1. Condition of storage battery, its ability to furnish ignition and cranking power. 2. Continuous load in excess of generator capacity, such as frequent cranking demand in combination with too short an operating time to replace battery loss. 3. Excessive starting current draw due to worn starting motor bearings or sprung armature shaft, etc. 4. High friction loss in engine, due to improper lubrication for season of use. 5. Condition of spark plug electrodes and insulators, must be of heat range to meet extremely severe service classification to result in good service life. See also Detonation, Condition and Under Power Loss. 6. Condition of distributor points, condenser, insulation and cables. 7. Ignition coil condition and connected into the circuit in proper polarity. 8. Ignition timing error. 9. Valve timing error.

Problem	Cause
Fuel system conditions affecting control of idling:	1. Poor setting of fuel adjustments to meet idling conditions. Poor adjustment of speed change linkage to secure specified idle speed. 2. Loss of idling adjustment control due to leakage of fuel through regulator valves or high-pressure diaphragm. 3. Loss of idling adjustment control due to ruptured or leaking economizer diaphragm. 4. Air leakage at throttle shaft, carburetor gasket, intake manifold gaskets or idle fuel lines and connections. 5. Foreign material in idle fuel passages or calibrations.
Other factors affecting control of idling:	1. Excessive intake valve stem and guide clearance. 2. Loss of engine compression due to piston blow-by or valve leakage. 3. Condition of spark plug electrodes, insulators, and cables. 4. Condition of distributor points, condenser, coil, and insulation. 5. Ignition timing error. 6. Valve timing error. 7. Loss of valve lift due to cam wear or valve lever adjustment.

REGULATOR-VAPORIZER SERVICE

Removal and Installation

CAUTION: Before attempting removal of the regulator-vaporizer unit, both the liquid and vapor service valves must be closed and the engine operated until all fuel in lines, filter and vaporizer is exhausted. If operation of the engine is not possible, the unit must be moved out into the open air where the system may be safely vented.

Where the condition which prompted the removal of the regulator-vaporizer was lack of power, or lean mixtures from insufficient fuel delivery, inspect the fuel filter element for restriction at the same time.

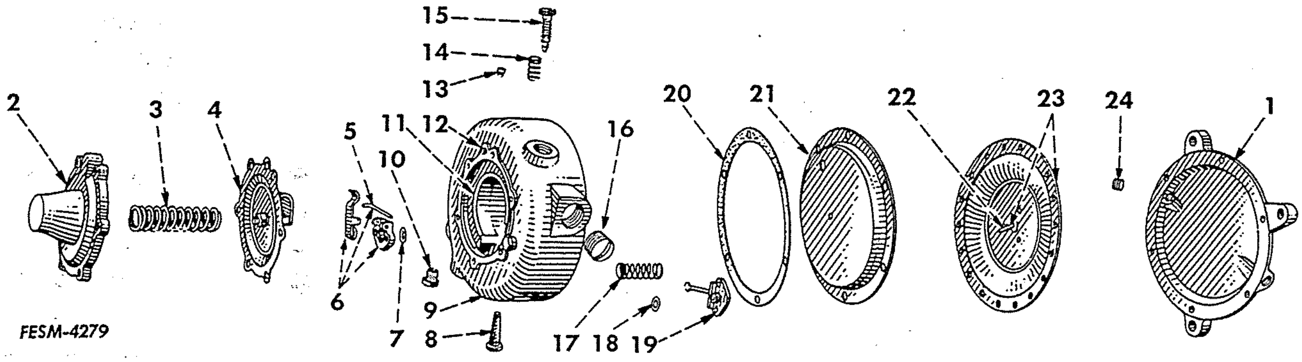
The engine cooling system should be drained, so that water inlet and outlet lines to the vaporizer may be removed. Clean the area surrounding the regulator-vaporizer unit to prevent entry of dirt into lines or connections which remain with the engine. This is insurance against induction of dirt into the system upon reassembly of the reworked unit.

Inspect fuel hose, idle fuel tubing and balance line connecting the vaporizer to the carburetor for possible leakage. Since these lines operate below atmospheric pressure, leakage or poor connections will be a source of entry of dirt or abrasives into the engine. Leakage of these connections or lines will also result in loss of engine power through lean mixtures. Renew tubing, fittings and hose where the old is found to be in questionable condition. Be sure hose used is of correct part number so that correct material is furnished and will not be affected by the dissolving action of the fuel.

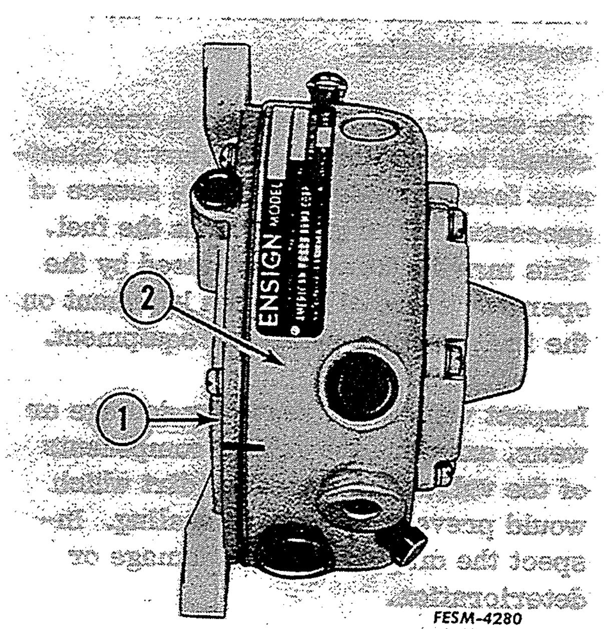
Be sure there are no restrictions in the vaporizer water jacket or the water inlet, or outlet lines connecting the vaporizer to the engine cooling system. Such restriction could result in a freeze-up of the vaporizer and insufficient vaporization of fuel when engine demand for fuel is increased by an increasing load.

When reinstalling the regulator-vaporizer unit, be sure to secure air and fuel tight connections. Fuel lines, fittings and connections which are normally under pressure may be checked for leaks by brushing them with liquid household detergent after momentary opening and closing of the vapor service valve at the tank. No leaks are permissible.

Inspection and Repair



1. Back cover plate	9. Regulator body housing	17. Low pressure spring
2. Pressure regulator cover	10. Pipe plug	18. O-ring
3. High pressure spring	11. Partial plate	19. Low pressure valve
4. High pressure diaphragm	12. Bushing	20. Gasket
5. Pivot pin	13. Bleed screw	21. Partition plate
6. High pressure valve	14. Spring	22. Push pin
7. O-ring	15. Idle adjusting screw	23. Low pressure diaphragm
8. Fuel inlet strainer	16. Plug	24. Plug



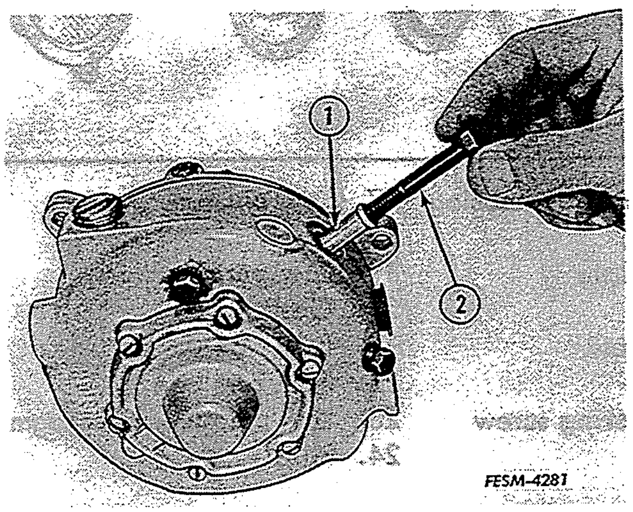
1. Back cover plate
2. Regulator body housing

After removal of the regulator-vaporizer unit from the engine, clean the outside surfaces of the unit of dirt accumulations so that the solvent used to clean the parts will not be contaminated.

Before disassembling the regulator unit, place a mark across the back cover plate and body so upon reassembly the cover can be readily replaced in its proper position.

The solvent used to clean internal parts of the regulator-vaporizer must be of petroleum base type, such as kerosene, oleum spirits, etc. Other types of solvents, such as carbon tetrachloride will destroy the material used in diaphragms and valves.

Disassemble the regulator-vaporizer, using care to prevent damage to sealing surfaces of diaphragm covers. Discard old gaskets, since new must be used upon reassembly. Remove flakes of gasket material which may adhere to the sealing surfaces. Thoroughly wash all parts in clean solvent, blow out all passageways with compressed air. Be sure that all loose scale or particles of hard foreign material is removed.



1. Fuel inlet strainer
2. 5/16" N.C. capscrew

On units so equipped, remove and clean or replace the inlet strainer. Install a 5/16 inch N.C. cap screw into the strainer bore. Turn the cap screw into the strainer approximately 1 to 1-1/2 turns. Pull the cap screw and strainer out of the bore.

Grease or oil picked up and held in solution in the liquid fuel from pumps and handling equipment, will be found in the vaporizing chamber where conversion of fuel from liquid to vapor occurs. Where a considerable amount of grease is found, it is possible that some of this material has been carried over into the carburetor, where channels may be plugged, upsetting gas-air mixtures. In which case the carburetor will also require cleaning.

The assistance of the LP Gas vendors should be solicited in an effort to eliminate foreign material and the source of excessive oil or grease from the fuel. This may be found to be caused by the operator's use of too much lubricant on the fuel transfer pump and equipment.

Inspect valves and seats for damage or wear, examine the rubber components of the valves for imbedded dirt which would prevent good valve sealing. Inspect the diaphragms for damage or deterioration.

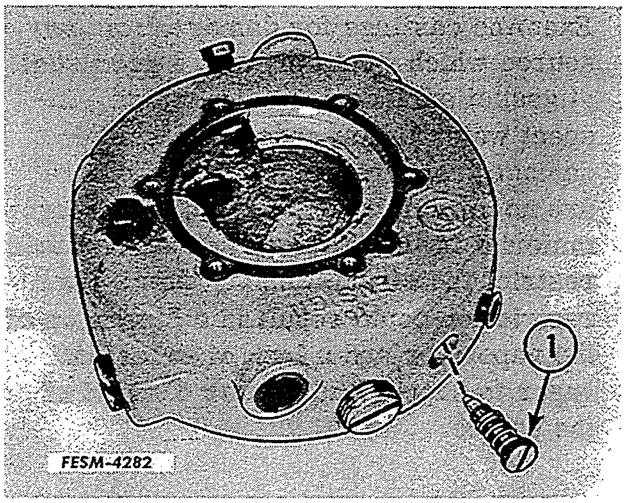
Leakage of the high-pressure valve will result in test gauge pressures above the specified range of 3-1/2 to 5 pounds per square inch. When this pressure builds up as high as ten pounds or more, the control of idle fuel adjustment will be upset, poor fuel economy will be experienced, and the engine will become increasingly hard to start due to rich mixtures. Leakage through the high-pressure diaphragm will have an identical effect, but <u>no</u> increase in test gauge pressure beyond the normal range may be indicated.

Leakage at the low-pressure valve will also upset the control of idle fuel adjustment and result in poor fuel economy. Because of this leakage of vapor into the carburetor and air induction system, the engine becomes "flooded" with fuel and starting is increasingly difficult. Leakage at the low-pressure valve may not be caused by any defect in this valve itself, but it may be forced open by pressures exceeding five psi from leakage at the high-pressure valve. Leakage of the low-pressure diaphragm effects only the sensitive response of that valve to the fuel demand of the engine, the response dropping off rapidly with the increase in size of hole in the diaphragm.

Examine castings for damage from any source which would prevent a good seal at gasket surfaces or connections. Inspect water jacket area for possible damage from freezing. Be sure there are no accumulations of mud or foreign material in the water jacket which would restrict the circulation of water. Such restriction could result in a freeze up of the vaporizer and a lack of sufficient vapor to support full power demand of the engine.

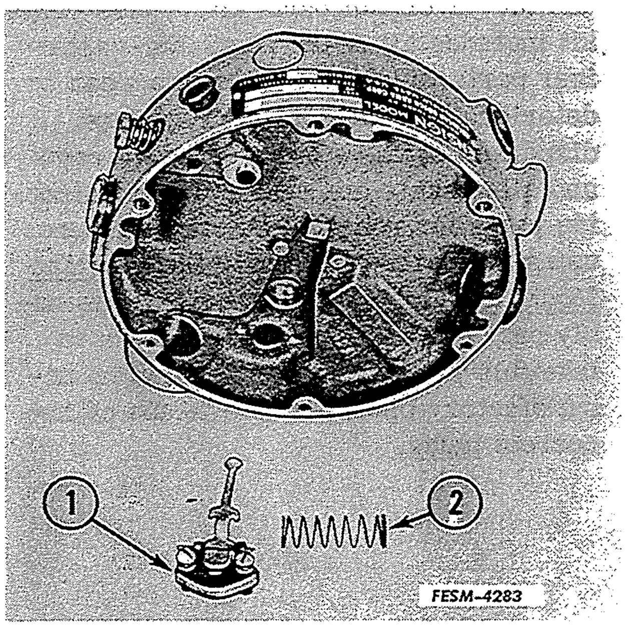
Where both the valves and diaphragms are found to be in questionable condition, use the "overhaul parts kit". This parts kit includes all of the regulator-vaporizer parts which are subject to wear or deterioration; the strainer, springs, diaphragms, valve assemblies, screws and all gaskets and seals. When selecting parts for renewal, be sure you are using the parts catalog for the <u>Machine Model and Regulator-Vaporizer</u> assembly part number involved. Failure to take this precaution could result in unsatisfactory operation due to use of incorrect parts.

Assembly and Adjustment



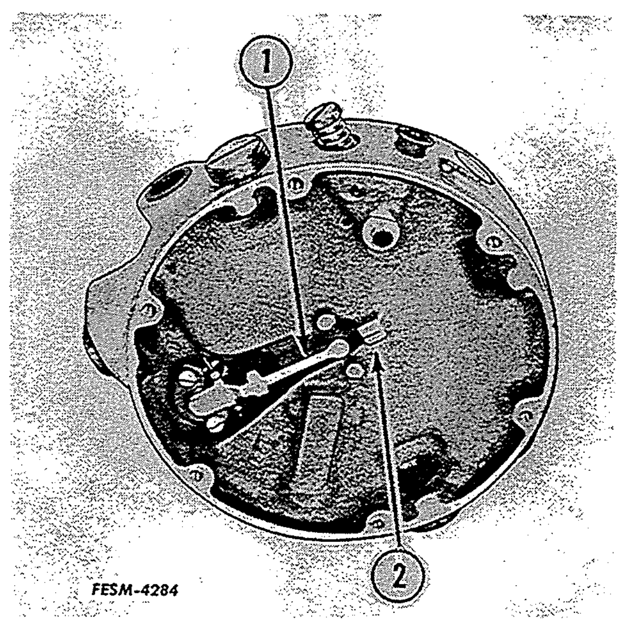
Install the idle adjusting screw and its retaining spring. Turn screw clockwise, down lightly against its seat and then turn counterclockwise 1-1/2 turns for a tentative adjustment. The idle adjustment will be completed after installing the regulator and in conjunction with adjustment of engine idle speed. Refer to "Fuel Adjustments", on page 3-36.

1. Idle adjusting screw and spring

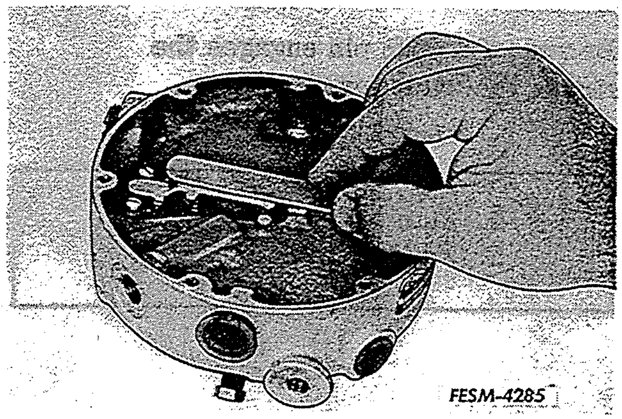


1. Low pressure valve assembly
2. Low pressure valve spring

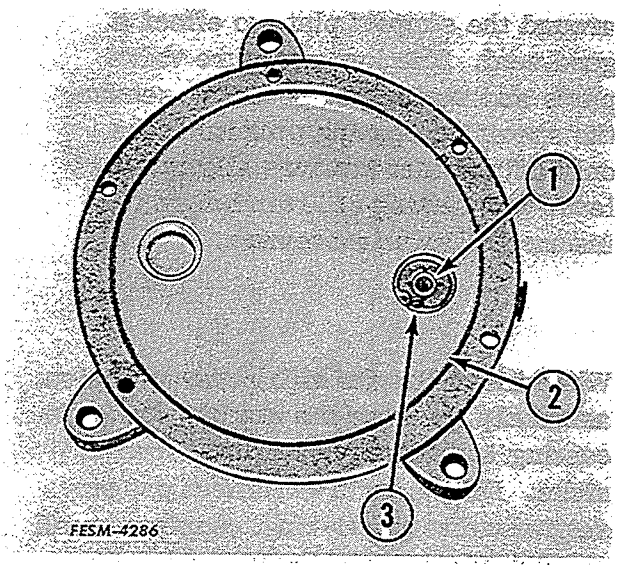
Install the low-pressure valve assembly and spring, using a small amount of clean light oil on the valve seat and O-ring seal. A post or boss is machined and marked with a line for the purpose of setting the low pressure valve lever. The valve lever should be centered on the line before tightening the screws holding the valve block.



1. Valve lever
2. Machined post with line



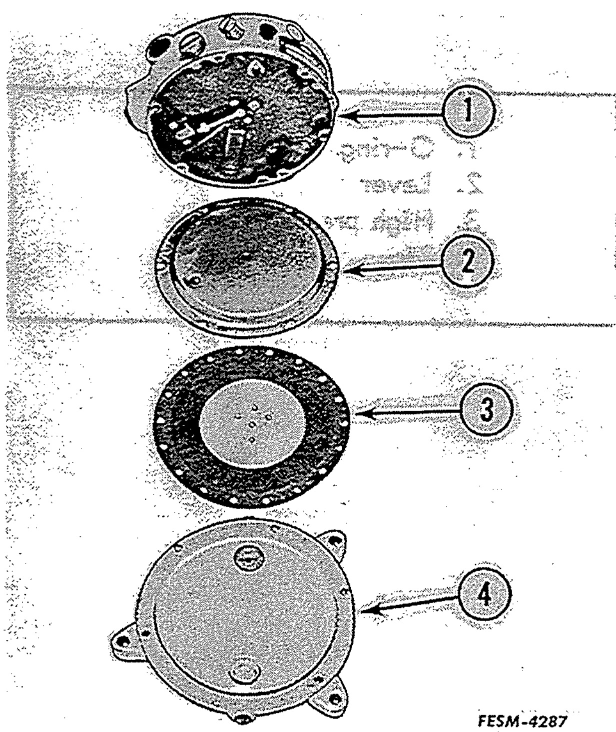
The top of the valve lever should be flush with the top of the post. Check with a straight edge, and bend the lever if necessary to correct height.



Install the compensator assembly in the back cover plate and secure with the snap ring.

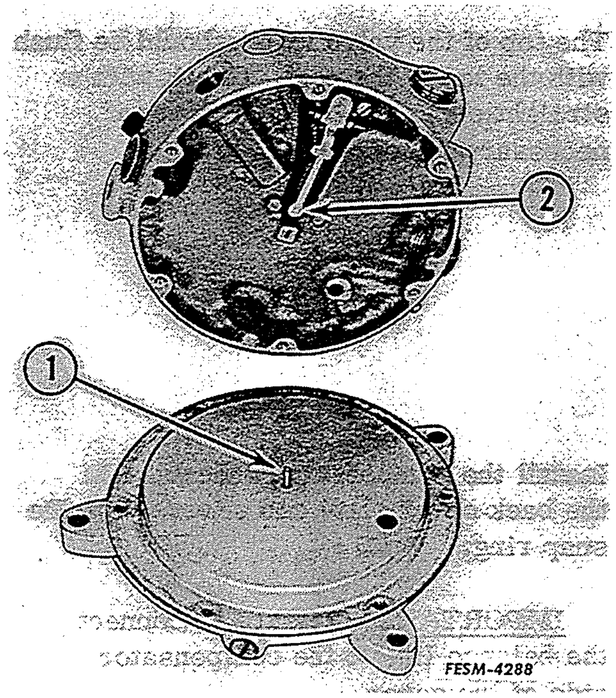
IMPORTANT: Be sure to connect the balance line to the compensator side of the cover.

1. Compensator assembly
2. Back cover plate
3. Snap ring



Using new gaskets, align the marks on the cover and body made during disassembly (see page 3-21), and install the partition plate, low pressure diaphragm and back cover plate on the body.

1. Regulator body
2. Partition plate
3. Low pressure diaphragm
4. Back cover plate

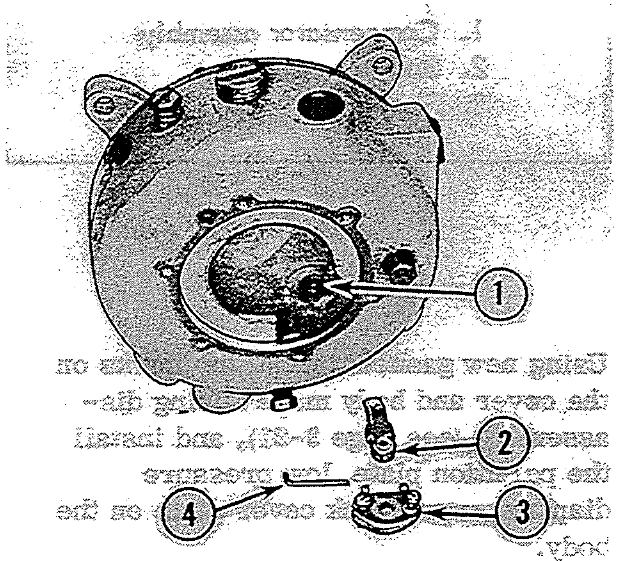


FESM-4288

Be sure the push pin engages the slot in the valve lever.

1. Push pin 2. Push pin to engage slot

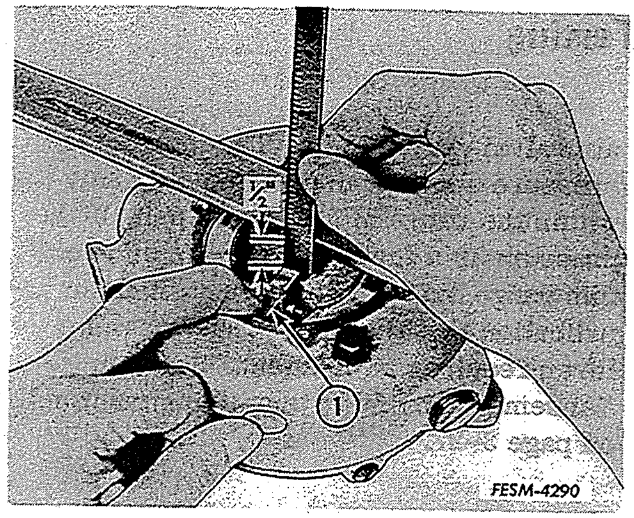
Tighten the retaining screws evenly around the support plate to effect a good seal. The low-pressure valve parts and spring are preset to secure the specified opening pressure, the only adjustment involves alignment of lever and setting of lever height to insure full valve movement.



FESM-4289

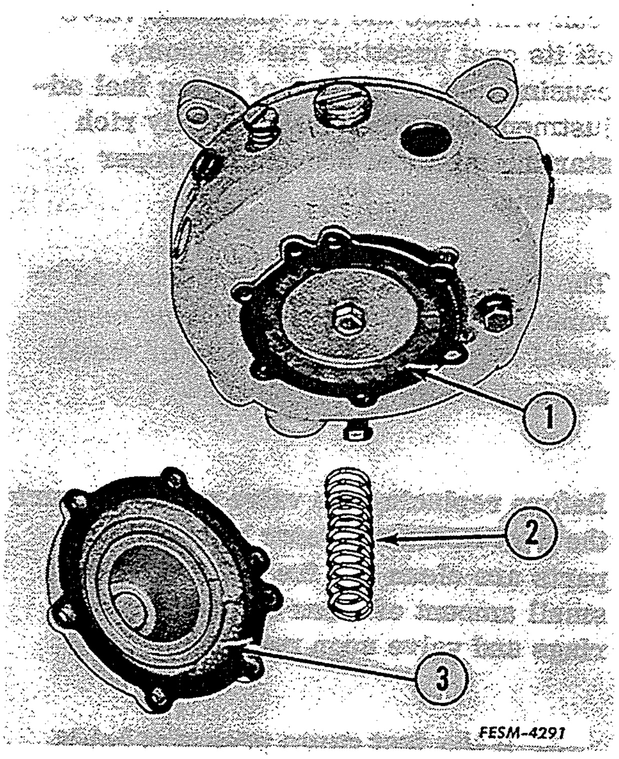
When installing the high pressure valve assembly, be sure the machined seat in casting is perfectly clean and free of nicks. Dirt or grit will affect proper seal of valve and O-ring. Apply a small amount of oil to the O-ring and valve seat to aid in initial sealing.

1. O-ring 2. Lever 3. High pressure valve 4. Pin



The high pressure lever height with valve closed, should be 1/2 inch. This is measured from the high pressure side of the body casting to the inside of the groove in the valve lever with the valve held firmly shut.

1. Valve held closed



Use new gaskets and install the high pressure diaphragm, spring and regulator cover.

1. High pressure diaphragm 2. Pressure spring 3. Regulator cover

Regulator Testing

A check of the regulator high and low-pressure reducing valve may be made with the regulator on the engine, or it may be removed and tested at the work bench. If tests are to be made on the engine, using fuel vapor as a pressure source, the machine must be moved out into the open air where fuel vapor may be safely vented. Where the tests are to be made at the work bench, the regulator must be supported in the same position as it is on the engine. Clean compressed air at 75 to 120 psi is substituted for fuel vapor and supplied to the regulator through inlet (A). Be sure to prevent entry of dirt during preparations, small particles caught on the valve seats will cause leakage.

A bench test fixture, Ensign TSE-1788-5 available, which includes a water manometer, a pressure gauge and necessary fittings and connections for attaching regulator to a source of compressed air. Full instructions for use are included. Order from Backarach Instrument Co., Division of American Bosch Arma Corp., 200 N. Braddock Ave., Pittsburgh, Pa., 15208.

The following procedure is outlined for testing the unit on the engine, the same sequence is used for bench test.

1. With both the vapor and liquid service valves closed, operate the engine until all of the fuel remaining in the lines is exhausted. Engine will stop when fuel filter and lines are empty. Remove 1/8" pipe plug and install 0 to 30 psi test gauge at location (R).

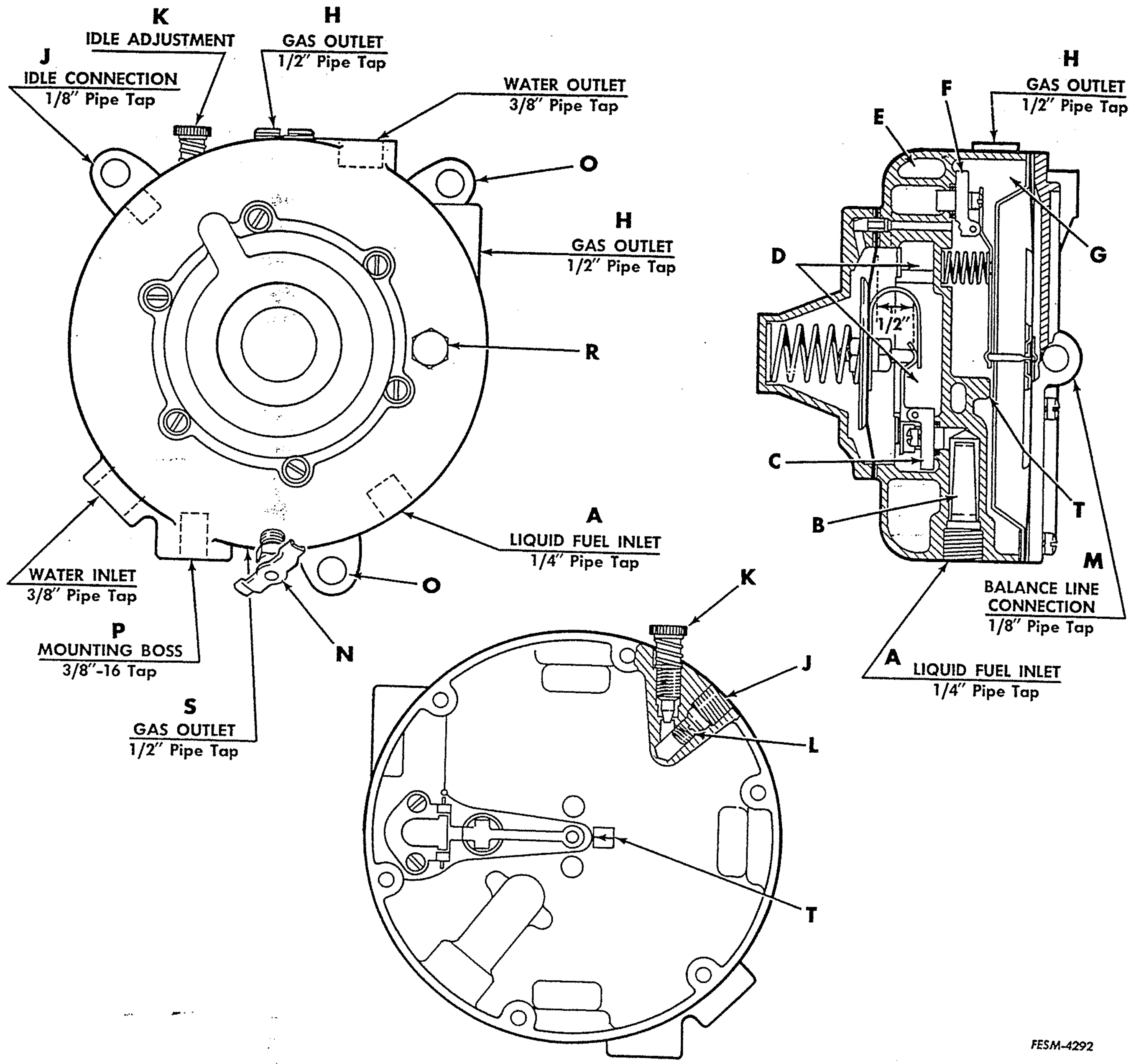
2. Open the vapor service valve (or air valve) <u>very slowly</u>. The test gauge pressure should raise and hold steady within the range of 3-1/2 to 5 psi. If the pressure is a few pounds under or over this range but <u>remains steady</u>, it is an indication that the high-pressure valve lever requires adjustment. Refer to "Assembly and Adjustment" instructions on page 3-27.

If test gauge pressure continues to increase beyond five psi, the high-pressure valve is leaking. A substantial leak will force the low-pressure valve off its seat upsetting fuel economy, causing loss of control of idling fuel adjustment and produces an overly rich starting mixture, preventing proper starting.

The high pressure valve and seat can be removed for inspection, cleaning or renewal by removing the regulator cover and high pressure diaphragm.

Before replacing the valve parts, be sure the port in the regulator body and the parts are clean and free of dirt. Use small amount of clean light oil on seal rings and valve upon reassembly.

3. If the test gauge pressure holds steady within the range of 3-1/2 to 5 psi and there is no control of idle adjustment or if improper starting is experienced, the low-pressure valve (F) may be leaking. A severe leak at the low-pressure valve can actually be heard. With engine stopped, if regulating unit is cold, showing moisture or frost after standing, the low-pressure valve is leaking.



4. There is also a possibility of the regulator unit passing fuel, even though both high and low-pressure valves are holding. This would be leakage past the diaphragm of the high-pressure valve. Notice that the spring loaded side of this diaphragm is vented to the low-pressure chamber (G).

The only positive method of checking this diaphragm is to remove the back cover plate, low-pressure diaphragm and partition plate. Adjacent to the valve (F) will be found the drilled passage venting the high-pressure diaphragm. Connect a pressure source to the fuel inlet (A) and apply liquid soap to opening of passage mentioned. If bubbles form, the high-pressure diaphragm is leaking and regulator unit must be further dismantled for repair.

5. The test gauge pressure may be satisfactory but the low-pressure valve will not pass fuel due to gummy or greasy residue deposited from fuel on valve parts. A ruptured diaphragm will prevent the operation of the low-pressure valve. Pinpoint openings in this diaphragm will not materially affect the normal operation but with increased size holes, the response of the valve will be reduced in proportion. The alignment of the valve may also prevent normal operation of the low-pressure valve.

Use of a water manometer (U-tube) for checking the response of the low-pressure regulator valve is outlined below:

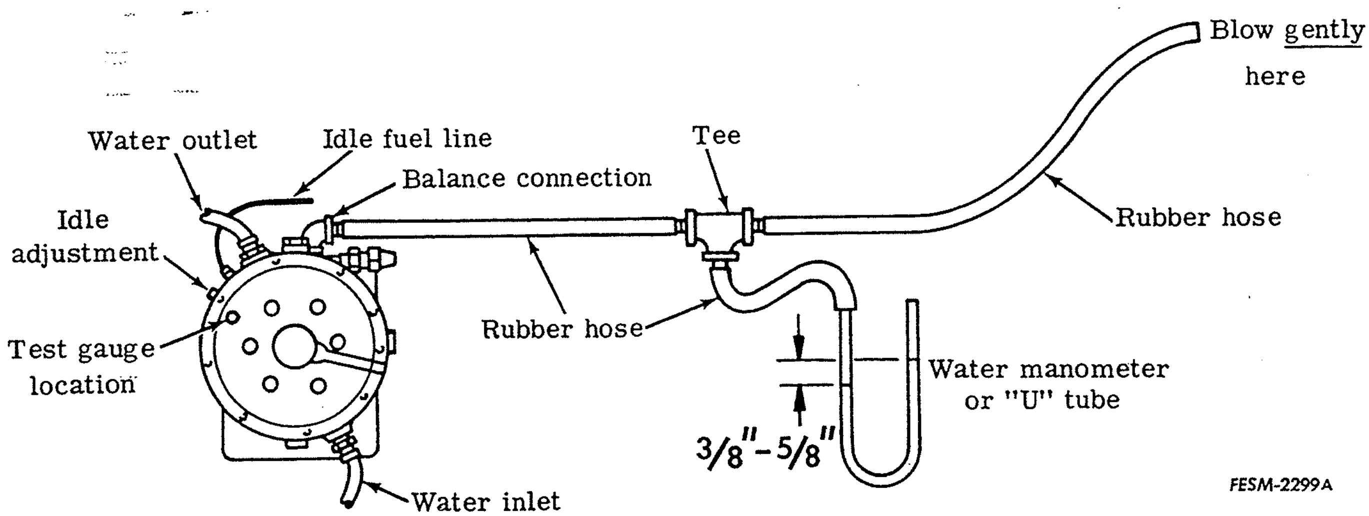
a. Disconnect balance line at (M) on regulator cover plate.

b. Connect a water manometer with suitable hose connections and a tee to the regulator balance connection. See Illust. below.

c. Open the vapor service valve (or air valve) slowly. Then blow very gently into open end of the manometer hose, carefully observing reading of manometer at which low-pressure valve opens and fuel (or air) begins to flow. This can be heard readily when the main fuel hose is removed from the regulator gas outlet (H). The manometer reading should show 3/8 to 5/8 inch. If it is substantially more than 5/8 inch, the valve is gummy or sticky or lacks response as outlined in test (5) above.

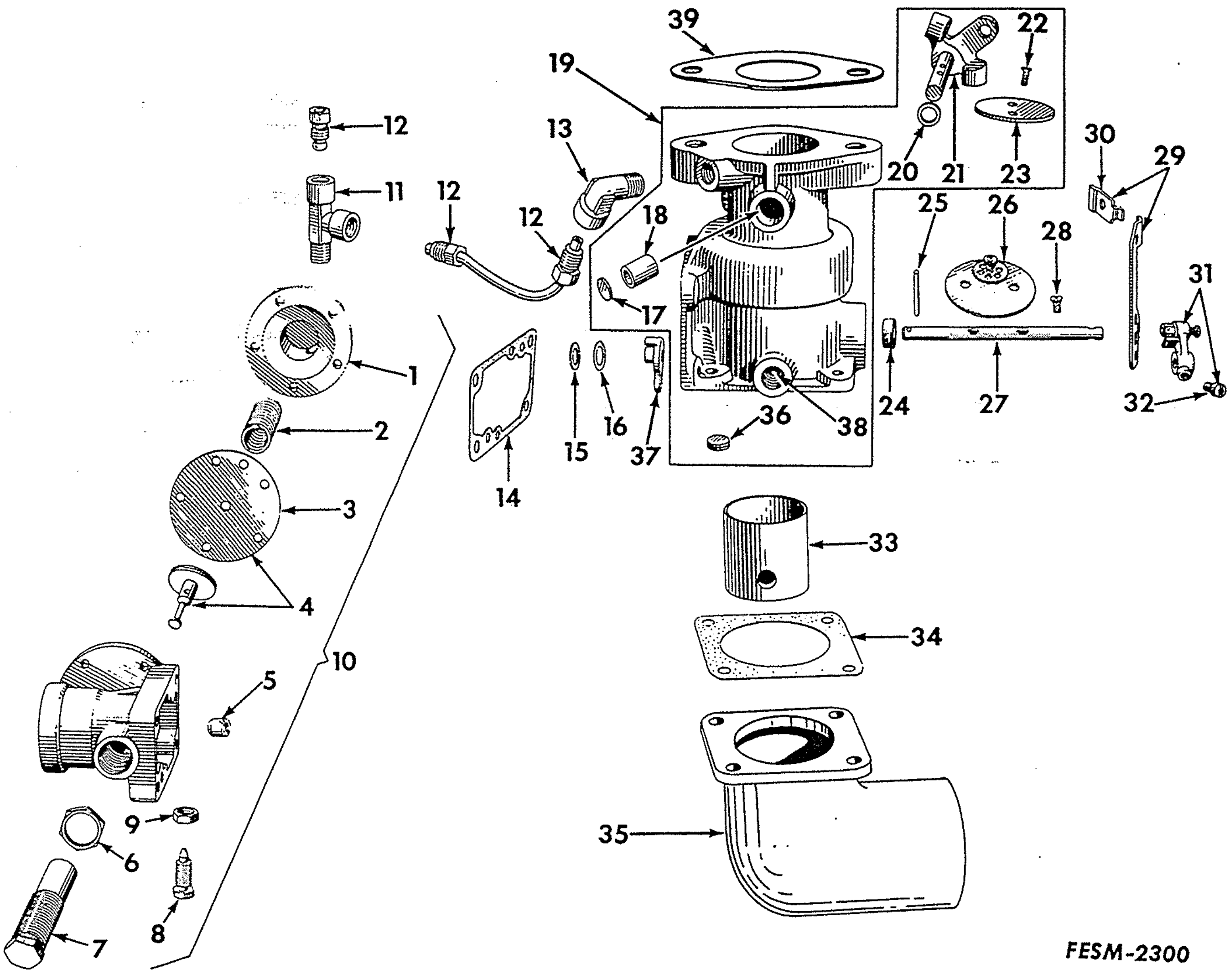
If the manometer reading is substantially less than 3/8 inch, the valve action is too sensitive. This may be caused by a valve (F) spring which has become weak, or wear on valve parts has increased height of valve lever. Replace spring, reset valve lever or renew valve assembly as required.

Idle control may be affected by foreign matter plugging the idle bleed screw (L). To check bleed screw, disconnect idle line at connection (J) and make certain it is not plugged. This orifice should be a #68 drill size. Examine the tip of the idle adjusting screw (K), and if damaged, replace it.



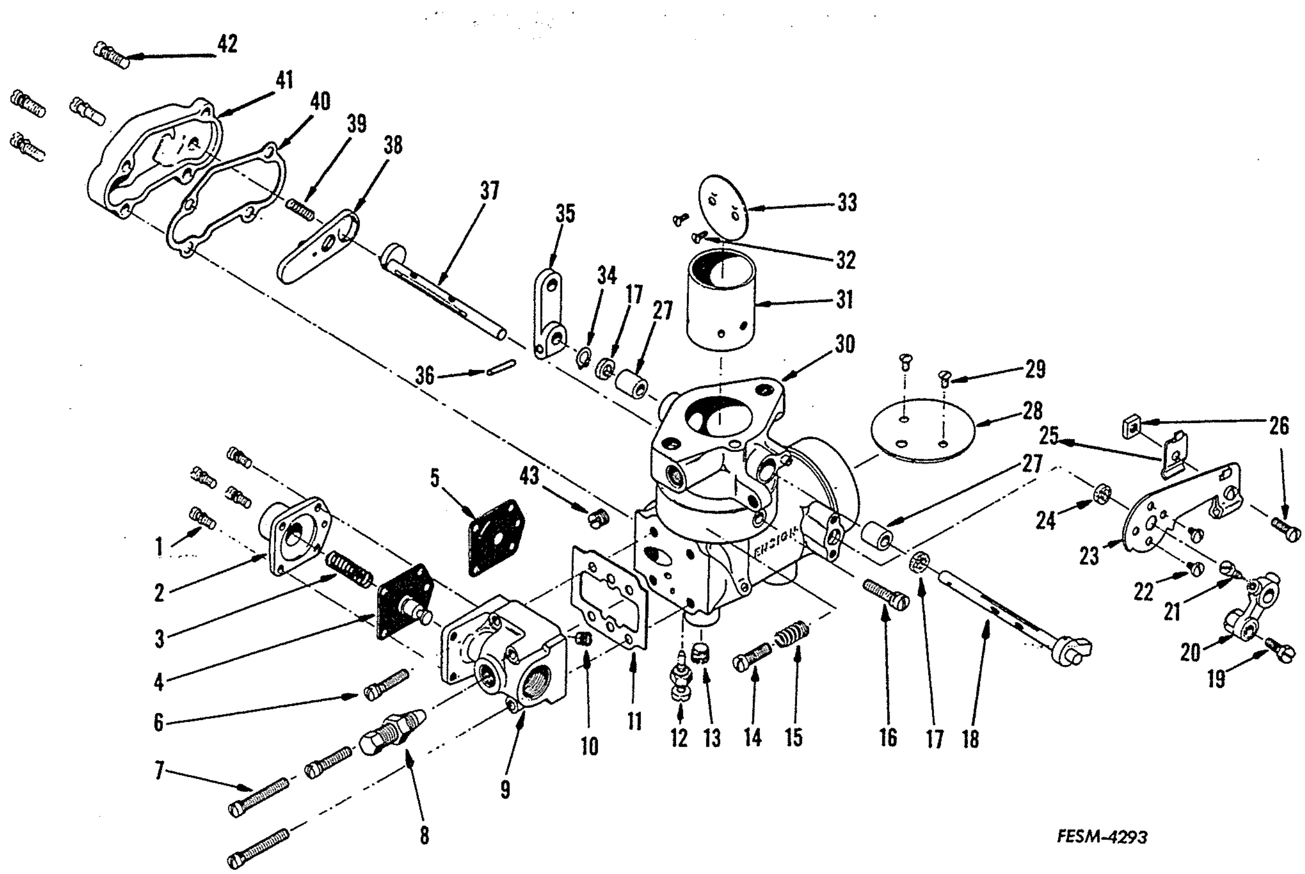
CARBURETOR SERVICE

Removal and Installation



Exploded view LP gas carburetor (C-153).

1. Economizer cover
2. Economizer spring
3. Diaphragm
4. Economizer valve with diaphragm
5. Economizer bleed orifice
7. Main fuel adjusting screw
8. Starting fuel adjusting screw
10. Inlet and economizer assembly
11. Economizer and idle line tee
13. Economizer and idle line elbow
14. Inlet assembly gasket
15. Shut-off valve washer
16. Spring washer
17. Expansion plug
18. Bushing
19. Body assembly
20. Throttle shaft seal
21. Throttle shaft
23. Throttle disc
24. Choke shaft seal
26. Choke disc assembly
27. Choke shaft
29. Choke tube bracket
31. Choke lever
33. Venturi
34. Gasket
35. Air intake elbow
36. Expansion plug
37. Starting shut-off valve
38. Balance tube nozzle
39. Gasket



Exploded view LP gas carburetor (C-135).

1. Screw	15. Spring	29. Screw
2. Economizer cover	16. Set screw	30. Partial body assembly
3. Economizer spring	17. Dust seal	31. Venturi
4. Economizer diaphragm assembly	18. Throttle shaft and stop assembly	32. Screw
5. Economizer diaphragm	19. Swivel screw	33. Throttle disc
6. Screw	20. Choke lever	34. Snap ring
7. Screw	21. Set screw	35. Throttle lever
8. Fuel adjusting screw	22. Screw	36. Groove pin
9. Economizer and gas inlet housing	23. Choke tube support	37. Choke shaft and cam
10. Orifice screw	24. Dust seal	38. Valve lever
11. Gasket	25. Clamp	39. Thrust spring
12. Starter adjusting screw	26. Screw	40. Gasket
13. Pipe plug	27. Throttle shaft bushing	41. Valve cover
14. Screw	28. Choke disc	42. Screw
		43. Plug

Before removing the carburetor from the engine for cleaning, inspection or repair; clean the area and various connections to prevent entry of dirt into those parts which remain with the engine.

After the carburetor is removed, inspect the air cleaner pipe, idle line, balance line, main fuel hose and their connections for possible air leaks. Since these lines operate below atmospheric pressure, leakage or poor connections will be a source of entry of dirt and abrasives into the engine.

Discard the carburetor flange gasket, clean manifold flange of any scraps of the old gasket which may adhere and would prevent sealing of new gasket. Renew tubing, fittings and hose where the old is found to be in questionable condition. Be sure the main fuel hose replacement is the correct part number so that hose material furnished will not be dissolved by contact with fuel. Be sure replaced lines and connections are air and dirt tight; no leakage is permissible.

After the carburetor is reinstalled on the manifold, recheck the adjustment of the governor to carburetor control rod to insure a wide open throttle at full load demand of the governor. Proceed as follows: With the engine stopped, advance the operator's speed control hand lever to create tension on governor spring. Adjust length of governor to carburetor control rod so that rod slides freely into the throttle lever, when throttle is wide open. Lengthen this control rod by one turn of its clevis, insert cotter pin and tighten lock nut on clevis.

Return the speed control hand lever to a position slightly advanced from low idle position. In this condition, check the governor to carburetor control rod for any tendency toward binding or interference through its full range of movement. Refer to Section 1 on "Governor" for full coverage on adjustments.

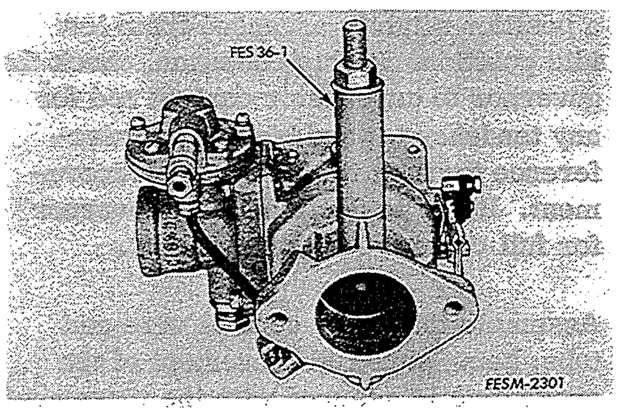
Assemble the choke control wire and tube, being sure full movement of the choke disc is assured with the movement of the operator's choke control knob.

Inspection and Repair

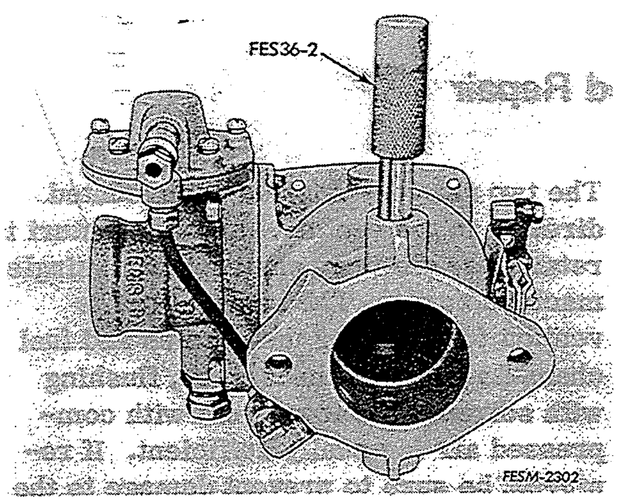
Before disassembly of the carburetor, clean the outside surface of dirt and accumulations, so that the solvent used to clean the dismantled parts will not become contaminated with excessive dirt. The solvent used to clean internal parts of the carburetor must be of petroleum base types such as kerosene, oleum spirits, etc. Do Not Use carbon tetrachloride since it will destroy the diaphragm material.

The two delivery nozzles are mounted directly in the venturi. And the venturi is retained in the body casting with a single machine screw. The removal of the venturi for cleaning the nozzles and fuel channels is rarely necessary, flushing with solvent and blowing out with compressed air is usually sufficient. If removed, be sure to prevent damage to the outside diameter of the venturi or to the bore of the body casting.

Examine the economizer diaphragm for damage or deterioration. A ruptured diaphragm will result in little or no economizer action and will also upset control of fuel for idling. The economizer valve must be free in its bore so that it may be moved freely by action of its diaphragm and spring. After considerable service, the valve and its bore in the inlet assembly may become worn, reducing the effectiveness of economizer action and increasing part throttle fuel consumption. When this occurs, renew the complete economizer assembly, transferring the bleed orifice to the new assembly.



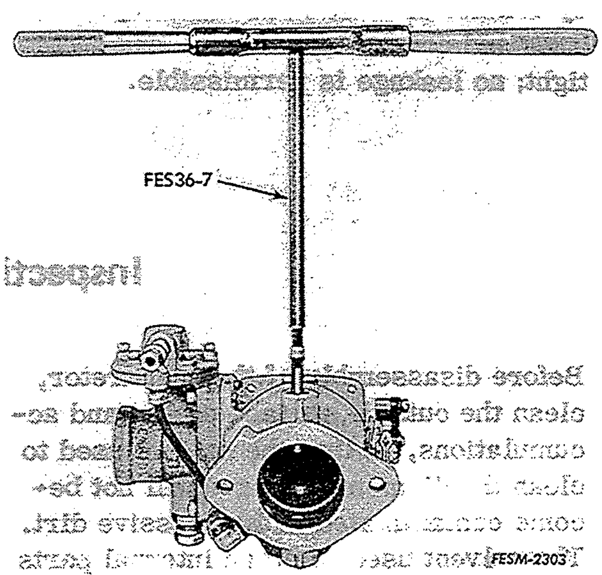
Removing throttle shaft body bushings (CBX carburetor shown).



Installing throttle shaft body bushings (CBX carburetor shown).

There are no adjustments for the economizer, its calibration is assured by use of the specified spring and the specified economizer bleed orifice. Where economizer parts are questionable, replace with new, being sure that the correct replacements are selected from parts list covering the machine model and part number of carburetor involved. Surfaces of the economizer cover and body must be undamaged to effect a seal at the diaphragm. The five retaining screws for the cover must be tightened evenly to prevent cocking of the cover.

The maximum clearance between the throttle shaft and the body bushings should not exceed .007 inch. If a new shaft will not bring the clearance down to an acceptable figure, the bushings can be replaced. Use tool FES 36-1 to remove the worn bushings and FES 36-2 to install the new bushings. Ream the bushings after installation using FES 36-7.

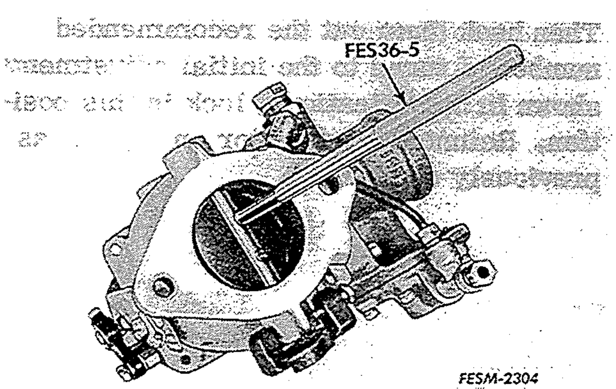


Reaming bushings after installation (CBX carburetor shown).

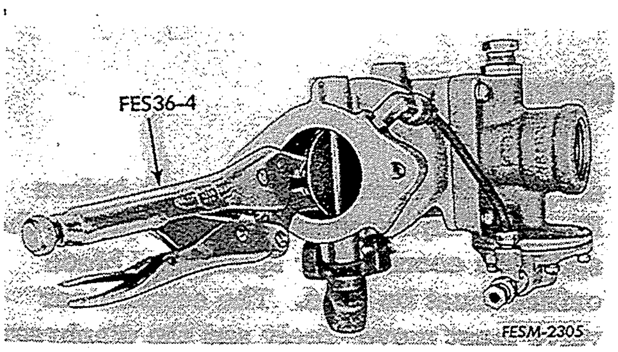
The maximum clearance between the choke shaft and the bores in the body should not exceed 0.007 inch. Where the use of a new shaft will not bring the clearance down to an acceptable figure, a new body is recommended.

The spring loaded air valve in the choke disc must be free to open against its spring tension. Where the air valve is worn and damaged, replace, using a new complete choke disc of the correct part number for the carburetor involved.

The starting shut-off valve is lightly spring loaded to hold it against the machined face of the body inlet. With the closing of the choke disc, the starting shut-off valve covers the main fuel inlet. On rare occasions, the starting shut-off valve may become raised from its machined surface by scale or coating of



Installing throttle disc screws (CBX carburetor shown).



Locking throttle disc screws (CBX carburetor shown).

foreign matter, causing excessive flow of fuel during starting procedure. Where found, this condition must be corrected to restore good starting characteristics.

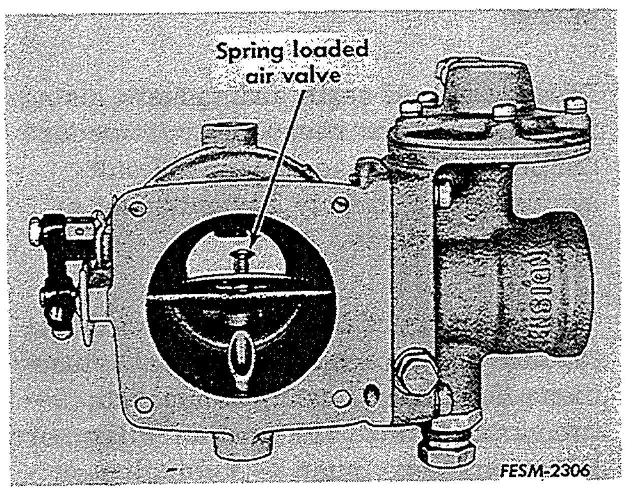
Flush out the starting gas passages in the inlet assembly and blow out thoroughly with compressed air. When heavy accumulations of oil or grease are found in the carburetor, the regulator-vaporizer will also be loaded with this material and will require cleaning.

Examine the starting fuel adjusting screw point for damage from being forceably seated, renew if necessary. Examine, also, the inner end of the main fuel adjusting screw; if this has been bent or damaged by rough handling, it should be replaced.

Discard all old seals and gaskets, using new material for reassembly, to secure the best possible sealing of the unit against entry of dirty air and upset of air-fuel mixtures.

The assembly of the throttle disc in the throttle body bore is not critical, since there is no relationship to maintain between the throttle disc and an idling port. However, there must be no binding or interference with the throttle movement from fully closed to fully opened position. Install but do not tighten the two throttle disc screws using FES 36-5 until the disc has been centered in the throttle bore at fully closed position. Clinch over the exposed ends of the throttle disc screws to lock them in place using FES 36-4. This must be done carefully to prevent distortion of the throttle disc or shaft. Set the throttle stop screw to 3 or 4 turns open from fully closed position as a tentative idle speed. Final idle speed adjustment will be made after the carburetor is installed and the engine started.

The choke disc is assembled on its shaft with the spring loaded air valve up, in order that manifold vacuum will cause air valve to open. Center the choke disc in its bore before tightening its retainer screws. Be sure that the choke disc opens fully and closes fully without interference. Check the shaft lever travel, being sure that its movement is sufficient to completely open and close both the choke and fuel shut-off valves. Inspect the starting shut-off valve to be sure that it is held in contact with the machined face of the body by its spring loading washer. Only a light spring loading is required, but the contact must be held to prevent drawing fuel through the main fuel inlet port in the starting position.



Proper installation of choke disc spring loaded air valve (CBX carburetor shown).

After assembly of the economizer diaphragm and cover, diaphragm leakage may be checked by placing the mouth over the opening in the economizer cover. If you can continue to draw air through this opening, leakage is occurring and the unit must be reopened. Leakage may be at the juncture of diaphragm and cover or at juncture of diaphragm and valve or through a puncture of the diaphragm material.

Mount the inlet and economizer assembly and the air intake elbow and their gaskets on the carburetor body, tightening the retaining screws evenly. Recheck the choke lever movement to be sure there is still no interference.

Upon returning the main adjusting screw and the starting fuel adjusting screw to their positions in the carburetor, turn them down lightly against their seats. Then back them out the recommended number of turns to the initial adjustments shown in Specifications, lock in this position. Reinstall carburetor on engine, as previously outlined.

Fuel Adjustments

Due to the action of the economizer, final adjustment of the air-fuel mixture can be accurately made without the necessity of placing the engine under load.

The condition of the fuel economizer must however be determined and, where necessary, corrections must be made before final fuel adjustments are attempted. The specified economizer spring and bleed orifice must be used. The economizer valve must move freely and the diaphragm and tubing must be air tight. See instructions on economizer on page 3-34.

Proceed with the fuel adjustments in the following sequence, after condition of economizer has been approved.

1. Set the starting fuel screw, main fuel screw and idle fuel screw to the initial adjustments for the machine model involved, as listed in Specifications.

2. The setting of the starting fuel screw should be as specified in specifications. Should a greater or lessor setting be found necessary it may be due to fuel leakage from regulator to carburetor, poor adjustment of idle fuel screw (in regulator) or air leaks into carburetor or manifold which make unusual starting adjustments necessary. Should these defects be an extreme condition, it may be impossible to secure a satisfactory starting adjustment.

3. Start and operate the engine until it is warm and is operating on liquid from the fuel tank. Adjust the throttle stop screw to result in a slow idle speed of 425 RPM. Adjust the idle fuel screw on the regulator-vaporizer to secure smoothest engine operation. Each small change in the throttle stop screw and in resulting engine speed change may require a slight readjustment of the idle fuel screw for smoothest operation.

4. The recommended initial main adjustment for each machine model, as shown in "Specifications", will be found to be very accurate with very slight changes for fuel variations. Should changes in excess of 1/2 turn from these recommended settings be found necessary, it may be due to fuel leakage from regulator to carburetor, poor adjustment of idle fuel screw or air leaks into the carburetor or manifold.

A manifold vacuum gauge can be a useful tool in adjustment of idle and main fuel screws. The gauge used should have a damper or throttling screw to reduce oscillations of the indicating pointer so that slight changes in mean manifold vacuum can be observed. The ideal adjustment has been reached when the manifold vacuum reading is the highest. The vacuum gauge must be closely observed since very small changes in gauge readings occur with changes in carburetor adjustment.

The use of exhaust gas analyzers is not recommended as a method of air-fuel adjustment, due to serious errors which often occur in LP Gas system calibration as a result of their use. The short exhaust system of these engines contribute to analyzer error, slight amounts of soot, moisture or oil fog will rapidly foul the analyzer units greatly affecting their accuracy. There is no convenient method in the field for quickly checking the accuracy of an analyzer reading.

All analyzers have an inherent scale reversing characteristic, in that, as the air-fuel mixture is leaned out beyond a certain point, the analyzer will begin to show a progressively richer mixture. Some confusion exists in connection with the dial readings of exhaust analyzers, the greater number of which are calibrated only for gasoline. While these meters will react to the combustion products of LP Gas, the actual dial calibration for LP Gas differs considerably from that calibrated for gasoline. The higher proportion of hydrogen to carbon in LP Gas accounts for this difference. Some analyzers have a dual scale covering both fuels, others furnish a conversion chart. Due to these many opportunities for error, the manifold vacuum gauge method of air-fuel adjustment outlined is advised.

FOREWORD

The instructions and special tools shown in this Blue Ribbon Service Manual are for use by International Harvester Dealers and their factory trained servicemen.

The specifications as listed in this manual are current as of the printing date. Due to changes and improvements in our products, dealers are periodically issued service bulletins to keep this manual up-to-date. We suggest you refer to the most recent information when performing service work on this equipment.

International Harvester Factory Trained servicemen are best qualified to service IH equipment.

CONTENTS

SPECIFICATIONS

	BC-144	BD-144A	BD-154
General			
Number of cylinders	4	4	4
Bore and stroke-inches	3-3/8 x 4	3-3/8 x 4	3-1/2 x 4
Displacement-cubic inches	144	144	154
Engine RPM (Governed)			
Low Idle	500 ± 25	520 - 580	520 - 580
High Idle	2200 ± 25	2075 ± 25	2200 ± 25
Rated Load	2000	1875	2000
Horsepower (Rated) @ PTO Shaft (Rated Engine Speed)			
B-275 Tractors	--------	32.3	--------
B-414 and 3414 Tractors	36.5	--------	36.0
I-424 and 2424 Tractors	--------	--------	36.5
Compression ratio	6.3:1	21.1:1	23.0
Compression pressure at cranking speed psi	80 - 105	330 - 355	445 - 470
Crankcase refill capacity - quarts	5	5	5
Firing order	1-3-4-2	1-3-4-2	1-3-4-2
Crankcase			
Tappet bore, I.D. - inch	.5615 - .5630	.5615 - .5630	.5615 - .5630
Cylinder head bolt heli-coil inserts (below surface) - inch . .	3/32 - 1/8	3/32 - 1/8	3/32 - 1/8
Crankshaft and Main Bearings			
Number of main journals	5	5	5
Main journal diameter - inches .	2.124 - 2.125	2.124 - 2.125	2.124 - 2.125
Crankpin diameter - inches	1.7495 - 1.750	1.7495 - 1.750	1.7495 - 1.750
Main bearings, running clearance - inch	.002 - .004	.002 - .004	.002 - .004
Thrust bearing location	Rear main	Rear main	Rear main
Thrust bearing end clearance - inch	.004 - .008	.004 - .008	.004 - .008

	BC-144	BD-144 A	BD-154
Camshaft			
Camshaft bearings (reamed to size) diameter - inches	For Camshaft Bearing Installation Refer to Page 15.		
Front bearing	1.8135 - 1.8145	1.8135 - 1.8145	1.8135 - 1.8145
Center bearing	1.5795 - 1.5805	1.5795 - 1.5805	1.5795 - 1.5805
Rear bearing	1.5015 - 1.5025	1.5015 - 1.5025	1.5015 - 1.5025
Cam lobe lift (total) - inch			
Intake	.2195	.2195	.2195
Exhaust	.1975	.1975	.1975
Front bearing journal diameter - inches	1.811 - 1.812	1.811 - 1.812	1.811 - 1.812
Center bearing journal diameter - inches	1.577 - 1.578	1.577 - 1.578	1.577 - 1.578
Rear bearing journal diameter - inches	1.499 - 1.500	1.499 - 1.500	1.499 - 1.500
Thrust taken by	Thrust plate	Thrust plate	Thrust plate
Number of bearings	3	3	3
Bearing running clearance - inch	.0015 - .0035	.0015 - .0035	.0015 - .0035
Camshaft end play	.008 - .017	.008 - .017	.008 - .017
Connecting Rods			
Side clearance - inch	.003 - .010	.003 - .010	.003 - .010
Bearing running clearance - inch	.001 - .0029	.001 - .0029	.001 - .0029
Bearing O.D. and spread - inches	1.876 + .025	1.876 + .025	1.876 + .025
Pistons			
Skirt clearance - measured 90° from pin hole at bottom - inch			
Graded	.0031 - .0039	.0031 - .0039	.0031 - .0039
Individual replacements	.0031 - .0047	.0031 - .0047	.0031 - .0047
Number of rings per piston	4	5	5

	BC-144	BD-144 A	BD-154
Pistons—Continued			
Width of ring groove:			
Top compression - inch	.0953 - .0963	.0963 - .0969	.0972 - .0982
Second compression - inch . .	.0953 - .0963	.0967 - .0973	.0965 - .0975
Third compression - inch . . .	.0953 - .0963	.0959 - .0965	.0965 - .0975
Oil control - inch	.189 - .190	.1877 - .1883	.1887 - .1893
Ring clearance in groove:			
Top compression - inch	.0018 - .0033	.0028 - .0039	.0035 - .0055
Second compression - inch . .	.0018 - .0033	.0032 - .0043	.0028 - .0048
Third compression - inch . . .	.0018 - .0033	.0024 - .0035	.0028 - .0048
Oil control			
Top - inch	.0025 - .0040	--------	--------
Lower - inch	--------	.0012 - .0023	.0012 - .0028
Piston Pins			
Diameter-inch (standard)	1.1021 - 1.1023	1.1021 - 1.1023	1.1021 - 1.1024
Length-inches	2.898 - 2.902	2.898 - 2.902	3.1097 - 3.0236
Clearance between end of pin and retainer ring - inch	.012 - .019	.012 - .019	.012 - .020
Maximum allowable clearance in rod bushing - inch	.0005 - .0010	.0005 - .0010	.0005 - .0010
Maximum allowable clearance in piston - inch	.0003 Loose .0004 Tight	.0003 Loose .0004 Tight	.0003 Loose .0004 Tight
Piston Rings			
Compression:			
Number of rings per piston . .	3	3	3
Type:			
Top	Chrome	Chrome (Internally stepped)	Chrome (Internally stepped)
Second	Taper face	Plain	Internally stepped
Third	Taper face	Plain	Internally stepped

	BC-144	BD-144A	BD-154
Piston Rings—Continued			
Width of ring:			
Top - inch	.0930 - .0935	.0930 - .0935	.0927 - .0937
Second - inch	.0930 - .0935	.0930 - .0935	.0927 - .0937
Third - inch	.0930 - .0935	.0930 - .0935	.0927 - .0937
Oil Control Rings			
Type			
Top	Slotted	Multi-piece	Multi-piece
Lower	--------	Slotted	Drilled and Grooved
Number per piston	1	2	2
Ring Gap:			
Top compression - inch	.012 - .018	.012 - .018	.010 - .015
Second compression - inch	.012 - .018	.012 - .018	.010 - .015
Third compression - inch	.012 - .018	.012 - .018	.010 - .015
Oil control			
Top - inch	.012 - .018	.015 - .045	--------
Lower - inch	--------	.012 - .018	.010 - .015
Cylinder Sleeves			
Type	Replaceable wet	Replaceable wet	Replaceable wet
Diameter, outside (at packing ring location) - inches	3.6865 - 3.688	3.6865 - 3.688	3.6865 - 3.688
Wall thickness - inch	.2134 - .2235	.2134 - .2235	.15065 - .16125
Flange thickness - inch	.227 - .229	.227 - .229	.227 - .229
Top surface of cylinder sleeve extends above top surface of crankcase - inch	.001 - .005	.001 - .005	.001 - .005
Valves			
Head Diameter:			
Intake - inches	1.407 - 1.417	1.465 - 1.475	1.465 - 1.475
Exhaust - inches	1.245 - 1.255	1.171 - 1.181	1.171 - 1.181
Face angle - degrees	45 +0 -30'	45 +0 -30'	45 +0 -30'

	BC-144	BD-144A	BD-154
Valves—Continued			
Stem Diameter:			
Intake - inch	.341 - .342	.341 - .342	.341 - .342
Exhaust - inch	.341 - .342	.341 - .342	.341 - .342
Clearance in guide:			
Intake - inch	.002 - .004	.002 - .004	.002 - .004
Exhaust - inch	.002 - .004	.002 - .004	.002 - .004
Valve Seats			
Seat angle - degrees	45	45	45
Valve Guides			
Length - inches			
Intake	2.469 *	3-1/4	3-1/4
Exhaust	2.625 *	3	3
Inside Diameter - inch	.344 - .345	.344 - .345	.344 - .345
Installed height above cylinder head surface - inch	--------	.940 ± .030	.940 ± .030
Installed height measured up from spring recess - inch	.828 *	--------	--------
Valve Springs			
Free length - inches			
Intake and exhaust	2.085	2.531 ± .047	Inner 2.125 Outer 2.550
Test length - inches			
Intake and exhaust	1.700	1.922	Inner 1.653 Outer 1.870
Test load - pounds			
Intake and exhaust	36.4 ± 5%	30.2 ± 5%	Inner 13.0 ± 5% Outer 31.0 ± 5%

* For Specifications of valve guides and springs used on engines when equipped with dual valve springs (early models) refer to following page.

	BC-144	BD-144 A	BD-154
Valve Guides **			
Length - inch	2.625	--------	--------
Inside diameter - inch	.344 - .345	--------	--------
Set height of guide measured up from spring recess-inches	1.047	--------	--------
Intake and Exhaust Valve Springs **			
Outside diameter - inch			
Intake and exhaust			
Inner	.879	--------	--------
Outer	1.316	--------	--------
Free length - inch			
Intake and exhaust			
Inner	2.125	--------	--------
Outer	2.550	--------	--------
Test length - inch			
Intake and exhaust			
Inner	1.653	--------	--------
Outer	1.870	--------	--------
Test load - pound ± 5%			
Intake	13.0	--------	--------
Exhaust	31.0	--------	--------
Valve Tappets			
Diameter - inches	.560 - .561	.560 - .561	.560 - .561
Bore in crankcase - inch	.5615 - .5630	.5615 - .5630	.5615 - .5630
Tappet clearance in bore - inch	.0005 - .003	.0005 - .003	.0005 - .003
Push rod diameter - inch	5/16	5/16	5/16
Push rod (bottom of cup to ball tip) length - inches	10.690 - 10.720	10.510 - 10.540	10.510 - 10.540

** Specifications of valve guides and springs used when equipped with dual valve springs (early models).

	BC-144	BD-144 A	BD-154
Valve Lever and Shaft			
Valve lever shaft diameter - inch	.748 - .749	.748 - .749	.748 - .749
Valve lever bushing inside diameter - inch	.751 - .752	.751 - .752	.751 - .752
Valve lever clearance on shaft - inch	.002 - .004	.002 - .004	.002 - .004
Tappet clearance (engine hot, not running) - inch	.020	.020	.020
Clearance (engine cold) - inch	.020	.020	.020
Valve Timing			
Intake opens - degrees	20 BTDC	20 BTDC	20 BTDC
Intake closes - degrees	40 ATDC	40 ATDC	40 ATDC
Exhaust opens - degrees	40 BBDC	40 BBDC	40 BBDC
Exhaust closes - degrees	10 ATDC	10 ATDC	10 ATDC
Cylinder Head			
Bolt diameter - inch	7/16 x 14 UNC 2A	7/16 x 14 UNC 2A	7/16 x 14 UNC 2A
Timing Gears			
Backlash between any pair of gears - inch	.0025 - .0045	.0025 - .0045	.0025 - .0045
Idler gear end clearance - inch	.007 - .012	.007 - .012	.007 - .012
Idler gear to shaft clearance - inch	.0015 - .0028	.0015 - .0028	.0015 - .0028
Idler gear I.D. - inches	3.0005 - 3.0013	3.0005 - 3.0013	3.0005 - 3.0013
Lubrication System			
Oil pressure at rated rpm - psi	30 - 35	30 - 35	30 - 35
Oil pump			
End clearance between gear and end plate - inch	.0035 - .006	.0035 - .006	.0035 - .006

	BC-144	BD-144 A	BD-154
Lubrication System—Continued			
Clearance, gear to housing - inch	.0053 - .0083	.0053 - .0083	.0053 - .0083
Backlash between idler and body gears - inch	.003 - .006	.003 - .006	.003 - .006
Backlash between drive pinion and camshaft - inch	.008 - .012	.008 - .012	.008 - .012
Drive shaft diameter - inch	.4930 - .4940	.4930 - .4940	.4930 - .4940
Drive shaft running clearance - inch	.002 - .0035	.002 - .0035	.002 - .0035
Idler gear shaft diameter - inch	.4945 - .4955	.4945 - .4955	.4945 - .4955
Idler gear running clearance, - inch	.0015 - .0035	.0015 - .0035	.0015 - .0035
Clearance between body and drive pinion - inch	.002 - .004	.002 - .004	.002 - .004
Oil filter (engine)			
Number used	1	1	1
Oil pressure valve location	Oil pump body	Oil pump body	Oil pump body
Oil pressure valve regulating spring			
Free length - inches	2.556	2.556	2.556
Test length - inches	1.73	1.73	1.73
Test load - pounds	15.510 ± 3%	15.510 ± 3%	15.510 ± 3%
Pressure regulating valve			
Valve diameter - inch	.738 - .740	.738 - .740	.738 - .740
Valve clearance in bore - inch	.008 - .012	.008 - .012	.0018 - .012
Water Pump			
Type of seal	Diaphram	Diaphram	Diaphram
Rotation, drive end	Clockwise	Clockwise	Clockwise
Clearance from face of body to face of impeller hub	Flush	Flush	Flush
Electrical	Refer to Electrical Specifications Manual GSS-1308-C		

	BC-144	BD-144A	BD-154
Thermostat			
Number used	1	1	1
Open at, degrees F	170 - 179	170 - 179	170 - 179
Wide open at, degrees F	199	199	199
Carburetor			
Type	Down draft	--------	--------
Make and size	Zenith 30VNN	--------	--------
External adjustments	Idle and speed	--------	--------
Fuel level (from surface of float chamber) - inch.	7/8	--------	--------
Venturi size m.m.	22	--------	--------
Compensating jet number	75	--------	--------
Slow running jet number	50	--------	--------
Main jet	77	--------	--------
Main air bleed size	2.6	--------	--------
Needle valve size m.m.	1.5	--------	--------
Governor			
Type	Centrifugal	--------	--------
Governor shaft dimensions			
Sleeve contact area - inch . . .	.501 - .502	--------	--------
Carrier contact area - inch . .	.613 - .623	--------	--------
Sleeve I.D. - inch.	.5045 - .5060	--------	--------
Governor shaft bushing I.D. - inch	.5035 - .5045	--------	--------
Governor Spring			
Test length - inch	3.810	--------	--------
Test load - pounds	20.7	--------	--------
Minimum length in use - inches .	2.50 - .06	--------	--------
Maximum length in use - inches .	4.047	--------	--------

	BC-144	BD-144 A	BD-154
Special Nut and Bolt Torque Data (Foot-Pounds Torque)			
Cylinder head bolts	75 - 80	75 - 80	75 - 80
Connecting rod bolts	40 - 45	40 - 45	40 - 45
Main bearing cap bolts	70 - 75 †	70 - 75 †	80 - 85
Rear oil seal retainer bolts	27 - 31	27 - 31	27 - 31
Front pulley nut to crankshaft . .	225 - 250	225 - 250	225 - 250
Idler gear shaft bolt	75 min.	75 min.	75 min.
Nozzle body stud or bolt to cylinder head	--------	20 - 30	20 - 30
Nozzle body nut to stud	--------	30 - 35	30 - 35
Flywheel bolt	65 - 70	65 - 70	65 - 70
Water pump locating screw	10 - 11	10 - 11	10 - 11
Tappet adjusting screw nut	20 - 25	20 - 25	20 - 25
Governor gear nut	110 - 125	--------	--------
Flywheel Housing	When assembled on the engine, the large bore of the housing is to be concentric with the crankshaft within .005 inch (.010" total indicator reading). The rear face of the housing is to be square with the crankshaft within .003 inch (.006" total indicator reading).		
For Injection Pump and Injection Nozzle Service	Refer to GSS-1326-B		
For Venting Procedure of the Diesel Fuel System	Refer to the Operator's Manual		

† With place bolts 80 - 85 ft. lbs. of torque.

SERVICE PROCEDURE

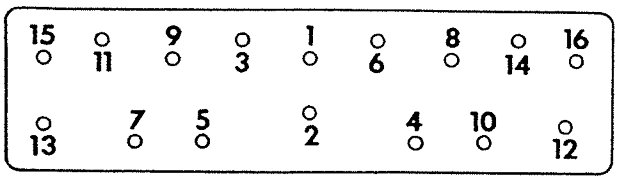
Cylinder Head Installation

1. Apply a light coating of lubricant to the metal sides of the cylinder head gasket. (All gaskets used in reassembly must be new.) If the gasket is copper faced asbestos the upper face is marked TOP to prevent incorrect assembly.

2. Install two cylinder head aligning dowels FES 44-11 into the crankcase. These dowels hold the gasket in position and ensure correct alignment of the cylinder head.

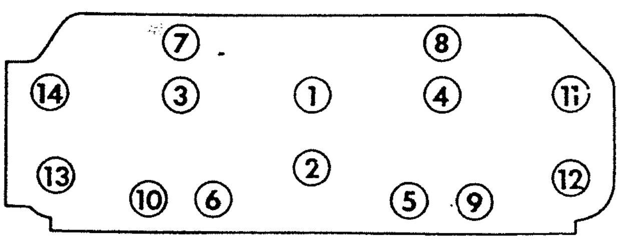
3. Install the cylinder head on the guide dowels and screw in the capscrews. Remove the guide dowels and replace them with capscrews.

4. Position the center valve lever shaft bracket and secure with the long capscrew.



FEA-75549

Illust. 1. Diesel cylinder head bolt tightening sequence.



FEA-75550

Illust. 2. Gasoline cylinder head bolt tightening sequence.

5. Torque the capscrews in the sequence shown in Illusts. 1 and 2 to 75-80 ft. lbs.

6. Remove the capscrew from the center valve lever shaft bracket and remove the bracket.

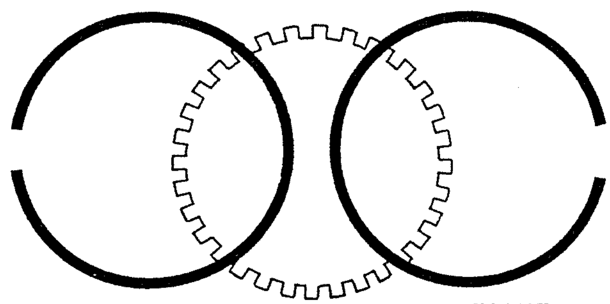
7. Install the valve push rods into the same locations from which they were removed.

8. Loosen the locknuts on each valve lever and back off the adjusting screws.

9. Install and secure the valve lever assemblies on the studs, maintaining inward pressure.

10. Install and torque the center bracket capscrew to 75-80 ft. lbs.

Multi-Piece Oil Control Ring Installation



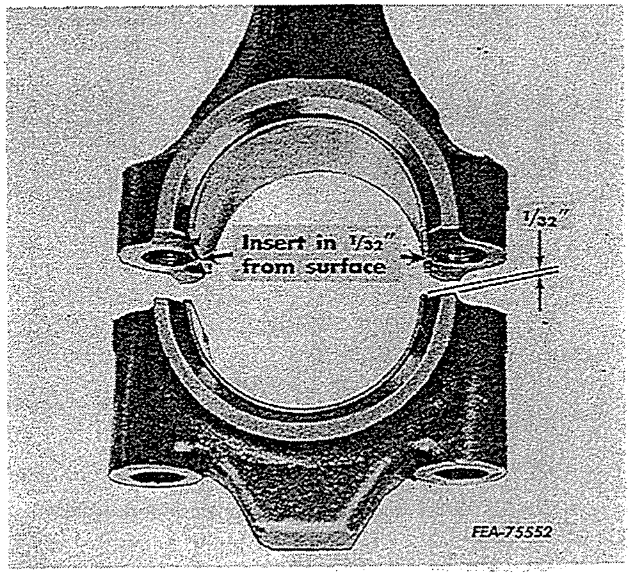
FEA-75551

Illust. 3. Oil ring.

The multi-piece oil control ring must be fitted to the top oil ring groove. The expander must be installed first, followed by the two flat rings which must seat correctly on the expander. The gaps in the flat rings must be at 180 degrees to each other.

NOTE: Pistons in early carbureted engines have an additional oil ring groove below the piston pin. Do not install a ring in this groove.

Connecting Rod Bearing Installation



Illust. 4. Correct connecting rod bearing installation.

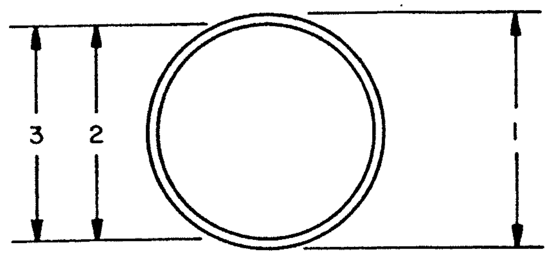
When correctly positioned, the connecting rod cap bearing half will stand out 1/32 inch on both sides above the cap surface and engage inside the rod half bore. See Illust. 4.

Install connecting rod assemblies in the engine so that the nibs on the connecting rod bearings face the camshaft, regardless of where the connecting rod number is stamped.

Camshaft Bearing Installation

When installing the front and rear bearings ensure that the edges marked 'FRONT' are to the front of the engine and that the holes in the bearings line up with the oil passages in the crankcase. The holes in the center bearing are equal distance from either edge. There is no front marking, but the oil holes must line up with the oil passages.

Press the center bearing into position first, then the other bearings. The rear bearing must be pressed in flush with the front of the bore in the crankcase.



BEARING DIMENSIONS					
			REAR	CENTER	FRONT
1	O.D.		1.634-1.637	1.712-1.715	1.947-1.950
2	I.D.	SEMI-FINISH	1.490-1.493	1.568-1.571	1.803-1.806
3	I.D.	LINE REAMED AFTER ASSEMBLY	1.5015-1.5025	1.5795-1.5805	1.8135-1.8145

FEA-75553

Illust. 5. Dimensions of camshaft bearing.

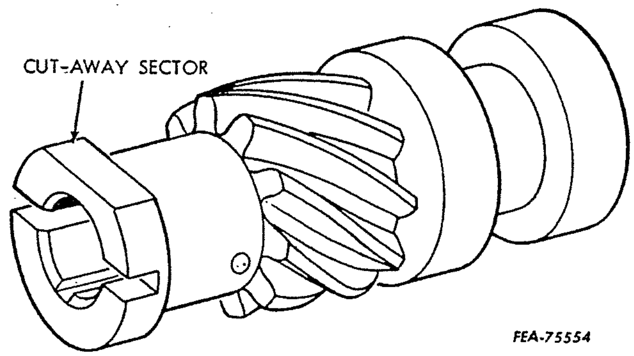
Bearings supplied for service are semi-finished and are to be line-reamed after installation. See Illust. 5.

NOTE: For specified bearing clearances refer to "Specifications."

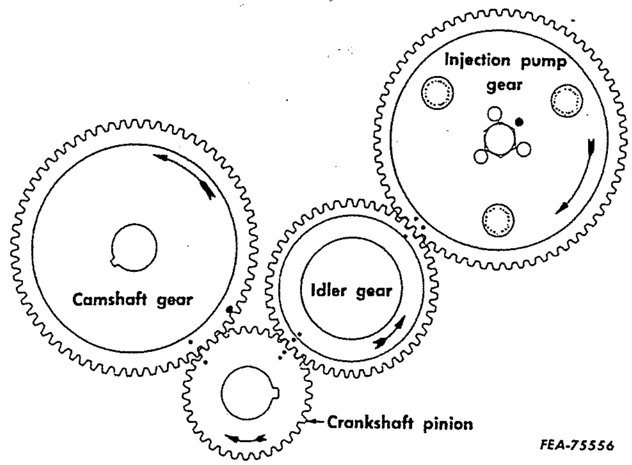
After reaming, thoroughly blow-out the casting and oil passages to ensure that there are no metal deposits present. Install the rear bearing expansion plug. Use a sealing compound on the plug and seat.

Lubricating Oil Pump Removal

(Engine Model BC-144 Only)



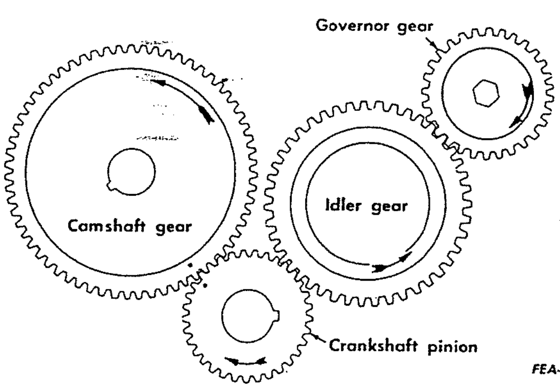
Illust. 6. Oil pump drive pinion.



Illust. 8. BD-144 and BD-154 gear train in time (TDC).

On the BC-144 series engine the oil pump can only be removed and installed when No. 4 piston is at top dead center of the compression stroke. This is due to the flange of the distributor drive having to pass the teeth of the oil pump drive gear on the camshaft. The distributor drive flange has a sector cut away to allow it to pass the gear. See Illust. 6.

Gear Train Timing



Illust. 7. BC-144 gear train in time (TDC).

Break-In Procedure of Rebuilt Diesel Engines

1. The cylinder head bolts should be properly torqued and valve levers adjusted to proper clearance.

2. The engine crankcase should be filled to the proper level with "Mil" SAE 20 lubricating oil. These oils are Mil-L-2104A or MS classification. Series 3 should not be used for break-in since this oil does not contain adequate "break-in" qualities. Use of Series 3 for break-in can result in improper "wear-in" of piston rings and excessive oil consumption. Supplementary oil additives are not to be used during the break-in period.

3. Start the engine and run at 1/4 throttle with no load until normal operating temperature is reached. Cover radiator if necessary to bring engine up to temperature.

"RUN-IN" WHEN DYNAMOMETER IS NOT AVAILABLE

Period	Engine RPM	Load	Remarks
1st Hour	3/4 of rated	None	Fourth gear on road.
2nd and 3rd Hours	3/4 of rated	Light	Operate 2 full gears below normal for load connected to drawbar.
4th Hour	Full	Medium	Operate 1 full gear below normal for load connected to drawbar.

Retorque the Head and Adjust Valves. Tractor is then ready for normal operation, except that it should not be run at low idle or high idle for long periods, nor should the engine be overloaded during the first 25 hours.

After 25 hours, drain the oil and replace with the proper quantity of Series 3 oil of the viscosity recommended for the prevailing temperatures.

Retorque the head and adjust valves after 100 hours of use.

"RUN-IN" WITH DYNAMOMETER

Period	Engine RPM	Load	Remarks
1/2 Hour	1/2 of rated	Set dynamometer to indicate 1/2 of rated hp of tractor.	Portable dynamometers indicate accurately only at full throttle. The actual load will be about 1/4 of rated.
1/2 Hour	3/4 of rated	Set dynamometer to indicate 3/4 of rated hp of tractor.	Load will be slightly over 1/2 of rated.
1/2 Hour-	Full	3/4 of rated hp.	Dynamometer will indicate correct hp.
Retorque Head and Adjust Valves.			
1-1/2 Hours	Full	3/4 of rated hp.	Dynamometer will indicate correct hp.

During the last hour, fuel adjustments, timing and pump advance should be adjusted. Do not operate engine at full load for more than 5 minutes at a time. Tractor is then ready for normal operation, except it should not be run at low idle or high idle for long periods, nor should the engine be overloaded during the first 25 hours.

After 25 hours, retorque the cylinder head bolts, adjust the valves, drain the oil and replace with the proper quantity of Series 3 oil of the viscosity recommended for the prevailing temperatures.

Break-In Procedure of Rebuilt Gasoline Engines

Fill crankcase with Mil-L-2104A or Service "MS" oil of SAE 20 weight to the proper level.

Run engine at 3/4 throttle, no load until normal temperature is reached. It may be necessary to cover radiator.

"RUN-IN" WHEN DYNAMOMETER IS NOT AVAILABLE

Period	Engine RPM	Load	Remarks
15 Min.	3/4 of rated	None	Operate tractor in fourth gear on road.
45 Min.	3/4 of rated	Light	Operate tractor 2 full gears below normal for the load connected to drawbar.
2 Hours	Full	Medium	Operate tractor 1 full gear below normal for the load connected to drawbar. Retorque head and adjust valves.

"RUN-IN" WHEN DYNAMOMETER IS AVAILABLE

Period	Engine RPM	Load	Remarks
1/2 Hour	1/2 of rated	Set dynamometer to show 1/2 of rated hp.	Load on the engine will be about 1/4 of rated due to reduced rpm.
1/2 Hour	3/4 of rated	Set dynamometer to show 3/4 of rated hp.	Load on engine will be slightly over 1/2 of rated.
1/2 Hour	Full	3/4 of rated hp.	Dynamometer will read correct hp.
Retorque Head and Adjust Valves.			
1 Hour	Full	3/4 of rated hp.	Dynamometer will read correct hp.

Tractor is then ready for normal operation. After 50 hours, retorque the cylinder head bolts, adjust the valves, drain the oil and replace with the proper quantity and the correct SAE weight for the prevailing temperature.

FOREWORD

The instructions and special tools shown in this Blue Ribbon Service Manual are for use by International Harvester dealers and their factory trained servicemen.

The specifications as listed in this manual are current as of the printing date. Due to changes and improvements in our products, dealers are periodically issued service bulletins to keep this manual up-to-date. We suggest you refer to the most recent information when performing service work on this equipment.

International Harvester Factory Trained servicemen are best qualified to service I.H. equipment.

INTRODUCTION

The purpose of this manual is to provide servicemen with the necessary information regarding overhaul and field adjustments for the C.A.V. (D.P.A. type) Fuel Injection Pump and Nozzle Service.

The "Principles of Operation" portion of the manual has been prepared to familiarize servicemen with the general function of the pump with specific detailed information covering the components which are affected by field adjustments.

Cleanliness cannot be overemphasized when performing service on any part of the diesel fuel system. Completely clean the injection pump and the surrounding area on the tractor before performing any service work.

LIBRARY FILING INFORMATION

1. File this manual in Book 10 after Divider Tab GSS-1326.
2. Enter the following information in the Service Manual Index. In the Tractor Fuel System Section on Page 7, Print or preferably Type in, the Manual Description, Form Number, and the Book filed in.

CONTENTS

SPECIFICATIONS

Injection Pump

Make	C. A. V.
Type	D. P. A.
Pump speed	1/2 engine speed
Drive	Gear in engine timing train
Rotation (viewed from drive end)	Clockwise
Injection timing	Mark on pump mounting flange and crankcase front cover plate

Transfer Pump

Type	Rotary vanes
Pressure at low idle	16-39 psi
Pressure at rated speed	38-51 psi
Pressure at cranking speed (fuel shut-off lever in off position)	Minimum of 5 psi
Vacuum (at full throttle)	10-15 inches Hg. before engine stalls

Feed Pump

Type	Diaphragm
Drive	Actuated from lobe on engine camshaft
Static fuel pressure (engine stopped)	6-10 psi

Governor

Type	Mechanical flyweight

Injection Nozzles

Type	Inward opening - Pintle No. BDN4SD6299
Nozzle opening pressure	2350 to 2425 psi
No face leakage (10 seconds)	150 psi below opening pressure
Nozzle back leakage	Back leakage should not allow pressure to exceed a fall from 1500 to 1100 psi in less than 10 seconds

	B-275 and TD-5	B-414 and 3414
Roller to roller dimension (for maximum fuel delivery)-inches	1.976	1.978

Governor linkage length (measured from rear barrel surface of the stud to the rear end of the spring retainer) inches	2-1/16 ± 1/32

Plungers

Diameter-inch	.275

End plate regulating valve spring

Free length-inches	....
Test length-inch	....
Test load-lbs.	....

Transfer pump liner I. D. -inches	1.094

Transfer pump vanes

Length-inches	....
Width-inch	....

Hole location for idling spring guide .... Center hole in control arm.

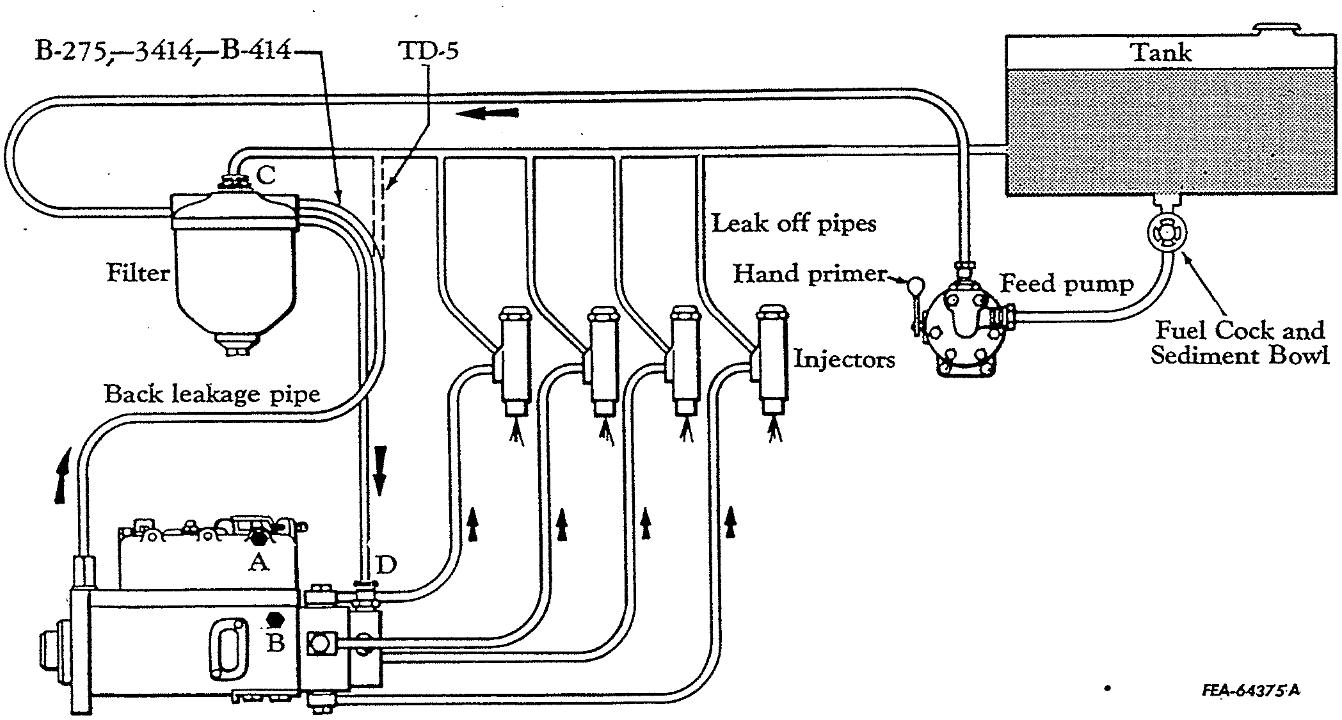
Hole location for governor spring in governor link .... Front hole.

Torque Specifications

Nozzle cap nut	50 ft. lbs.
Nozzle hold-down nuts	40-50 ft. lbs.
Drive hub securing screw	285 inch lbs.
Cam ring securing screw	265 inch lbs.
Drive plate screws	160 inch lbs.
Hydraulic head locating screw	285 inch lbs.
Hydraulic head locking screws	170 inch lbs.
Transfer-pump rotor	65 inch lbs.
End plate fuel inlet connection	360 inch lbs.
End plate screws	45 inch lbs.
Acorn nuts	30 inch lbs.

GENERAL INFORMATION

Fuel System



Illust. 1. Fuel system schematic.

As shown in Illust. 1, fuel flows by gravity from the fuel tank through the fuel cock and sediment bowl to the feed pump. The diaphragm type feed pump is actuated by a lobe on the engine crankshaft. A hand primer is incorporated in the feed pump to facilitate venting air and priming of the system with fuel. Fuel flows under low pressure from the feed pump to the fuel filter. The fuel filter has a replaceable element. A pressure relief valve or a reverse check ball and bleed orifice is incorporated in the filter cover to maintain proper, and relieve excess, fuel pressure. Filtered fuel, now under regulated low pressure, flows to the injection pump where a portion of the fuel is metered, increased in pressure and distributed to the injection nozzles. Fuel which is not injected is used to lubricate and cool the injection pump, then flows from the pump through the excess fuel return line to the fuel filter on the B-414, 3414 and B-275 or to the fuel tank on the TD-5 tractor.

Venting the Fuel System

(Refer to Illust. 1.)

1. Open the fuel cock on the sediment bowl.

2. Vent the sediment bowl.

3. Vent the inlet to the feed pump.

4. Operate the feed pump hand primer and while doing so, proceed as follows:

Note: It may be necessary, in some cases, to rotate the crankshaft approximately one revolution to permit hand operation of the priming pump.

(a) Vent the fuel filter. (Loosen the center capscrew in the filter cover.)

(b) Vent point "B" on the injection pump housing.

(c) Vent point "A" on the pump (governor housing).

5. Loosen two injector lines at the nozzle (1 and 4 are most convenient). Crank the engine until fuel spurts from these connections. Tighten the connections.

6. Engine is now ready to start and run. Further venting of the system or nozzles should not be necessary, however, smoother engine operation may be obtained sooner by venting each injector line at the nozzle fitting while the engine is running.

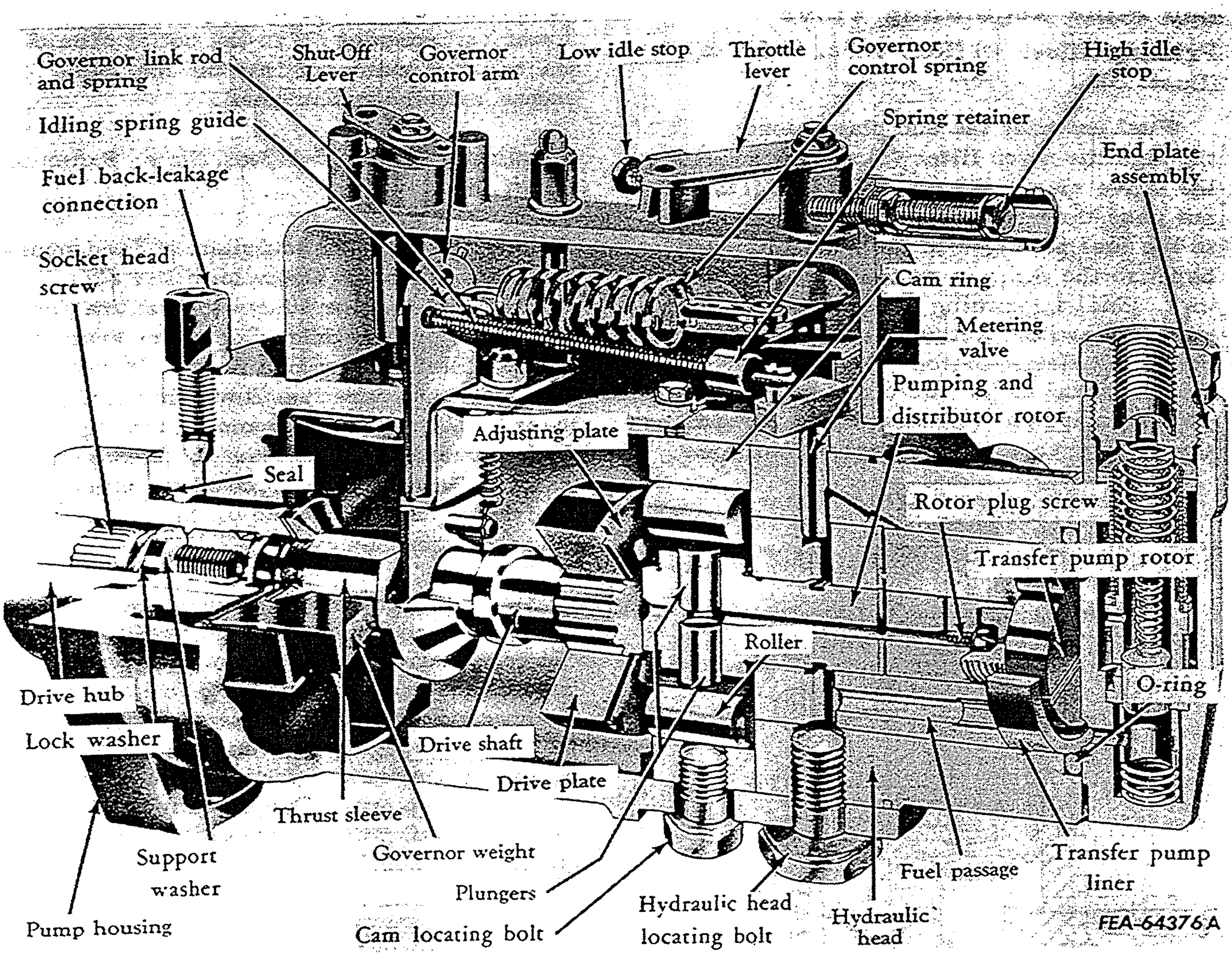
PRINCIPLES OF OPERATION

General

This injection pump is a single cylinder, opposed plunger, inlet metering, distributor type pump.

The function of the injection pump is to provide the engine with fuel in quantities exactly timed and proportioned to the amount of work it is required to do. Maximum efficiency can be possible only when these conditions are met.

A gear, dowel located on the pump drive shaft hub, is indexed to and driven from the idler gear of the engine timing gear train. The pump drive shaft, master spline - connected, drives the pumping and distributing rotor. A vane type transfer pump rotor is attached to and driven from the rear end of the pumping and distributing rotor. This transfer pump supplies fuel to the complete injection pump assembly for lubrication, cooling, metering and distribution to the nozzles. A metering valve, located in the hydraulic



Illust. 2. Cut-away of injection pump.

head, meters the fuel (within limits) for distribution to the nozzles. A piston sleeve type valve located in the end plate of the transfer pump permits venting and priming of the injection pump assembly and regulates the pressure of the fuel from the transfer pump. A cam ring having four opposite opposed lobes is located stationary in the pump housing. Attached to and rotating with the rotor shaft and within the cam ring are two movable opposed rollers and shoes which are in contact with the outer ends of the opposed plungers. The pumping action of this assembly increases the pressure of the fuel for injection. A flyweight type governor attached to and rotating with the drive shaft actuates linkage which in turn controls the rotary position of the metering valve.

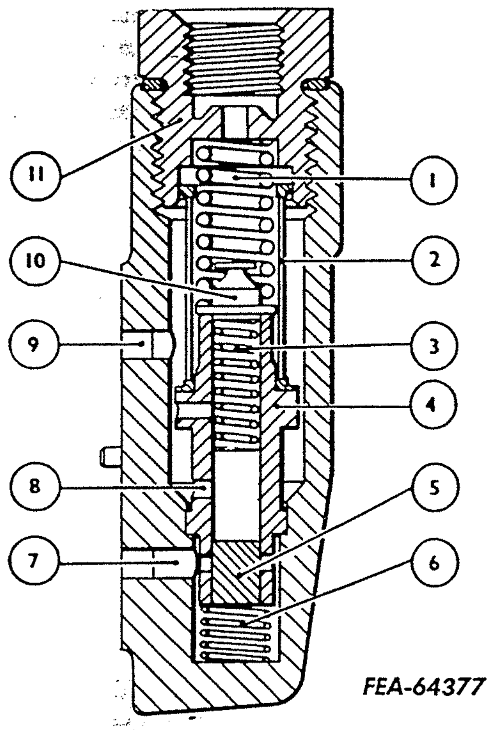
High idle and low idle adjustable stops restrict the movement of the throttle lever and shaft. A shut-off lever and linkage facilitates rotation of the metering valve to shut-off position regardless of throttle position.

There is no timing advance mechanism in this pump, therefore, end of injection is constant. Start of injection varies with the outward travel of the roller shoes and plungers. Due to the master spline connection of the drive shaft to the pumping and distributor shaft and the dowel location of the drive shaft hub to the injection pump drive gear, it is impossible, within limits, for the pump to be out of time with the engine.

End Plate Regulating Valve

Priming (Illust. 4) (Ref. No's. Refer to Illust. 3)

Fuel entering the end plate passes through the nylon filter (2) and surrounds the valve sleeve assembly (4). Fuel cannot pass through the transfer pump and into the fuel passages in the hydraulic head because the pump is stationary (not turning). Fuel at priming pressure enters the valve sleeve and acts against the upper face of the regulating piston (5). The piston is forced to the lower end of the valve sleeve, compressing the retaining spring (6) and uncovering the priming parts. Fuel then passes through the priming parts, the lower fuel passage (7) to the outlet side of the transfer pump and into the fuel passages in the hydraulic head.



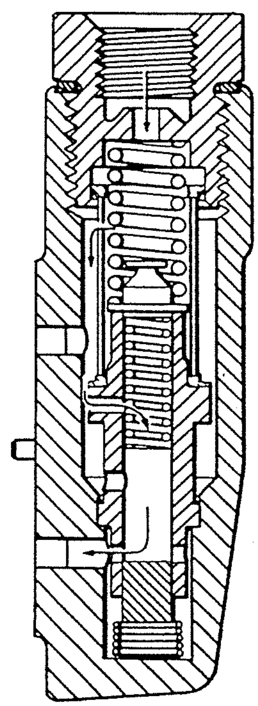
Illust. 3. Cut-away of end plate.

1. Sleeve retaining spring.
2. Nylon filter.
3. Regulating spring.
4. Valve sleeve.
5. Piston.
6. Retaining spring.
7. Fuel passage to transfer pump outlet.
8. Regulating port.
9. Fuel passage to transfer pump inlet.
10. Spring guide.
11. Fuel inlet connection.

Regulating (Illust. 5) (Ref. No's. Refer to Illust. 3)

Fuel entering the end plate at feed pressure flows through the nylon filter (2), surrounds the valve sleeve (4) out the fuel passage (9) to the inlet side of the transfer pump. The transfer pump rotor is rotating. Transfer pressure fuel flows through fuel passage (7) to the lower end of the regulating piston (5) and forces the piston upwards. This force is opposed by pressure exerted on the upper face of the piston by the regulating spring (3).

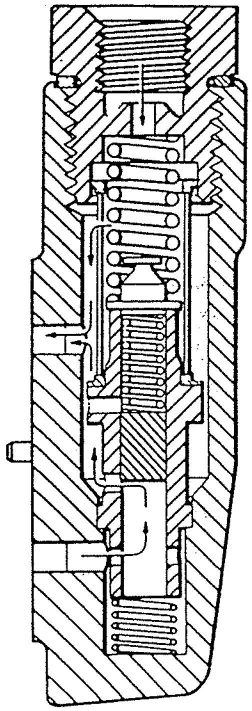
As transfer pressure increases, with increasing engine speed, the piston is forced upwards and the regulating spring is compressed. Movement of the piston progressively uncovers the regulating port (8) and regulates transfer pressure by by-passing excess fuel to the inlet side of the transfer pump. The effective area of the regulating port increases or decreases as engine speed increases or decreases.



Priming

FEA-64378

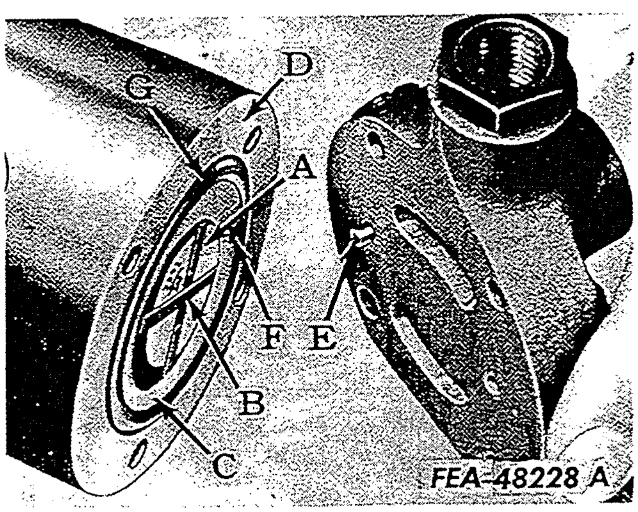
Illust. 4. Priming position of valve piston.



Illust. 5. Regulating position of valve piston.

Transfer Pump (Illust. 6.)

The transfer pump rotor "A" supports and rotates a pair of sliding vanes "B" in a liner "C".



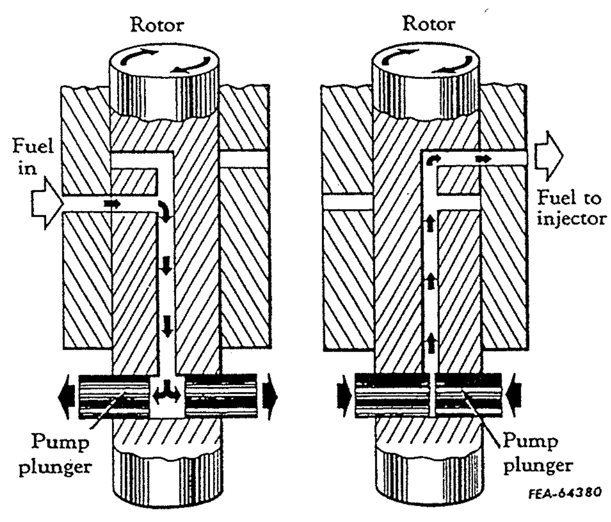
Illust. 6. Transfer pump assembly.

The liner is located and held in the hydraulic head "D" by a dowel "E" in the pump end plate. The dowel engages a slot "F" in the liner. An "O" ring "G" acts as a seal between the end plate and the hydraulic head.

Fuel Pumping and Distribution

Fuel Pumping (Illust. 7)

Transfer pressure fuel, metered by the metering valve, flows through a drilled passage in the hydraulic head to the rotor. When a charging port, drilled in the rotor, aligns with the drilled passage in the hydraulic head, as shown in Illust. 7, fuel is forced through the centrally drilled passage in the rotor and forces the pump plungers outward. As the rotor turns, the charging port in the rotor is closed. Further rotation of the rotor aligns the discharge port of the rotor with a discharge port in the hydraulic head. During this rotation the pump plungers are forced inward thus increasing the fuel pressure and forcing the fuel through the aligned discharge ports. A fuel line connected to the hydraulic head discharge port carries this high pressure fuel to the nozzle for injection.



Illust. 7. Charging and discharging principle.

A stationary cam ring, having four opposite opposed internal lobes, is located in the injection pump housing. The front end of the rotor has a cross bore containing two opposed plungers and carries with it a pair of rollers, roller shoes, and adjustable plates. As the rotor revolves the rollers ride over the lobes thereby forcing the plungers inward. Fuel is forced from between the plungers, through the central bore in the rotor and through the discharge ports of the rotor and hydraulic head.

Distribution (Illust. 8)

There is one charging port in the hydraulic head. There are four charging ports drilled crosswise through the rotor. Rotation of the rotor within the hydraulic head causes each rotor charging port to line up, in turn, with the charging port in the hydraulic head.

One discharge port is drilled in the rotor and four discharge ports are drilled in the hydraulic head. The centrally drilled passage in the rotor connects the plunger chamber and charging ports to the single discharge port. As the rotor turns, fuel is distributed to each of the four discharge ports in the hydraulic head.

The quantity of fuel, entering the pumping chamber and available for discharge, depends on the following factors:

1. Metering valve position.

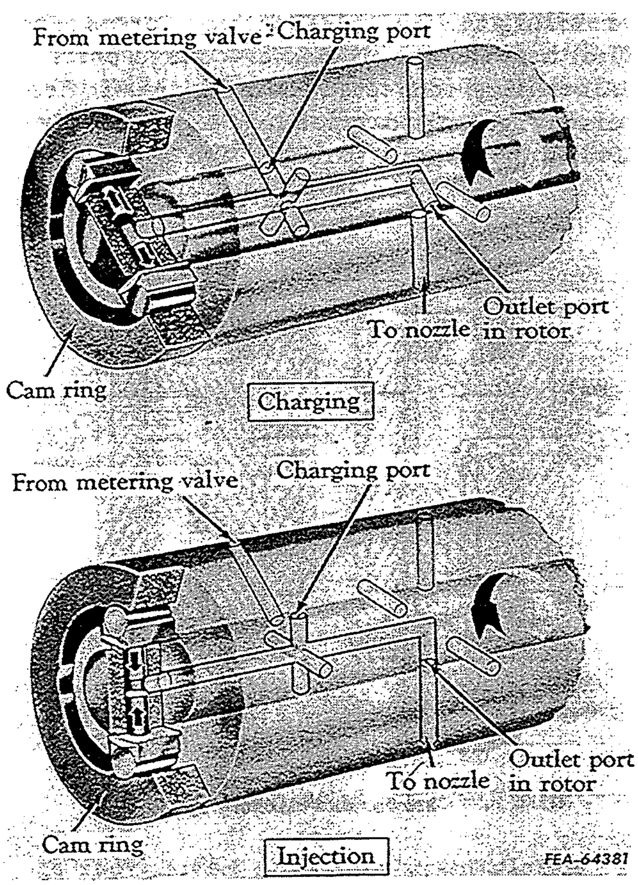
2. Fuel pressure at the charging ports.

3. Duration of time that the charging ports are in register.

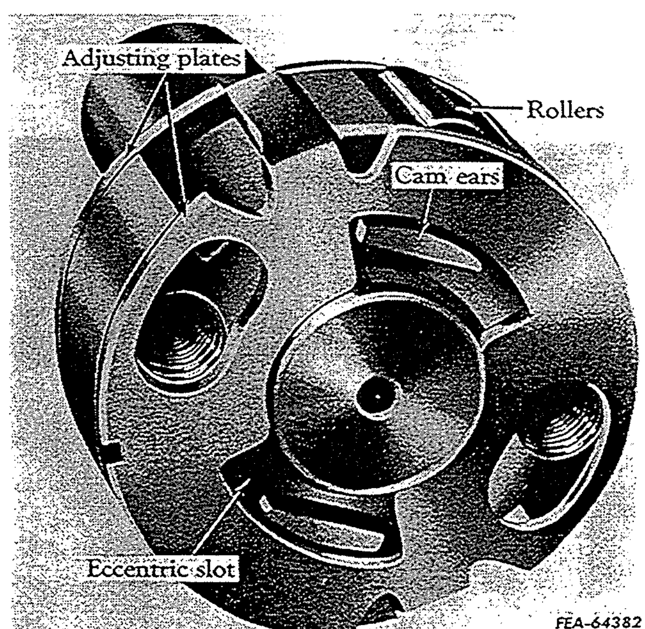
4. Total plunger displacement available as limited by the roller shoe adjusting plates.

Maximum Fuel Control

Roller shoes have protruding cam ears at each end. Interlocking adjusting plates, having internal eccentric slots, are positioned at each end of the rollers and turn with the rotor. Two small locking screws secure the driving head and adjusting plates to the rotor. The outward travel of



Illust. 8. Fuel distribution.



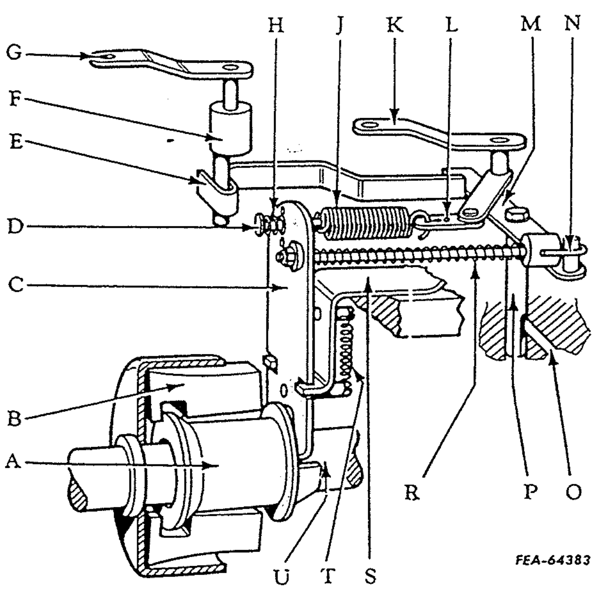
Illust. 9. Maximum fuel control. (Rotor assembly)

the rollers, shoes and plungers is restricted as the protruding cam ears of the shoes contact the eccentric slots of the plates. See Illust. 9.

Maximum fuel delivery required for high altitude operation is somewhat less than that for sea level. This coincides with altitude horsepower derating of the engine and must not be overlooked. Adjustments may be necessary to both service and production pumps.

Governor Control Linkage (Illust. 10)

Movement of the governor weights "B" causes the control sleeve "A" to move axially along the drive shaft "U". The governor control arm "C" is free to pivot about a fulcrum provided on the control bracket "S" and is held in contact with the end face of the thrust sleeve by spring tension. A spring-loaded hook rod "N" connects the upper end of the governor control arm with the lever "M" which is secured to the metering valve "P". Any movement of the governor weights in response to fluctuations of engine speed results in movement of the metering valve and a corresponding change of fuel quantity.



Illust. 10. Governor control linkage.

The "shut-off" shaft "F" is operated by movement of the lever "G". Movement of the shaft is transmitted to the control lever "M" on the metering valve by the "shut-off" bar "E", and rotates the metering valve to a position where the metering port "O" is completely closed. The hook rod "N" is spring-loaded so that this movement can be achieved without overcoming the resistance of the governor weights. When the "shut-off" control is operated, the light spring "R" is compressed and the front end of the hook rod passes through the governor control arm.

Speed selection is made by moving the throttle lever "K" which is mounted on the throttle shaft. A swivel link "L" is connected to a lever which is integral with the throttle shaft. The governor spring "J" connects the swivel link with the idling spring guide "D" which passes through a hole in the governor control arm. When the lever is moved to obtain increased engine speed, the light idling spring "H" is compressed as the guide is drawn through the control arm and tension is then applied to the main spring. Tension of the main spring acting on the control arm is transmitted to the control sleeve, and provides resistance to movement of the governor weights.

The application of the D. P. A. pump requires the idling spring guide "D" to be located through the center of the three holes in the upper end of the governor control arm "C". The governor spring "J" should be hooked in the front hole of the swivel link "L".

The metering valve "P" consists of a small shaft, slotted at one end. The valve is situated in a chamber in the hydraulic head, through which the fuel passes from the transfer pump to the inlet ports of the rotor. Rotation of the valve controls the effective area of the metering orifice, and regulates the fuel supply to the rotor by controlling the metering pressure in the passage "O".

TROUBLE SHOOTING CHART

Problem	Cause
Engine fails to start or is hard to start	1. Injection pump fuel shut-off arm and throttle lever not in the "run" position. 2. Air in fuel system. 3. Fuel does not meet specifications, or water is in fuel. 4. Cranking speed too slow. 5. Fuel not reaching transfer pump. 6. Glow plugs not hot. 7. Fuel return line plugged. 8. Injection pump not correctly timed to engine. 9. Faulty nozzles. 10. No fuel pressure to the injection pump plungers. 11. Piston rings or valves in poor condition. 12. No fuel injection occurring.
Engine starts, then stops	1. Insufficient fuel reaching the injection pump. 2. Water in fuel. 3. Air in fuel system. 4. Fuel return line restricted. 5. Engine seizure.
Engine surges	1. Air in fuel system. 2. Insufficient fuel reaching injection pump. 3. Improper governor action.

Problem	Cause
Rough and/or noisy engine operation (see also engine misfiring)	1. Injection pump timing not correct. 2. Air in fuel system. 3. Faulty nozzles. 4. Engine valves faulty. 5. Uneven engine compression.
Engine not developing full power	1. Restricted engine induction system. 2. Restricted exhaust system. 3. Throttle control does not move the throttle lever against high idle stop. 4. Timing of injection pump to engine not correct. 5. Fuel does not meet specifications. 6. Insufficient fuel reaching transfer pump. 7. Restriction in fuel return line. 8. Incorrect fuel transfer pump pressure. 9. Incorrect high idle speed. 10. Faulty nozzles. 11. Poor engine compression. 12. Insufficient fuel delivery.
Engine misfiring (also see rough and/or noisy engine operation and white exhaust smoke)	1. Injection pipes or fittings leaking. 2. Air lock in fuel system. 3. Faulty injection nozzle. 4. Incorrect engine valve lever adjustment, burned or stuck valve.
White exhaust smoke	1. Low engine temperature. 2. Air lock in fuel system. 3. Faulty nozzles. 4. Incorrect compression pressure.

Problem	Cause
Excessive black smoke at rated load speed	1. Restriction in engine induction system. 2. Low engine temperature. 3. Faulty nozzles. 4. Injection pump delivering excessive fuel.
Excessive black smoke during engine overload only	1. Injection pump delivering excessive fuel when engine is overloaded.
Blue smoke	1. Excessive oil consumption.
Incorrect vacuum	1. Loose or damaged inlet connections. 2. Unserviceable copper washer on inlet adaptor to end plate. 3. Regulating spring missing or broken. 4. End plate not tightened square to hydraulic head. 5. Faulty transfer pump seal. 6. Worn or damaged transfer pump blades. 7. Transfer pump liner improperly located. 8. Air leak in vacuum gauge connection.
Low transfer pressure	1. Regulating spring or piston missing. 2. Incorrect regulating spring. 3. Worn or damaged transfer pump blades. 4. Faulty transfer pump seal. 5. Loose or incorrectly tightened end plate. 6. Faulty washers on head locking and head locating screws. 7. Damaged seals on head locating fitting.
High transfer pressure	1. Sticking regulating piston. 2. Incorrect regulating spring - too strong.
Low and fluctuating transfer pressure	1. One transfer pump blade chipped or broken.

Problem	Cause
Incorrect maximum fuel delivery	1. Throttle not fully open. 2. Incorrect maximum fuel setting. 3. Faulty washer on rotor plug screw. 4. Loose rotor plug screw. 5. Sticking metering valve. 6. Air in system. 7. Sticking plungers or roller shoes. 8. Damaged washers on radial connections. 9. Incorrect transfer pressure. 10. Shut off mechanism fouling metering valve. 11. Governor link adjustment incorrect. 12. Governor spring linkage incorrectly assembled. 13. Cam ring reversed.
Low fuel delivery at cranking speed	1. Low transfer pressure. 2. Throttle not fully open. 3. Rotor plug screw washer damaged. 4. Rotor plug screw loose. 5. Sticking metering valve. 6. Sticking plungers and roller shoes. 7. Damaged washers on radial connections. 8. Plungers scored. 9. Outlet ports scored. 10. Excessive clearance, rotor to hydraulic head. 11. Air in system. 12. Scored metering valve.

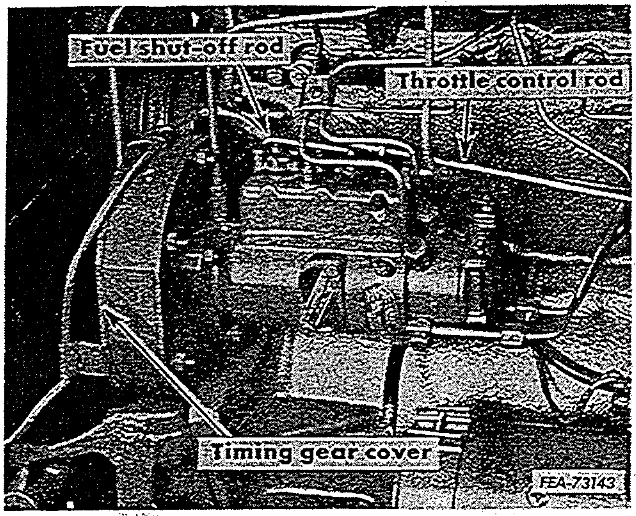
Problem	Cause
Fuel shut-off not working	1. Cut off lever fitted incorrectly to cut off shaft. 2. Cut off bar fouling control cover or control bracket. 3. Governor link binding in control arm. 4. Governor link length too long. 5. Excessive clearance, metering valve to hydraulic head. 6. Sticking metering valve.
Low fuel delivery at maximum speed	1. Maximum speed stop screw incorrectly adjusted. 2. Faulty or incorrect governor spring. 3. Governor spring linkage coupled to wrong holes. 4. Sticking metering valve.
Difficulty in obtaining proper fuel delivery setting	1. Governor spring damaged or of wrong type. 2. Governor link setting incorrect. 3. Governor spring linkage incorrectly coupled. 4. Drive hub securing screw loose. 5. Sticking metering valve. 6. Sticking governor thrust sleeve.

Removal (Illust. 11 and 12.)

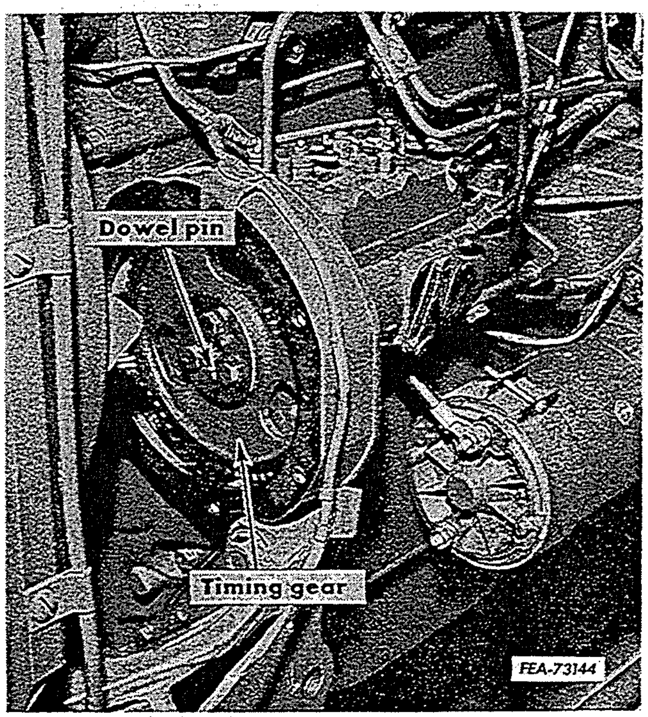
1. Completely clean the area surrounding the injection pump.

2. Close the fuel shut-off. Disconnect all fuel lines connected to the injection pump. Cap all fuel lines and plug all openings to prevent entry of dirt. Loosen the fuel inlet connection on the pump end plate.

3. Disconnect the throttle control rod and fuel shut off rod from their levers on the pump.



Illust. 11. Injection pump disconnects.



Illust. 12. Injection pump timing gear.

4. Remove the injection pump timing gear cover.

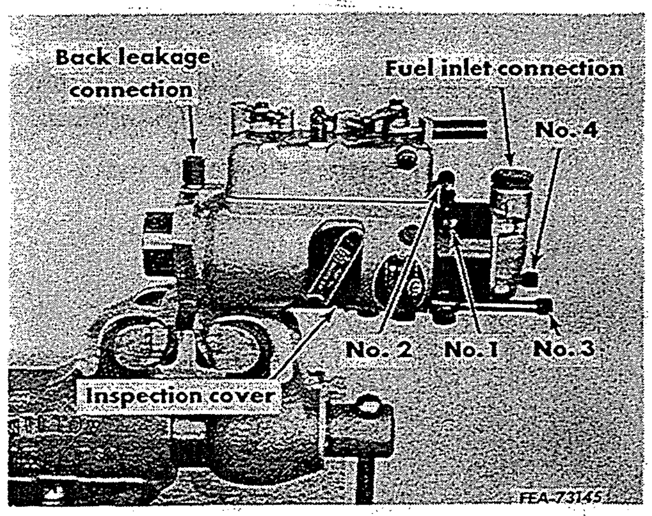
5. Remove the capscrews securing the timing gear to the pump flange.

6. Remove the nuts securing the injection pump to the crankcase front plate and remove the pump.

Disassembly

IMPORTANT: Before disassembling the pump, remove all external grease and dirt. Wash the pump with clean fuel oil and blow it dry with compressed air. Keep in mind that dirt, dust, and foreign matter are the greatest enemies of the fuel injection pump. As a precaution, keep all openings temporarily plugged.

The work bench and the area around it should be clean, as well as the tools to be used. A clean pan should be available in which all parts may be placed as disassembly proceeds, and also a pan of clean fuel oil, in which the parts may be washed.

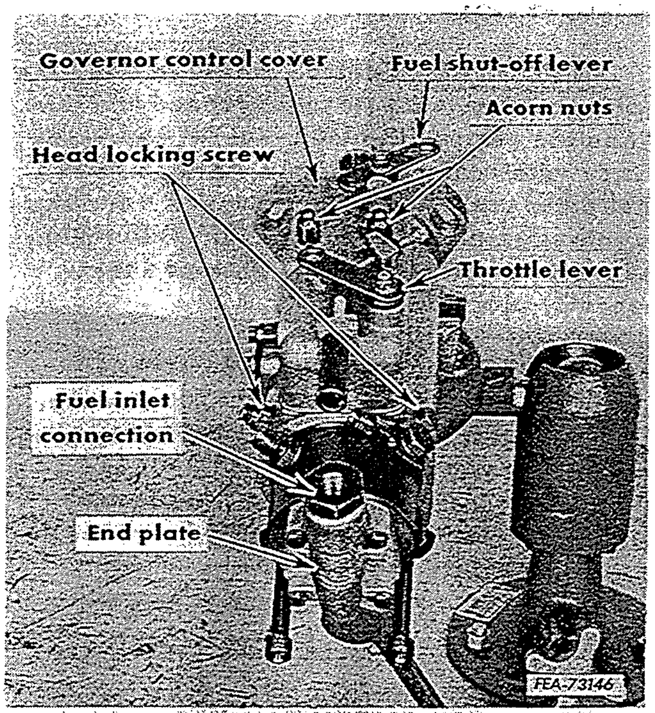


Illust. 13. Pump mounted in vise.

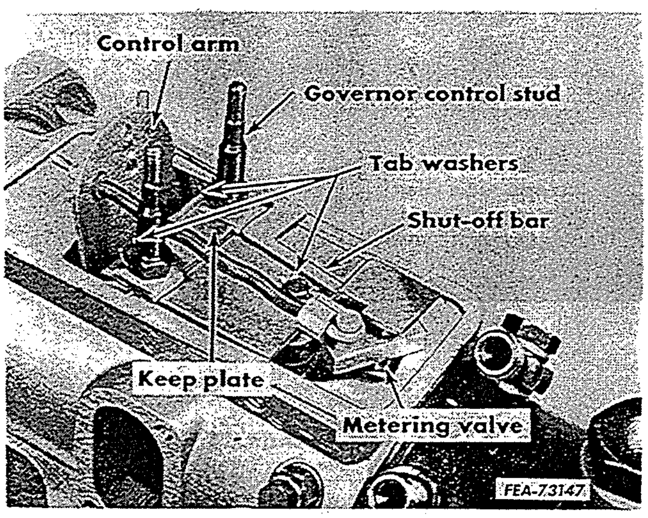
1. Mount the pump flange in a vise that has brass shields. (Illust. 13.) Remove the inspection cover and drain the fuel from the pump housing. Remove the injector lines and banjo bolts.

2. Remove the nuts securing the fuel shut-off and throttle levers to their shafts, (Illust. 14). Note the location of the star and plain washer to aid in reassembly. Remove the levers.

3. Remove the two acorn nuts and fiber washers securing the cover to the housing. (Illust. 14.)



Illust. 14. Fuel shut-off and throttle levers.

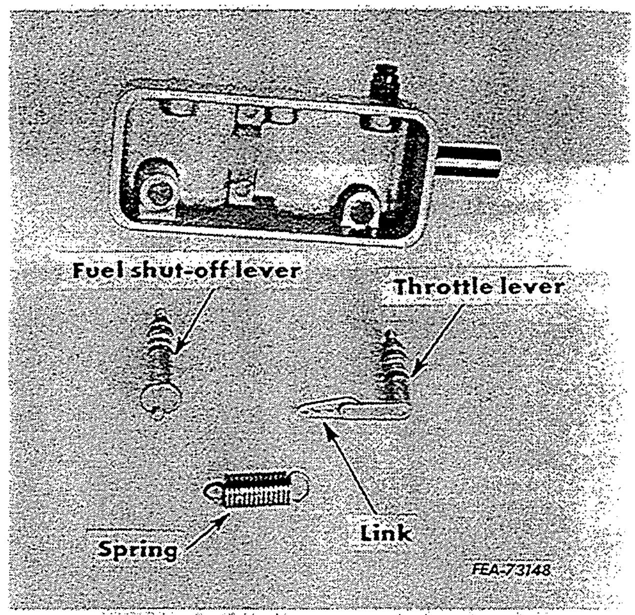


Illust. 15. Governor control linkage.

4. Lift the governor control cover and unhook the governor spring from the idling spring guide. Remove the governor control cover from the pump housing. Note the location of the spring guide in the control arm. Remove the idling spring guide and spring from the control arm, (Illust. 15).

5. Unlock the tab washers from the two governor control studs and the capscrew securing the linkage in the pump housing, (Illust. 15). Remove the studs and capscrew. Remove the keep plate shut-off bar. Remove the linkage assembly with metering valve from the housing.

6. Disconnect the metering valve from the hook lever and protect the precision ground surface from damage and corrosion by immersing it in clean fuel oil.



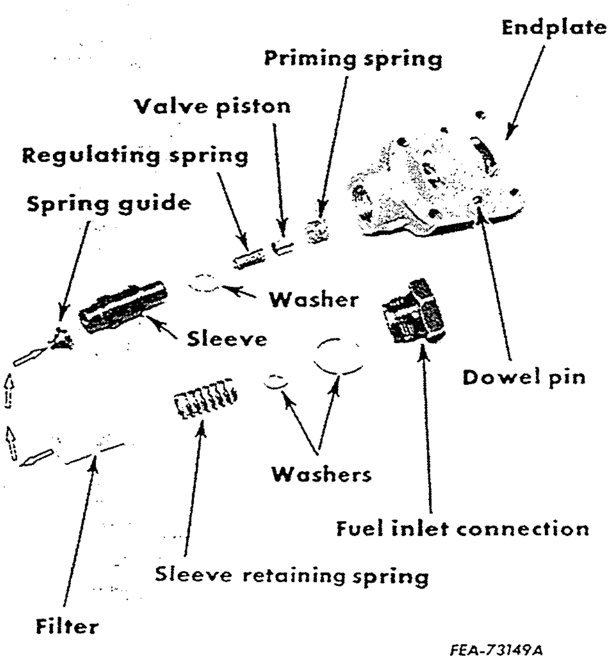
Illust. 16. Governor control spring location.

7. Remove the fuel shut-off and throttle levers from the governor control cover. Note the location of the spring hook up in the link. (Illust. 16.) Disconnect the control spring from the throttle lever link.

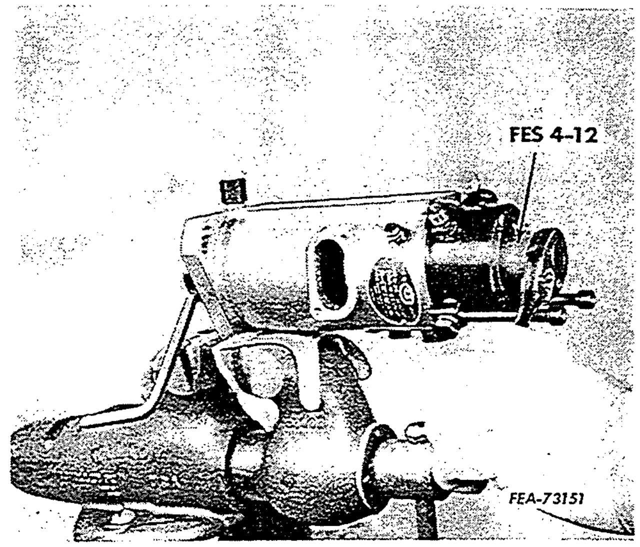
8. Remove the end plate from the pump housing (Illust. 14).

9. Remove the fuel inlet connection and remove the component parts from the end plate. (Illust. 17.)

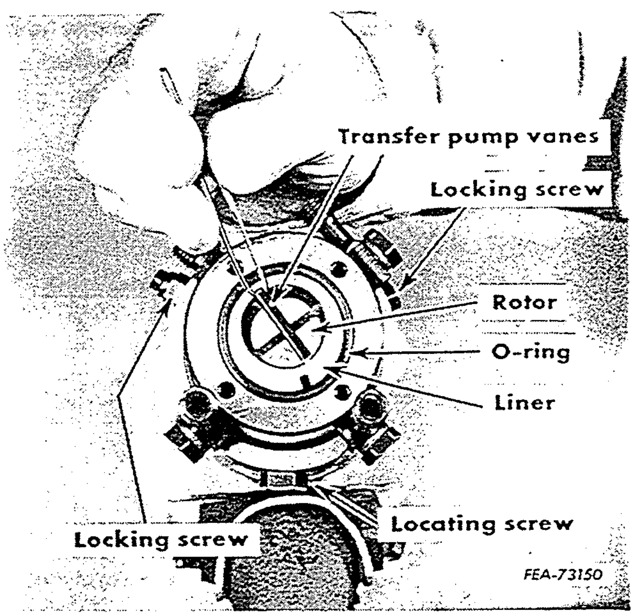
10. Using a pair of tweezers, remove the transfer pump vanes from the slots in the rotor, (Illust. 18). Remove the O-ring and the transfer pump liner from the housing.



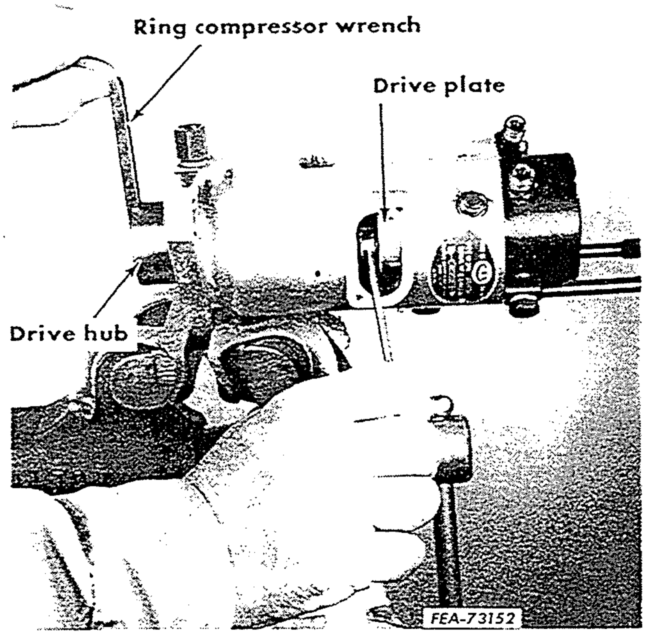
Illust. 17. End plate disassembled.



Illust. 19. Removing the transfer pump rotor.



Illust. 18. Removing transfer pump vanes.

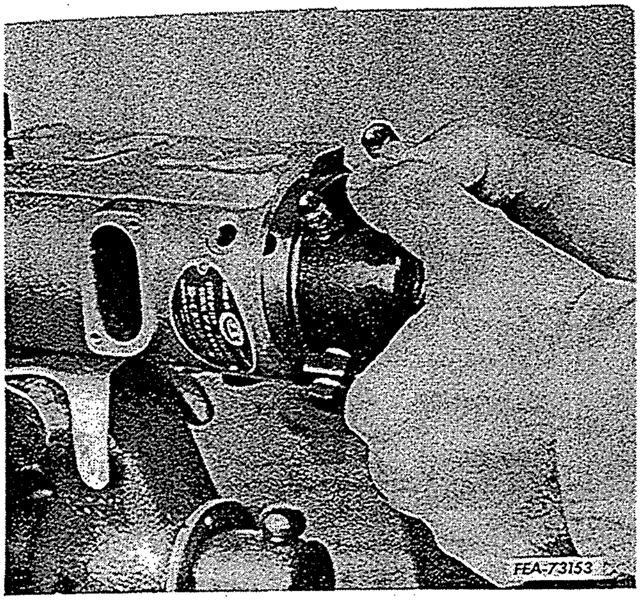


Illust. 20. Loosening drive plate screws.

11. Hold the drive hub with the square key and loosen the transfer pump rotor, using the transfer pump rotor wrench (FES 4-12) (Illust. 19). The direction for rotor removal is indicated by an arrow on the face of the rotor. (Illust. 18.) Do not remove the rotor at this time.

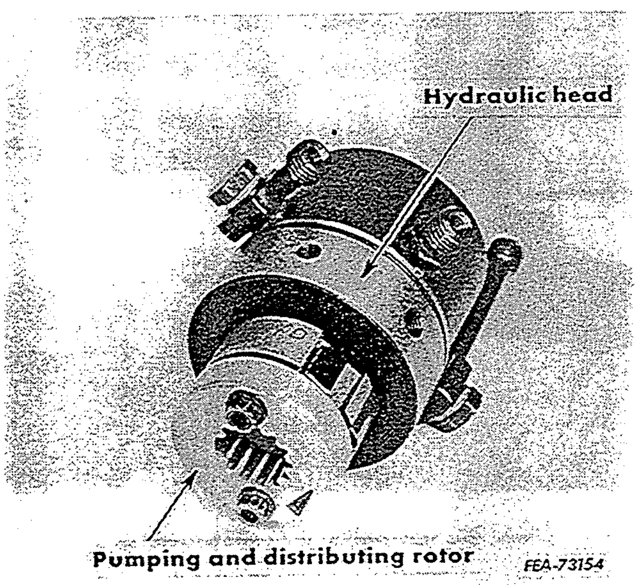
12. Loosen the two drive plate screws while holding the drive hub secure. (Illust. 20.)

13. Remove the three locking screws securing the hydraulic head in the pump housing. (Illust. 18.)



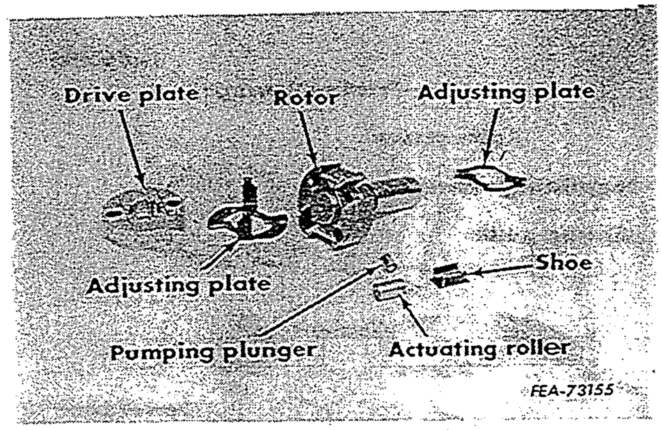
Illust. 21. Removing hydraulic head and rotor.

14. Remove the hydraulic head and rotor as an assembly. (Illust. 21.)



Illust. 22. Hydraulic head and pumping and distributing rotor.

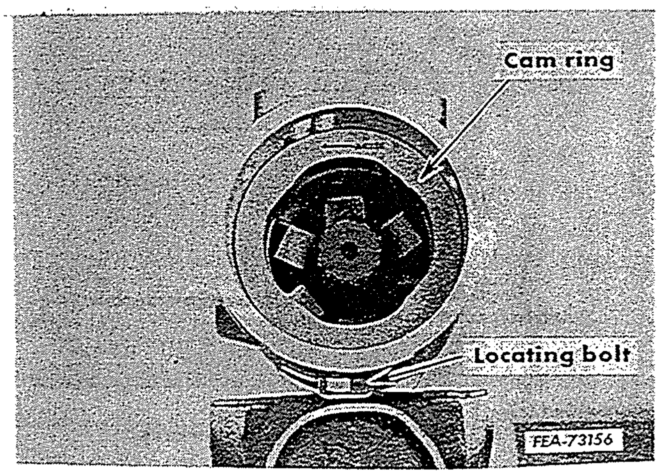
15. Remove the rotor. Separate the pumping and distributing rotor from the hydraulic head. (Illust. 22.) Note the position of the roller shoes and lock plates in the rotor as an aid in reassembly.



Illust. 23. Rotor disassembled.

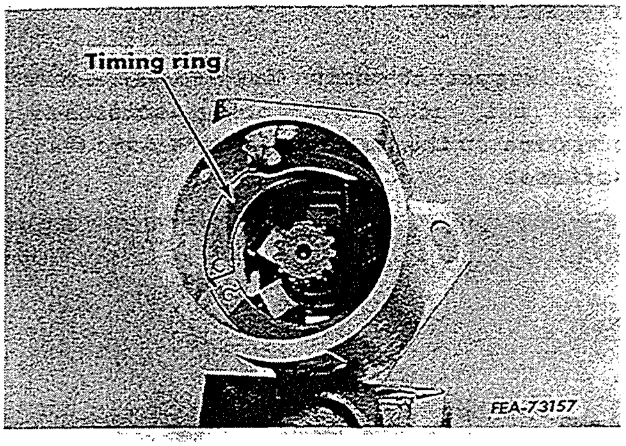
16. Remove the drive plate screws and drive plate. Disconnect the top and bottom adjusting plates and remove the actuating rollers and shoes from the rotor. Remove the two pumping plungers from the bore in the rotor (Illust. 23).

17. Remove the allen head setscrew and copper sealing washer from the transfer rotor and flush the rotor thoroughly in clean diesel fuel.



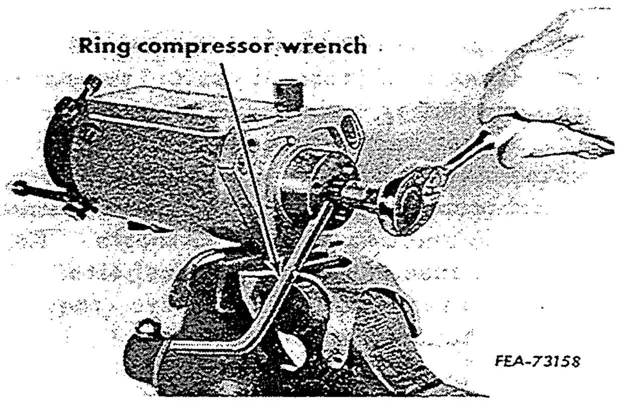
Illust. 24. Cam ring and locating bolt.

18. Remove the cam ring locating bolt and remove the cam ring (Illust. 24). The arrow on the cam ring corresponds to the arrow on the pump housing showing direction of pump rotation.



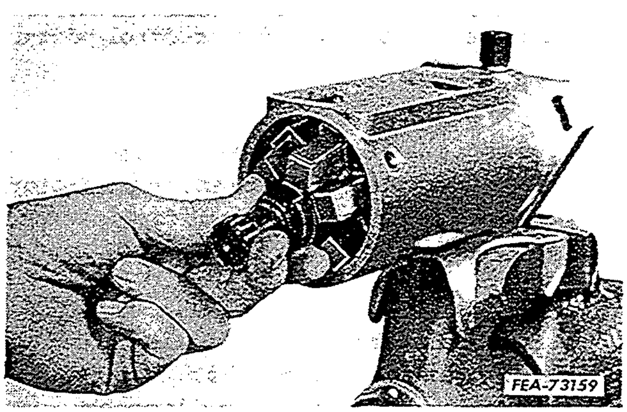
Illust. 25. Timing ring location.

19. On pumps equipped with a timing ring (Illust. 25), remove the timing ring from the housing and discard it as it is not needed.



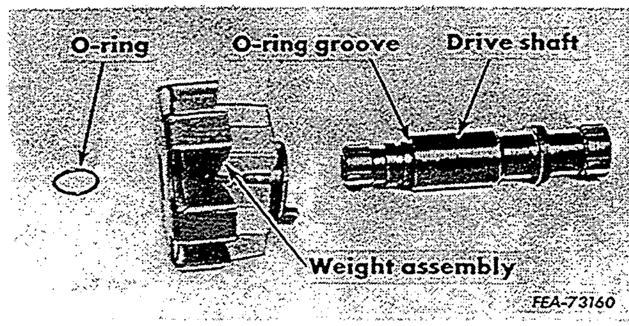
Illust. 26. Removing hub securing screw.

20. Lock the drive hub with the ring compressor wrench and remove the hub securing screw (Illust. 26).



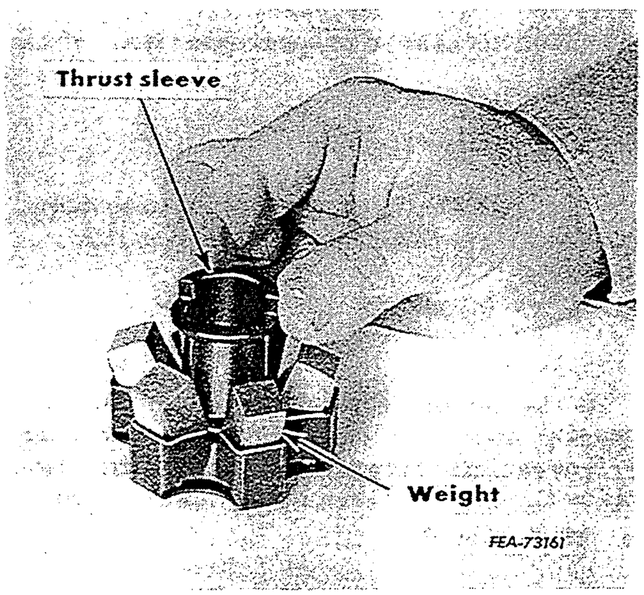
Illust. 27. Removing governor weight assembly.

21. Remove the governor weight assembly and splined shaft (Illust. 27).



Illust. 28. Governor weight and drive shaft.

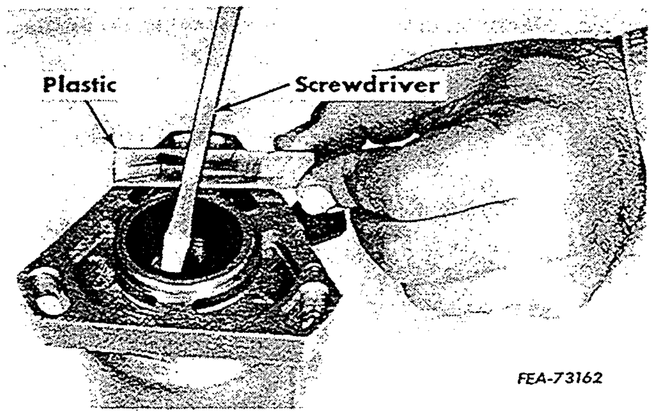
22. Remove the O-ring from its groove in the drive shaft. Pull the shaft out of the weight assembly (Illust. 28).



Illust. 29. Removing thrust sleeve and weights.

23. To remove the weights from their housing, lift out the thrust sleeve thereby allowing the weights to be removed with the thrust washer (Illust. 29).

24. Place a plastic or brass block on the flanged end of the housing, as shown in Illust. 30. Insert a dull screwdriver between the lower face of the seal and the bottom of the seal housing. Apply downward pressure on the screwdriver to pry out the oil seal. NOTE: The block keeps the screwdriver from contacting the housing.



Illust. 30. Removing housing oil seal.

Inspection and Repair

NOTE: Clean all parts of the injection pump in clean diesel fuel or solvent. All parts and drilled passages must be open and clean to assure proper operation of the pump.

End Plate (Illust. 17).

1. Check the pressure regulating valve sleeve for rust and the bypass port for clogging.

2. Check the regulating plunger for excessive wear, nicks or chipping, scratches or scores, and freedom of movement. Replace the part if there is any doubt as to its serviceability.

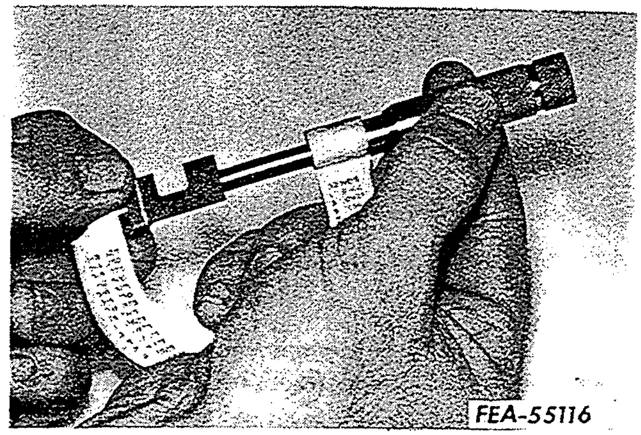
3. Inspect the end plate for wear from transfer pump end thrust; for rust, cracks or thread damage.

4. Check the bottom surface of the fuel inlet connection for rust and the threads for damage.

5. Inspect the inlet strainer for foreign material, or damage to the screen. Clean it thoroughly. Replace the strainer if it is damaged.

Transfer Pump

1. Inspect the pump liner for excessive wear, rust, nicks or chipping, scratches or scores on the inside diameter and flat surfaces.



Illust. 31. Measuring the blade length.

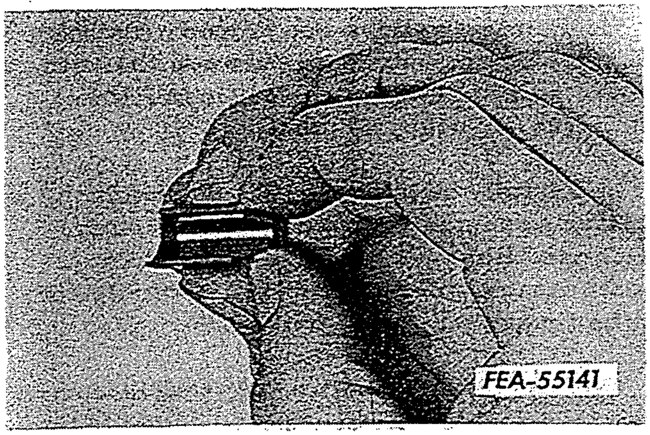
2. Inspect the blades for excessive wear, nicks or chipping of any of the edges. Check for pitting, embedded foreign particles or wear on the rounded ends. Determine this wear by measuring the length with a micrometer. Refer to "Specifications" on pages 5 and 6 for specified length. The blades are made of copper impregnated carbon and are brittle. Therefore, they should be handled with care. (Illust. 31.)

Hydraulic Head and Rotor

1. Inspect the head for excessive wear, rust, nicks or chipping, scratches or scores and thread damage. Inspect the metering valve bore and fuel control ports.

2. Inspect the plungers and check for complete freedom of movement in the rotor, then remove and examine them for scratches, nicks or signs of excessive wear.

3. If the plungers were sticking, but not visibly damaged, clean both plungers and bore with a soft brush and lacquer solvent such as lacquer thinner or acetone.



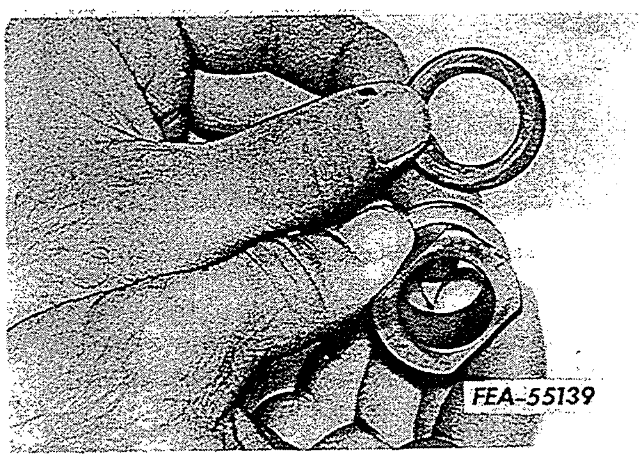
Illust. 32. Checking the cam roller and shoe.

4. Inspect each cam roller in its shoe for freedom of rolling and sliding, and the top edge of each shoe for chipping or excessive wear (Illust. 32).

5. Do not remove the rotor plug screw and sealing washer in the end of the rotor, as these parts are not serviced separately.

Governor

1. Examine the retainer sockets where the weights pivot, and the pivot points of all weights.



Illust. 33. Inspecting the governor sleeve and washer.

2. Inspect the thrust sleeve and washer for excessive wear, rust, nicks, scratches or scores, cracks or distortion; especially at points of contact with the governor arm. (Illust. 33.)

3. Inspect the pivot points of the governor arm and pivot bracket and the governor arm fork where it contacts the thrust sleeve.

4. Examine the metering valve linkage hook, the spring retainer, throttle shaft lever, shut-off cam, and the throttle and shut-off shaft assemblies for excessive wear.

5. Check the metering valve arm for looseness. The valve must be tight in the arm. Be sure the metering valve arm pin is tight in the arm.

Cam, Drive Shaft, Drive Hub and Pump Housing

1. Since only the working surfaces of the lobes on the cam I.D. are ground, the tool marks between the lobes should not be considered damaged. The cam finish is discolored from heat treatment rather than from operation. Carefully inspect the I.D. and edges of all flat surfaces. If there is evidence of excessive wear, rust, nicks, scratches or scores, cracks or distortion, or "flaking out," replace the cam.

2. Check the drive shaft for rust, excessive wear or nicks where the governor thrust sleeve slides. The drive hub seal grooves must be smooth for the seals to function properly.

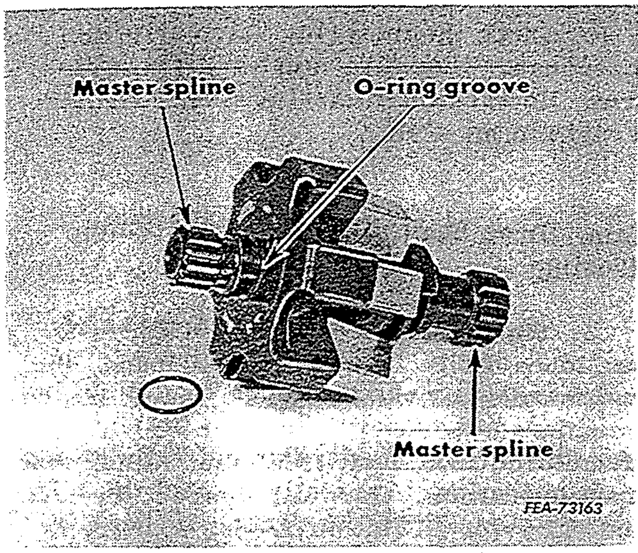
3. Inspect the pump housing internally for burrs or scratches and remove any found--carefully. A scratch at the point of contact with the seal could be a source of leakage. Inspect the drive shaft bore in the housing for excessive wear, scratches and nicks.

Reassembly

1. Use all new O-rings and oil seals when reassembling the injection pump. Dip all parts in clean diesel fuel.

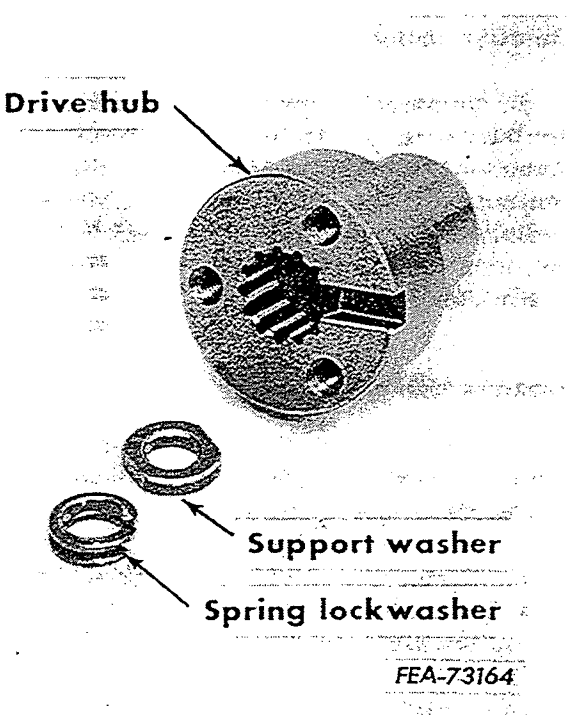
2. Using step plate No. 630-4, install a new drive hub oil seal into its bore in the pump housing. Be sure the seal bottoms on its seat. The seal is correctly seated, when a continuous black line can be seen when the seal is viewed through the flanged end of the pump housing.

3. Reassemble the weights in the carrier being sure the thrust washer and the flange of the thrust sleeve engage the slots of all the weights.



Illust. 34. Weight carrier assembly.

4. Install the splined drive shaft in the carrier and install a new O-ring in the shaft groove (Illust. 34).



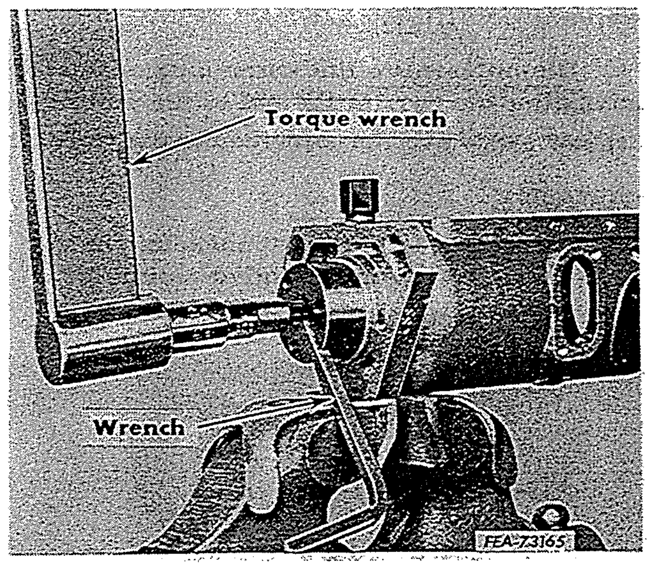
Illust. 35. Drive hub and support washer.

5. Install the drive hub support washer (Illust. 35), in the recess between the two sets of splines in the hub and install the hub in the oil seal and housing.

6. Install the drive shaft and weight carrier assembly into the pump housing (Refer to Illust. 27). Engage the drive shaft master spline with the master spline in the inner end of the drive hub.

NOTE: In this position the weight carrier is trapped between the end face of the drive hub and a shoulder on the drive shaft.

7. Install the drive hub spring lock washer and allen screw.



Illust. 36 Torquing drive hub allen screw.

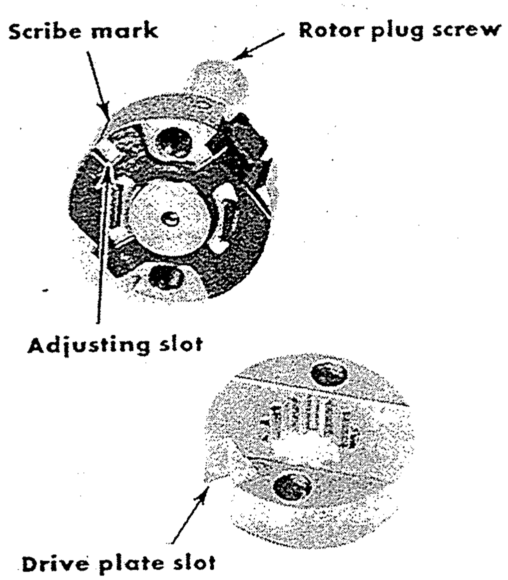
8. Using the piston ring compressor wrench to lock the hub, torque the allen screw to 285 inch lbs (Illust. 36).

9. Install the cam ring in the housing against the timing ring. The direction indicated by the arrow on the face of the cam ring should correspond with the arrow on the name plate showing direction of pump rotation (Illust. 24).

10. Install the cam ring locating bolt (Illust. 24).

11. Place the bottom adjusting plate in position on the pumping and distributor rotor so that the adjusting slot lines up with the scribe mark on the rotor head.

NOTE: Be sure to position the adjusting plate so the slots in the plate are in line with the roller shoe guides.



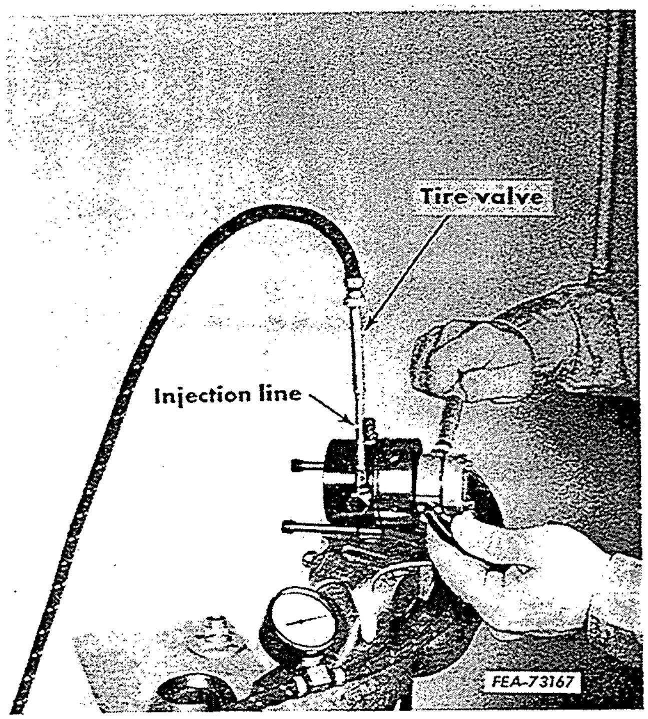
Illust. 37. Proper position of roller shoes and adjusting plates.

12. Install the twin plungers in their bore in the rotor, and install the roller and shoe assemblies in their guides in the rotor.

13. Install the top adjusting plate so the ears of the shoes engage the slots in the plates and the lugs of the top plate engage the slots of the bottom plate. (Illust. 32.)

14. Install the drive plate to the rotor, recessed side of the plate to the rotor, and install the plate capscrews finger tight. The slot in the drive plate should line up with the adjusting slot in the adjusting ring. (Illust. 37.)

15. Install the pumping and distributor rotor into its bore in the hydraulic head. Install the rotor, finger tight only at this time.

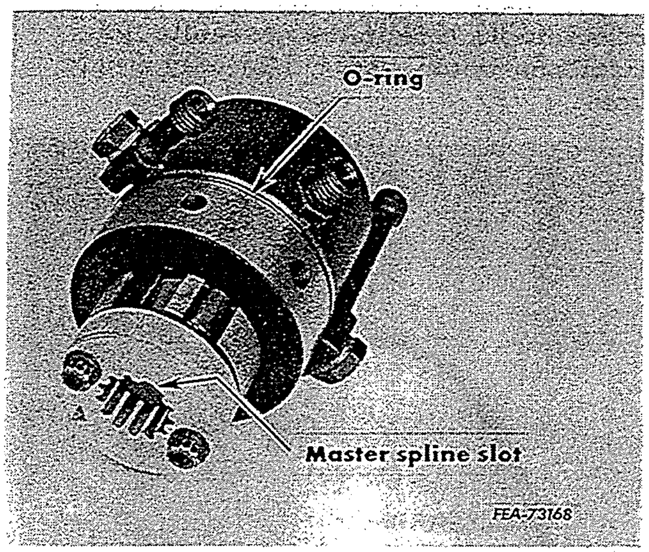


Illust. 38. Checking roller to roller dimension for maximum fuel adjustment.

16. Secure the hydraulic head and rotor assembly in a vise (Illust. 38). Be sure the machined circumference of the hydraulic head does not contact the vise. Apply air pressure (30 to 100 psi) to one of the fuel injector line connections. (Illust. 38.) Rotate the rotor until the plungers and roller shoes are forced to the maximum fuel position. Check the roller to roller dimension with a micrometer and if necessary, rotate the adjusting plate until the specified roller to roller dimension is obtained. Refer to "Specifications".

NOTE: The air pressure line installed on the hydraulic head can be made from an injection line with a tire valve brazed to it.

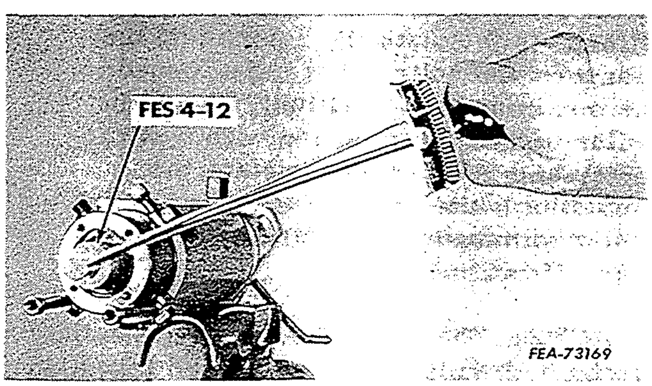
17. Disconnect the air pressure equipment.



Illust. 39. Drive plate master spline slot.

18. Install a new O-ring on the hydraulic head. Install the hydraulic head and rotor assembly into the housing, engaging the master spline on the inner end of the drive-shaft with the master spline slot of the drive plate (Illust. 39). Rotate the head to prevent damage to the O-ring as it enters the pump housing.

19. Locate and secure the head by installing the head locating screw. Tighten the screw to 285 inch lbs. torque. Install the two head locking screws and tighten them to 170 inch lbs. torque. Torque the cam ring locating bolt to 265 inch lbs.



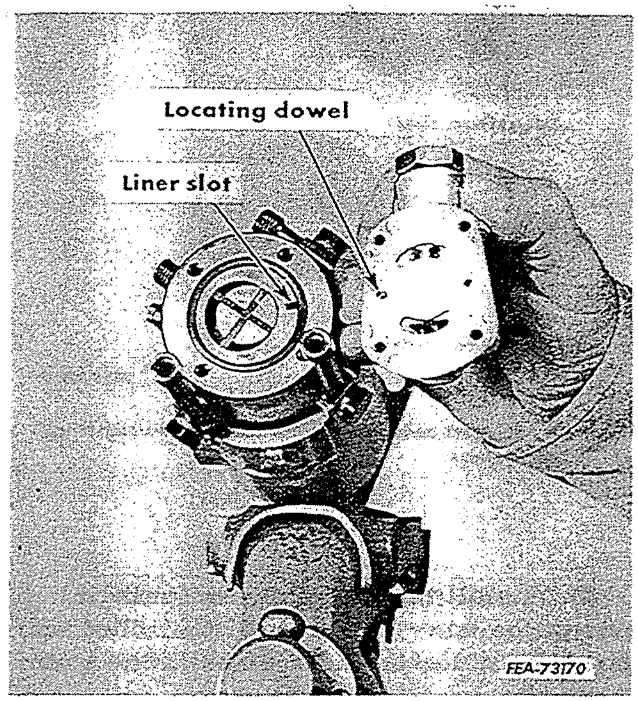
Illust. 40. Torquing transfer pump rotor.

20. Lock the drive hub from turning and tighten the rotor to 65 inch lbs. torque (Illust. 40).

21. Install the transfer pump liner in its bore in the hydraulic head. Install a new O-ring around the liner.

22. Install the pump vanes in the slots in the rotor. Refer to Illust. 18. Rotate the liner to be sure the vanes do not bind.

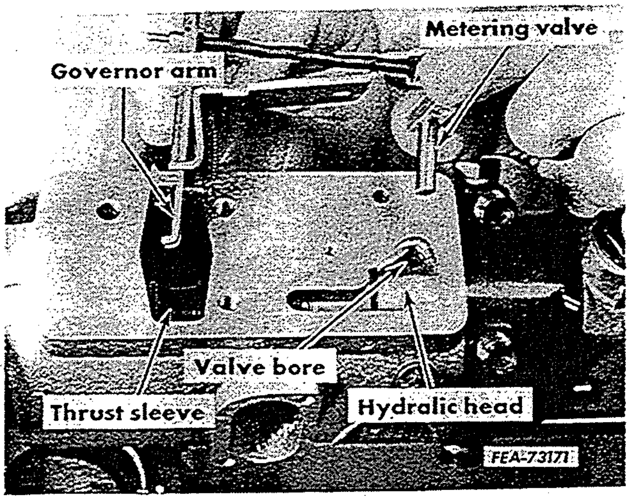
23. Install the priming spring in the base of the end plate valve chamber. Refer to Illust. 17. Insert the piston and regulating spring in the sleeve and a new washer on the sleeve. Install the spring guide filter retaining spring, washers and fuel inlet connection.



Illust. 41. End plate locating dowel.

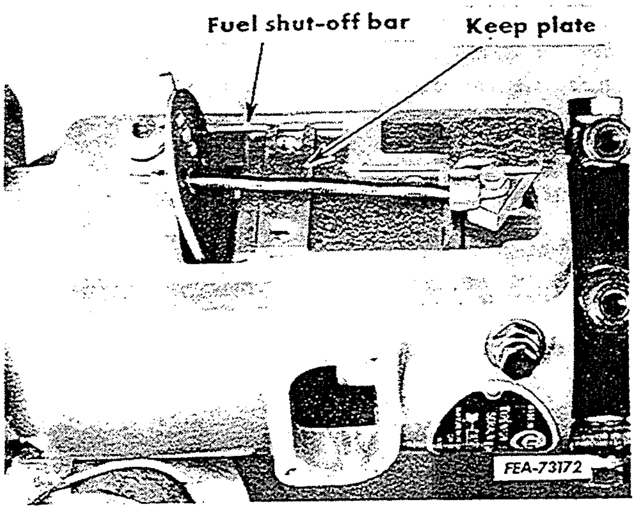
24. Install the end plate assembly on the pump housing, being sure the locating dowel on the face of the end plate engages the slot in the transfer pump liner (Illust. 41). Install the end plate capscrews and tighten them to 45 inch lbs. torque. Tighten the fuel inlet connection to 360 inch lbs. torque after the pump is installed on the engine.

25. Rotate the thrust sleeve so the seat for the governor arm is exposed and to the top. Install the governor control linkage



Illust. 42. Installing governor linkage.

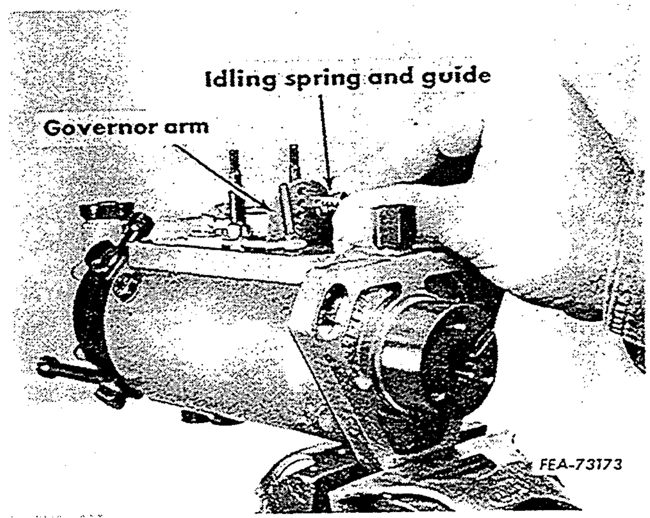
on the pump housing and engage the lower end of the governor arm with the thrust sleeve and position the metering valve in its bore in the hydraulic head (Illust. 42).



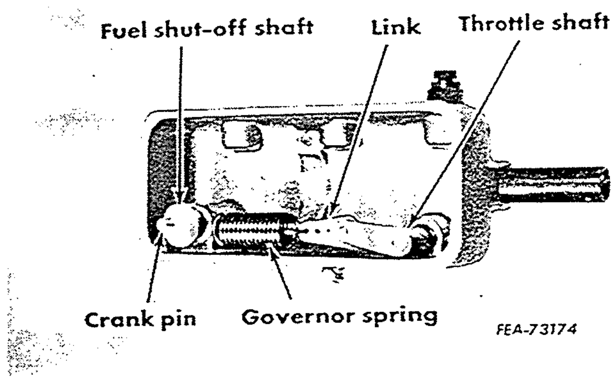
Illust. 43. Position of keep plate and fuel shut-off bar.

26. Install the keep plate in position on the governor control bracket (Illust. 43). Install the fuel shut-off bar. Install the governor control studs with new tab washers. Install the screw and tab washer at the end of the bracket near the metering valve. Tighten the screw and studs securely. Bend lock tabs up to lock screw and studs in place.

27. Install the idling spring and guide into the center of the three holes in the governor arm (Illust. 44).



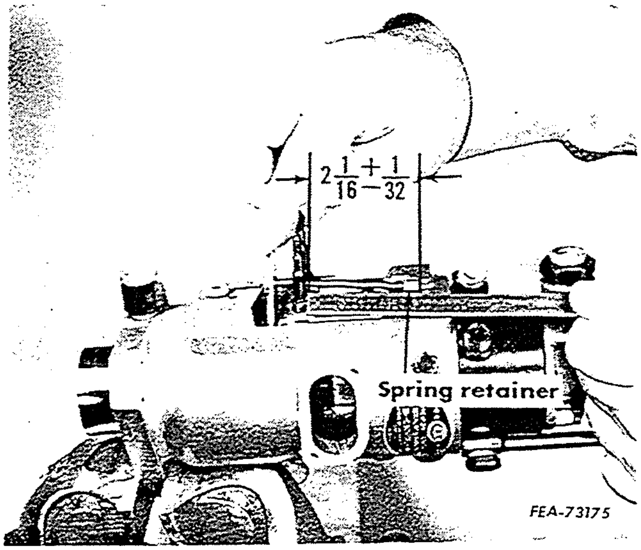
Illust. 44. Installing idling spring and guide.



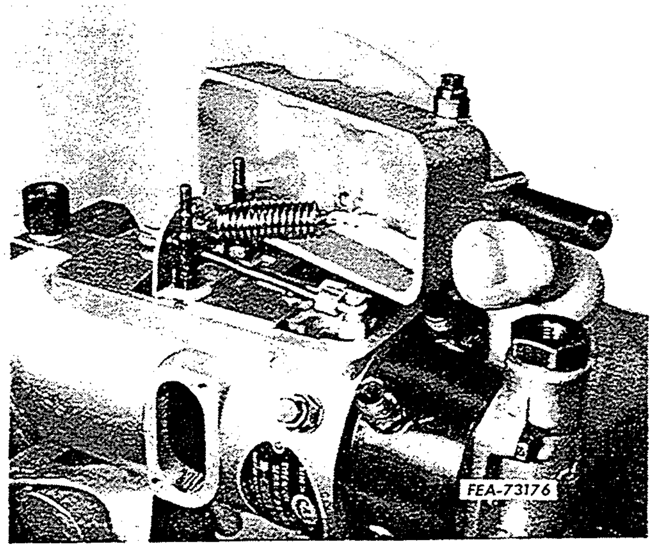
Illust. 45. Governor control housing assembled.

28. With new O-rings installed on the fuel shut-off and throttle shafts, press the shafts through their bores in the governor control housing. Install one end of the governor spring to the front hole in the link (Illust. 45).

29. Move the governor control arm to the full throttle position, (toward the rear



Illust. 46. Checking linkage setting.



Illust. 47. Installing governor control housing.

of the pump) and hold it in that position. Measure from the rear barrel surface of the stud (not the hex head) to the rear end of the spring retainer. Measurement should be 2-1/16 ± 1/32 inches (Illust. 46).

30. Install the governor control housing with new gasket on the pump housing, being sure to hook the governor spring to the idling spring guide and also being sure the fuel shut-off shaft crank pin engages the slot in the fuel shut-off bar. (Illust. 47.)

31. Install the acorn nuts with washers on the studs and tighten them to 30 inch lbs. torque.

32. Install the washers and levers on the throttle and fuel shut-off shafts. Secure the levers in place with the nuts.

Installation

The installation procedure is the reverse of the removal procedure. Refer to "Field Adjustments" for final adjustments on pages 29 to 32.

FIELD ADJUSTMENTS

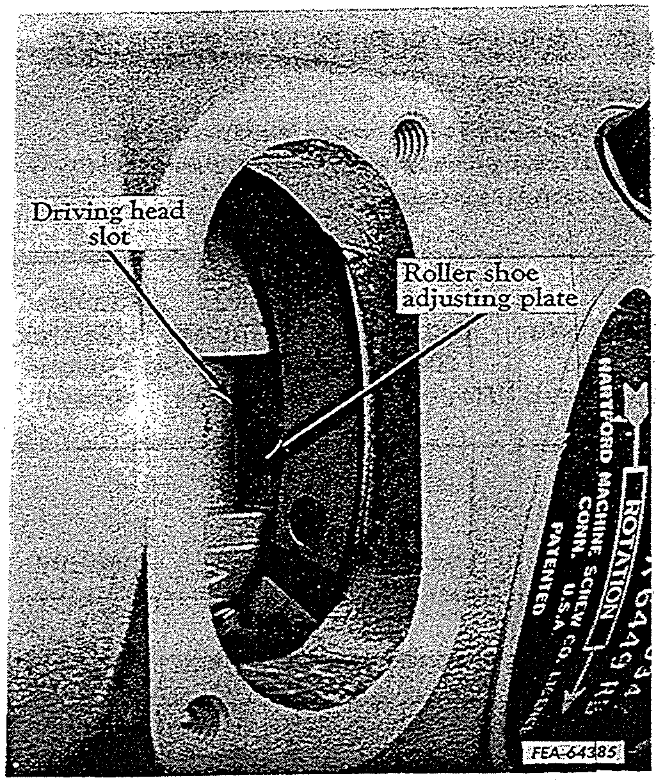
Maximum Fuel

1. Close the fuel cock at the fuel tank.

2. Remove the part number plate, inspection cover and gasket from the pump and drain the fuel.

3. Rotate the engine crankshaft clockwise as viewed from the front of the tractor, until the slot in the driving head is in position as shown in Illust. 48 (about 4 o'clock).

4. Loosen the two capscrews which secure the driving head to the rotor using a 5/16 inch 12 point straight shank, box end wrench.



Illust. 48. Rotor position for making maximum fuel adjustment.

NOTE: The roller shoe adjusting plates are now free and ready for adjustment.

5. Insert a small tool, such as a pin punch, screwdriver or allen wrench, through the inspection cover opening and engage the small slot in the roller shoe adjusting plate (inner black ring).

NOTE: Very small movement of the ring is required to change maximum fuel delivery.

Fuel delivery is increased by rotating the adjusting plate downward (direction of pump rotation as indicated by the arrow on the serial number plate). Decrease fuel delivery by rotating the plate in the opposite direction.

6. Tighten the drive plate capscrews to 125 inch pounds torque. (Approximately 31 lbs. pull on a spring scale hooked perpendicular to the end of a wrench 4 inches long.)

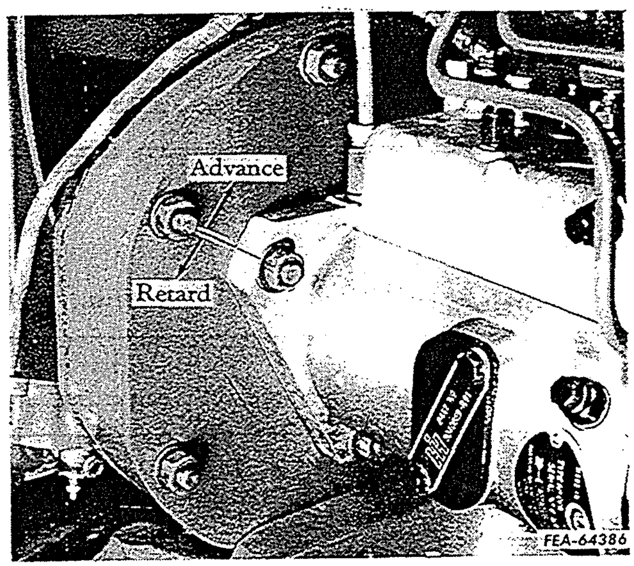
7. Install the gasket, inspection cover, part number plate and capscrews on the housing. Tighten the capscrews securely.

8. Vent the fuel system as outlined on page 7.

9. Start and operate engine to check results of adjustment. Readjust if necessary by repeating steps 1 through 8. Install and lock seal wire to the inspection cover capscrews.

10. Maximum fuel delivery is correct for existing conditions when medium exhaust smoke is visible when the engine is loaded to maximum torque speed.

Pump Timing to Engine



Illust. 49. Pump timing marks.

The injection pump has a single scribe mark on the pump mounting flange (Illust. 49). For normal timing this mark is located midway between two scribe marks on the engine front cover plate. Movement of the pump flange mark between the two marks on the front plate gives a variation of three (3) degrees. In some cases the scribe marks are not clear, therefore, should it be necessary to remove the injection pump from the tractor it is recommended that all three scribe lines be marked clearly before the pump is removed.

EFFECTS OF PUMP TIMING AND ADJUSTMENTS

Normal pump timing and adjustment results in a compromise between engine noise, power, color of exhaust and fuel consumption. The following chart shows the results of normal setting as well as results of deviating from the normal setting.

Settings	Engine Noise	Fuel Consumption	Horse Power at Rated Speed	Maximum Torque (Horse Power)	Smoke (At Rated Speed)	Smoke (At Max. Torque Speed)
Pump Timing						
Normal	normal	normal	normal	normal	light	medium
Advance (1-1/2°)	increase	slight decrease	slight decrease	decrease	light	medium
Retard (1-1/2°)	decrease	slight increase	increase	increase	light	medium
Governor Linkage (Hook Rod)						
Normal	normal	normal	normal	normal	light	medium
Longer (1/32")	normal	slight increase	increase	increase	medium light	medium
Shorter (1/32")	normal	slight decrease	decrease	decrease	very light	medium light
Maximum Fuel						
Normal	normal	normal	normal	normal	light	medium
Increase (1/32")	normal	no effect at rated	normal	increase	light	black
Increase (1/32")	normal	increase at max. torque	normal	increase	light	black
Decrease (1/32")	normal	no effect at rated	normal	decrease	light	medium light
Decrease (1/32")	normal	decrease at max. torque	normal	decrease	light	medium light

ENGINE—PTO RATIO CHART

The following chart is a guide to assist servicemen in performing proper Pre-delivery and Testing service.

SPEEDS	B-275	TD-5	B-414	3414
Maximum Idle Speed				
Engine crankshaft	2000	2200	2200	2200
Power take-off	593	1077	600	600
Rated Speed				
Engine crankshaft	1900	2000	2000	2000
Power take-off	563	979	545	545
Maximum Torque Speed				
Engine crankshaft	1300	1300	1400	1400
Power take-off	385	636	382	382
Minimum Idle Speed				
Engine crankshaft	550	550	550	550
Power take-off	163	269	150	150

The following formulas may be used to calculate speeds other than those shown above.

B-275	TD-5	B-414 and 3414
$\frac{\text{Crankshaft speed} \times 16}{54}$ = PTO speed	$\frac{\text{Crankshaft Speed} \times 23}{47}$ = PTO speed	$\frac{\text{Crankshaft Speed} \times 15}{55}$ = PTO speed

TESTING

Transfer Pump Pressure

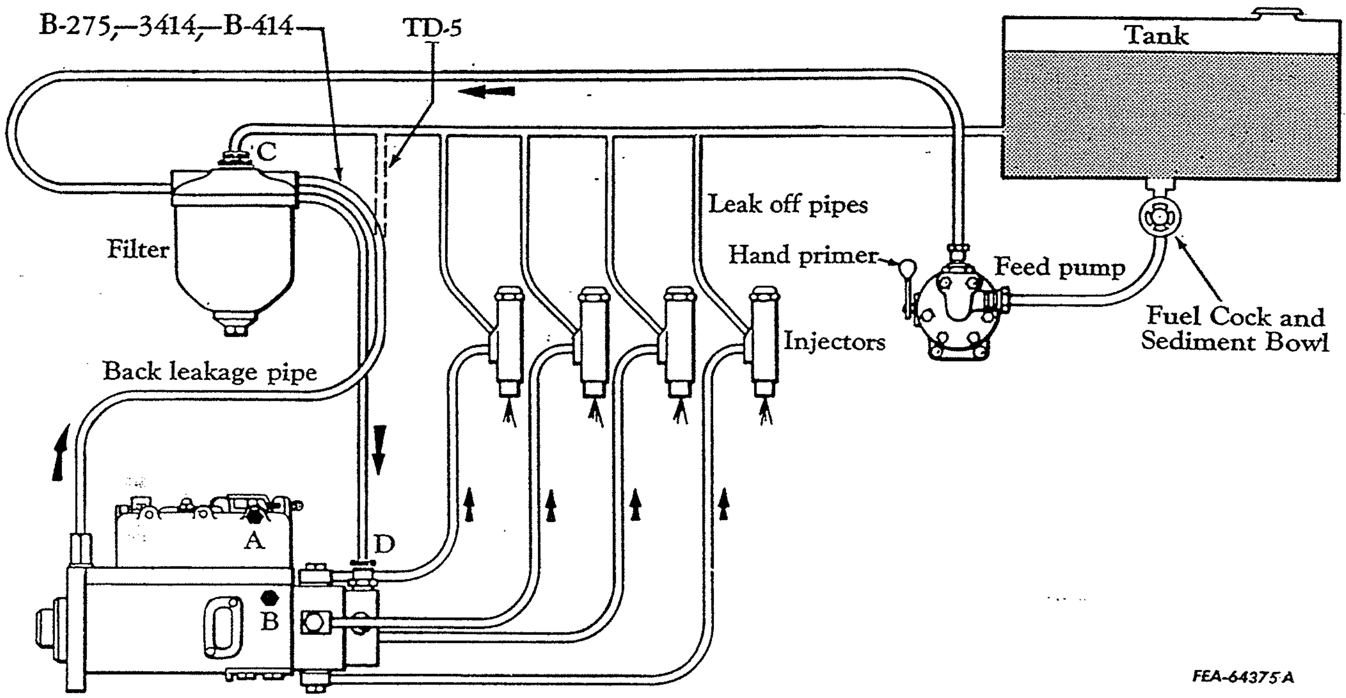
(Refer to Illust. 50.)

1. Remove the hydraulic head locking screw (with vent screw) "B" from injection pump housing.

2. Install adapter FES-4-16 with gasket and compound gauge. Vent air from pump before securing pressure gauge.

3. Vent governor cover at "A".

4. With hand throttle lever in low idle position and fuel shut-off lever in the off position, disengage engine clutch, crank engine and observe pressure reading on gauge. Specified pressure is a minimum of 5 psi.



Illust. 50. Fuel system schematic.

5. Leave hand lever in low idle position. Place fuel shut-off lever in run position. Start the engine and observe gauge reading. Specified reading is 16-39 psi.

6. Specified pressure at rated speed is 38-51 psi.

Feed Pump Static Pressure

1. Disconnect feed pump to filter fuel line at the feed pump.

2. Install adapter FES-4-15 with gaskets and low pressure gauge.

3. Vent fuel system. Refer to page 7.

4. Start and run engine for approximately one minute.

5. Stop the engine and observe static pressure reading on gauge. Specified pressure is 6-10 psi.

Transfer Pump Vacuum

This test to be performed only when transfer pump pressure test proves unsatisfactory.

1. Close the fuel cock at the fuel tank.

2. Remove the filter to transfer pump fuel line. Install a compound gauge and adapter FES-4-14 in the fuel inlet connection "D", (Illust. 1). Fuel line can be re-connected to filter for spill line.

3. With the hand throttle lever in the full throttle position and the fuel shut-off lever in the run position, disengage the engine clutch, start the engine and observe the reading on the gauge. A vacuum of 10-15 inches Hg. should be developed before engine stalls.

NOTE: Fuel system must be vented after completion of this test. Refer to page 7 for venting procedure.

NOZZLE SERVICE

Principles of Operation (Illusts. 51 and 52.)

The engine must receive each charge of fuel in such condition that it can be completely consumed. It is the function of the injection nozzle to meet this condition.

The injection nozzle is positioned in the cylinder head by the nozzle holder and injects fuel directly into the pre-combustion chamber. The pintle type nozzle has the desirable feature of being self-cleaning in action, which extends the injector service periods. The outer end of the valve is extended to form a pintle, the dimensions of which govern the spray form. The spray cone atomizes the diesel fuel, resulting in efficient combustion and maximum engine performance.

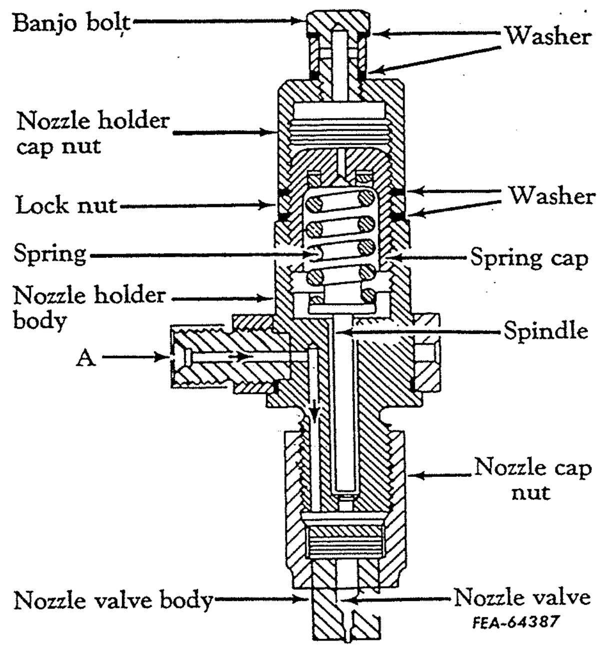
The pintle nozzle is closed after each injection.

An adjustable spring cap threaded into the nozzle holder body compresses the spring against the spindle which forces the nozzle valve against its seat in the nozzle valve body. This spring tension determines the opening pressure of the nozzle valve.

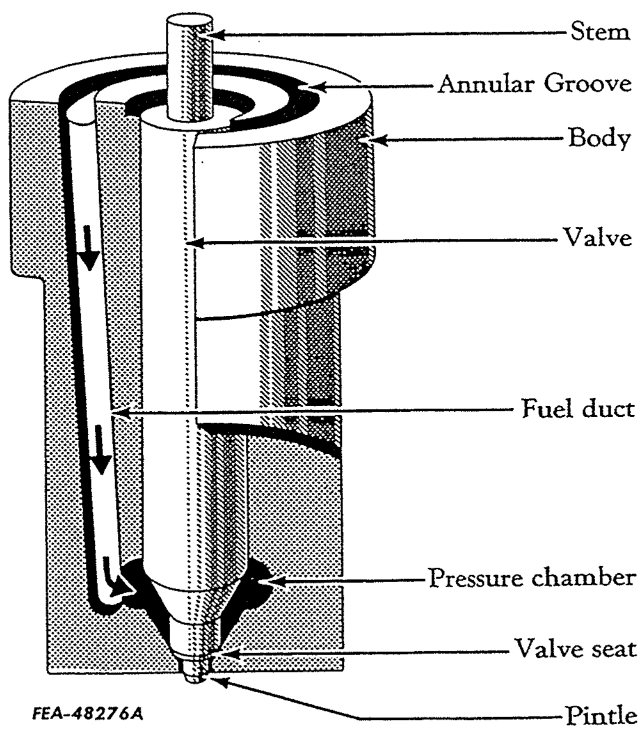
The lock nut secures the spring cap in its adjusted position.

The nozzle valve is precision lap fitted to the nozzle valve body. This close fit determines the back leakage of the nozzle valve and accurately guides the valve to its seat. The nozzle cap nut secures the nozzle valve body to the nozzle holder body.

The nozzle holder cap nut and banjo bolt receives and directs back leakage fuel to the return line. Copper washers provide a seal against fuel leakage and entry of foreign materials.



Illust. 51. Cross section of injection nozzle assembly.



Illust. 52. Cross section of injection nozzle.

Fuel is fed through the inlet connection "A" (Illust. 51) by way of drillings in the nozzle holder to the annular groove on the face of the nozzle body. The fuel is then fed through drillings in the nozzle body (fuel duct) to the pressure chamber just above the nozzle seat. The pressure of fuel from the injection pump, acting in the fuel already present in the annular groove, fuel duct and pressure chamber, exerts pressure on the nozzle valve, lifting it off its seat to allow fuel to be forced under high pressure into the pre-combustion chamber.

If the injection nozzle does not function properly, the fine adjustments and care given to the injection pump can be defeated at this stage of the fuel system.

Testing

NOTE: The isolating or check valve in the test equipment must be closed at all times except when taking pressure readings during the following tests. Sharp pressure fluctuations caused by pumping impose a high shock loading on the gauge mechanism.

CAUTION: When a nozzle is spraying during any of the following tests, the nozzle holder must be turned away from the operator. The spray has a very great penetrating power and the hands must not be brought into contact with it.

To be satisfactory a nozzle must have the following main characteristics.

1. Pressure tight seats.

2. Freedom from excessive back leakage.

3. Satisfactory spray form or atomization.

4. Correct opening pressure.

Before a nozzle is disassembled, it should be checked for the correct opening pressure range.. After reassembly and before installation, the nozzle opening pressure should again be checked.

NOTE: To obtain a true indication of nozzle performance during the following tests, the fuel used in the test must be pure and clean.

Connect the nozzle to suitable hand operated equipment, one type shown in Illust. 53 using two C-4 nuts and a C-2 adapter, from the Kiene tester. The gauge must record up to 2500 psi.

With the nozzle connected and the check valve closed, pump several times quickly to flush out the nozzle passages and seat. Normally this will remove any small particles trapped between the valve and seat that might impair the efficiency of the nozzle.

Opening Pressure Test

After flushing the nozzle, open the check valve, allow the pressure to escape. Then pump the handle to raise the pressure steadily and observe the gauge pressure at which the valve opens. The opening pressure should be 2350 to 2425 psi.

Illust. 53. Testing nozzle opening pressure.

Seat Leakage Test

To check the tightness of the seat, first atomize the nozzle two or three times. Open the check valve and wipe the nozzle dry. Pump up the pressure to within 150 psi below the opening pressure and hold for 10 seconds and examine the face for leakage. There should be no leakage, however, a slight dampness will be present at the orifice due to the capillary action of the fuel below the seat.

Atomization and Dispersion

To check the spray formation and atomization efficiency with the hand lever type of equipment, operate the hand lever slowly. The nozzle should buzz or chatter with an evenly distributed spray free from irregular streaks. The spray must not be solid or streaky, and it must issue squarely from the nozzle face. As mentioned previously, this type of check gives only an approximate indication of nozzle performance.

Back Leakage Test

The test specifications for used injection nozzles may vary for back leakage. To check the back leakage, pump up the pressure to above 1500 psi and record the time required for the pressure to drop from 1500 psi to 1100 psi. A nozzle in good condition should not lose this pressure in less than ten seconds at 60°F. At higher temperatures a lower figure may be obtained.

Observe that no leakage occurs at the lapped pressure faces of the nozzle holder and nozzle. Leakage may be external (visible at the nozzle cap nut screw thread) or internal. In the latter case, it cannot be readily distinguished from excessive leakage past the journal and guide of the valve. Do not overtighten the cap nut to correct leakage at the lapped joint. Instead, remove the nozzle and recheck the pressure faces for signs of dirt or surface imperfections. Clean thoroughly and retest. If the pressure drop time is still low, excessive leakage past the journal and guide of the valve is indicated.

NOTE: Before removing the nozzle holder from the test equipment, slowly release the fuel pressure to prevent damage to the gauge due to a sudden pressure drop.

Disassembly (Ref. No's. Refer to Illust. 54.)

Cleanliness cannot be overstressed when working on any part of the fuel injection system. The close tolerances maintained in pumps and nozzles are to ensure long life and efficient operation. They become adversely affected by the entry of minute particles of grit, metal, or soft material which prevents the valve and other parts from functioning properly. A work bench suitable for nozzle maintenance should be absolutely free from dust, dirt, metal filings, grease, and acids. Cotton waste and fluffy rags should not be used around this bench. It should be provided with a small vise, with the jaws protected and a dust proof drawer for holding special nozzle cleaning tools.

1. Install the nozzle in a vise. Clamp the retaining flange only, being sure not to damage or distort the holder.

2. Remove the nozzle holder cap nut (3), lock nut (5) and spring cap (6).

3. Remove the spring (7) and spindle (8).

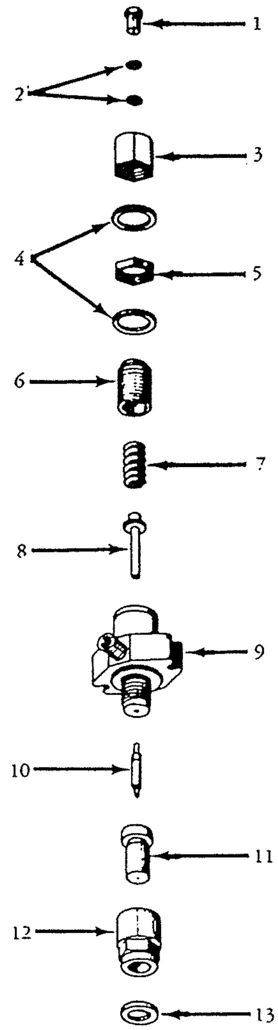
4. Remove the nozzle cap nut (12), nozzle valve body (11), and the nozzle valve (10) as an assembly.

5. Soak the nut, body and valve assembly in "Gunk" for several minutes to dissolve carbon and varnish.

6. Remove the valve from the valve body if it will slide out easily.

7. Remove the cap nut (12) from the body (11).

NOTE: If the valve body sticks to the cap nut, removal can be accomplished by additional soaking or by tapping the valve body from the nut using a plastic head hammer and driver (FES-5-4) as shown in Illust. 55. A wooden dowel or brass rod



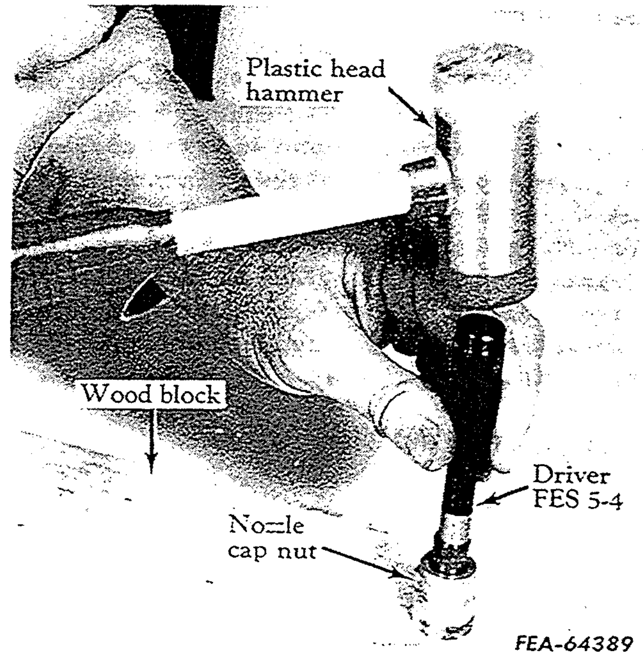
FEA-64388

Illust. 54. Exploded view of injection nozzle.

1. Banjo bolt.
2. Washer.
3. Nozzle holder cap nut.
4. Washer.
5. Lock nut.
6. Spring cap.
7. Spring.
8. Spindle.
9. Nozzle holder body.
10. Nozzle valve.
11. Nozzle valve body.
12. Nozzle cap nut.
13. Washer

with recessed end can be used in place of the driver shown.

8. Place the valve and valve body on a clean cloth in a pan of clean diesel fuel.

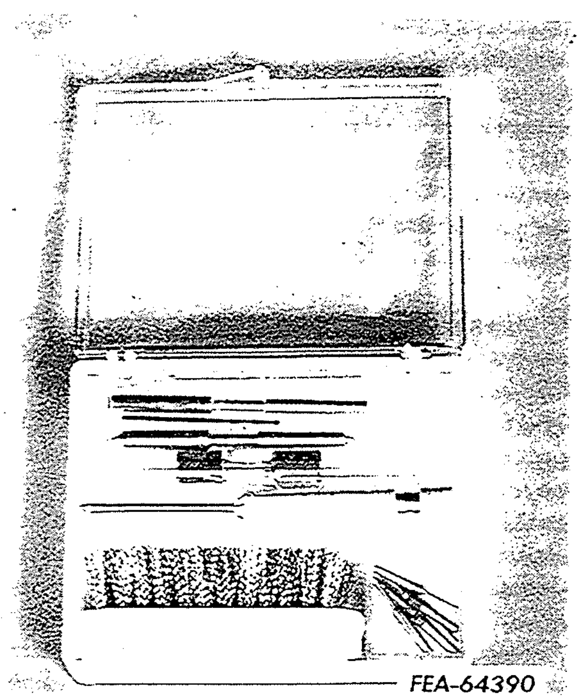


FEA-64389

Illust. 55. Driving valve body from nozzle cap nut.

Cleaning and Inspection

(Use Nozzle Cleaning Kit, Number FES-19-9.)

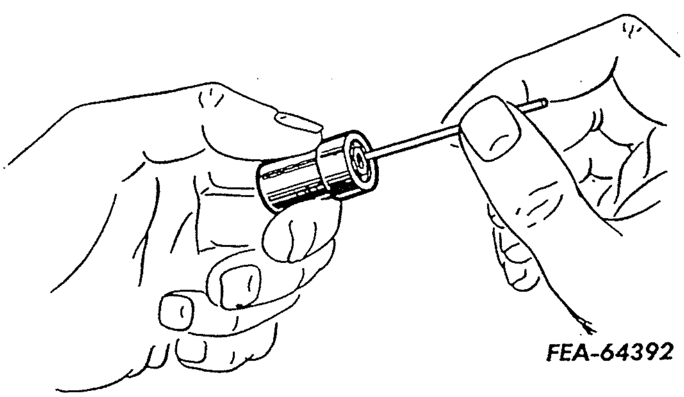


FEA-64390

Illust. 56. Nozzle cleaning kit.

Illust. 57. Cleaning and polishing valve body (orifice end).

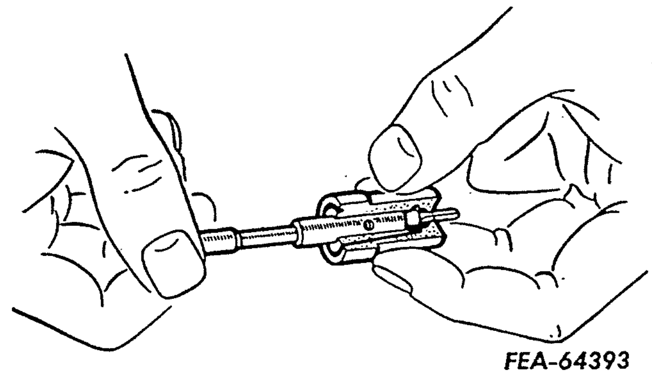
1. Rinse the pintle valve body in diesel fuel to remove gunk. Dip bristles of brass wire brush in diesel fuel. Brush valve body sufficiently to clean and polish it. (Illust. 57.) Particular attention is directed to the orifice end. Rinse in diesel fuel.



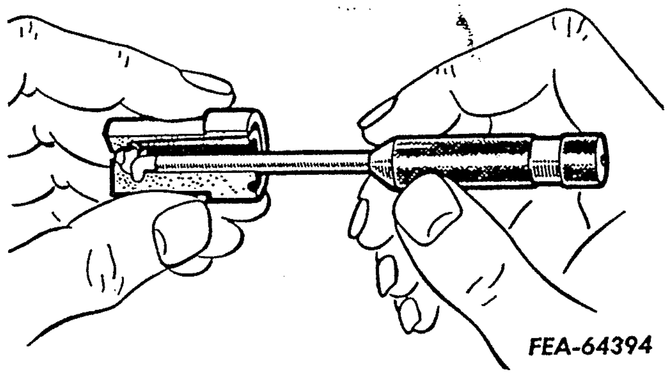
Illust. 58. Drill cleaning of fuel duct.

2. Clean the nozzle valve body bores with the drill provided in the Nozzle Cleaning Kit. These bores seldom become blocked. Rinse in diesel fuel. (See Illust. 58.)

3. Clean orifice in valve body using probe and holder as shown in Illust. 59. Turn holder and probe in a rotary motion until orifice is clean. Rinse in diesel fuel.

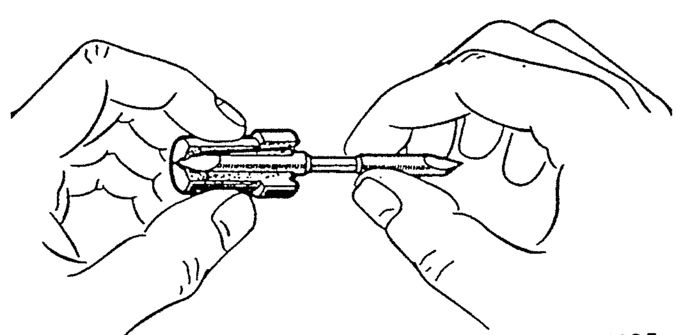


Illust. 59. Cleaning pintle orifice in valve body.



Illust. 60. Cleaning fuel pressure chamber.

4. Insert pressure chamber groove scraper into position as shown in Illust. 60. Press scraper against inside of valve body and rotate to remove carbon. Rinse in diesel fuel.

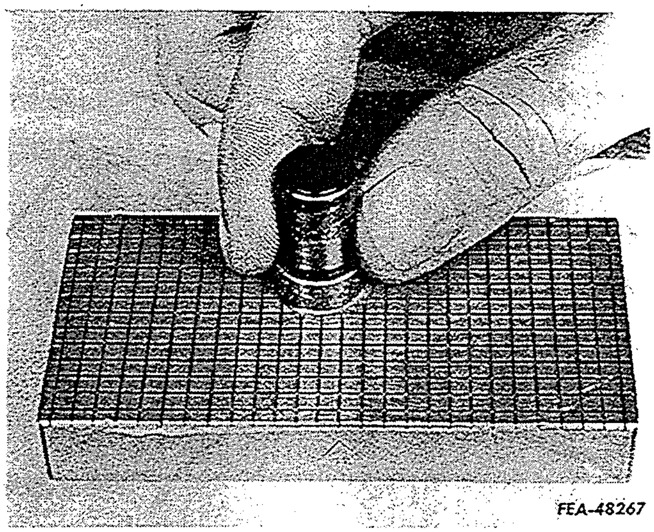


Illust. 61. Cleaning valve seat in valve body.

5. Insert seat cleaning tool against seat in valve body as shown in Illust. 61 and rotate to remove carbon. Rinse in diesel fuel.

6. If the upper end of the valve body and the lower end of the nozzle holder body require additional service to provide proper sealing proceed as follows:

(a) Use lapping plate No. FES-19-1 coated with mutton tallow.



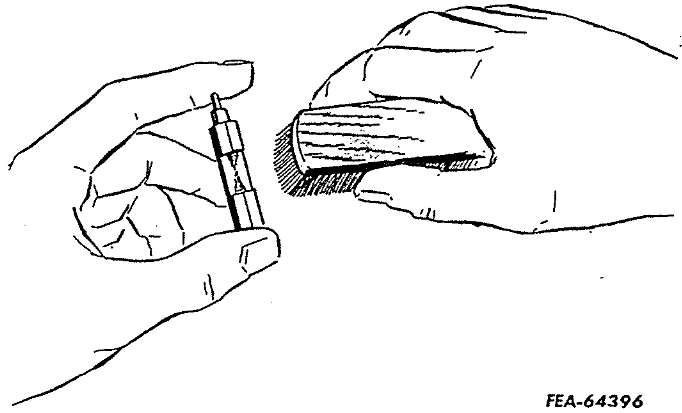
FEA-48267

Illust. 62. Cleaning the lapped surface of the nozzle body.

(b) Place the lapped surface of the valve body on the lapping plate as shown in Illust. 62, and move in a circular motion being careful to hold even pressure on the valve body so that the entire surface will make contact. This cleaning operation will remove carbon or discoloration and leave a mirror finish. Scratches, nicks or pitting cannot be removed and may cause leakage.

(c) The nozzle holder body can be lapped as described in step (b).

7. Dip the valve and valve holder tool in clean diesel fuel. Slide the valve into the holder tool and remove carbon from



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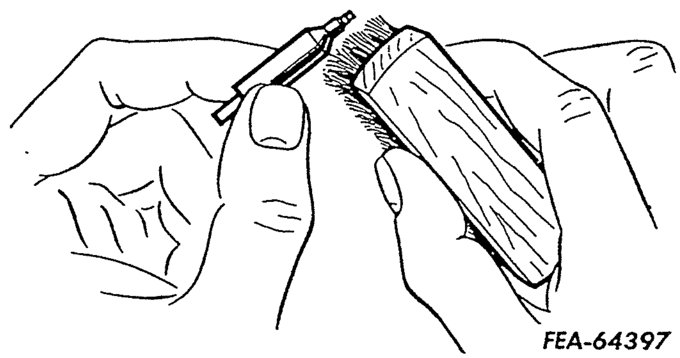
Illust. 63. Removing carbon from valve.

the valve by brushing it with the brass wire brush. Rotate the valve in the holder while brushing until the entire pintle and seat on the valve is free of carbon.



FEA-64397

Illust. 64. Cleaning and polishing valve and pintle.

8. Dip the valve and brass wire brush in diesel fuel. Gently polish the valve and pintle as shown in Illust. 64. It is important to be extremely careful with the valve and pintle to prevent damage. A scratch or burr may cause valve leakage or spray distortion. Clean in diesel fuel.

9. If additional cleaning and polishing of the valve and valve seat is required, proceed as follows:

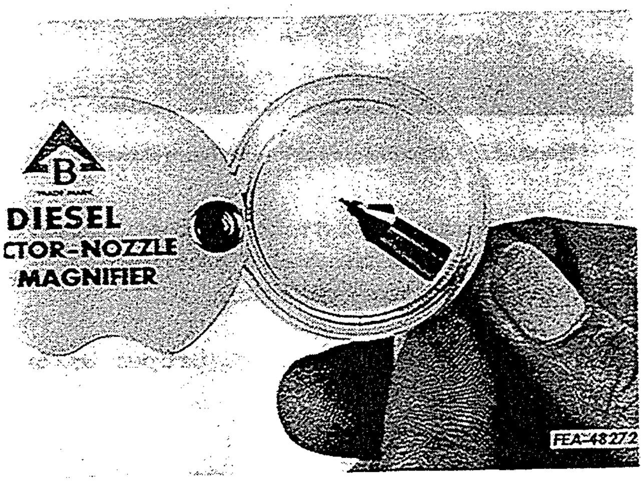
(a) Apply a very small amount of No. 400 lapping compound to the valve or seat.

(b) Insert the valve into the body against the seat.

(c) Rotate the valve against the seat while applying very light pressure.

NOTE: Be sure to keep lapping compound away from the pintle. Any lapping action to the pintle will destroy its fit.

(d) Remove the valve and thoroughly wash both parts in diesel fuel to remove all compound.

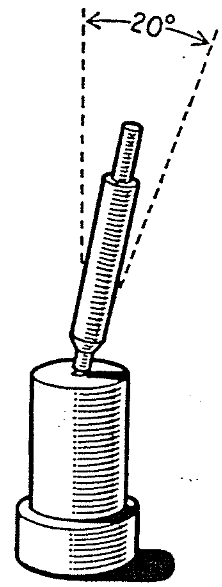


Illust. 65. Inspecting the nozzle under a magnifier.

10. Inspect the nozzle valve seat under a good magnifying glass for indication of a damaged seat. See Illust. 65. Check the lapped surface of the valve for scoring and scratches. If the valve seat is damaged the nozzle should be replaced. If the valve is satisfactory, place it on a clean cloth in a pan of clean diesel fuel.

11. Examine the fit of the nozzle valve stem to the guide bore in the nozzle valve holder.

NOTE: A good fit is essential as the clearance governs the degree of back leakage. The needle must be able to move freely yet not permit excessive back leakage. Too close a fit can result in seizure.



Illust. 66. Checking wear and alignment of the valve pintle.

Examine the clearance between the pintle and the spray hole. With the valve stem removed, reversed, and the pintle inserted into the spray hole, it should not tilt at greater than 20° from the axis of the spray bore.

If the nozzles meet the above inspection requirements, the nozzles can be reassembled.

Reassembly

Assemble the nozzle valve holder and nozzle valve after immersing in No. 2 diesel fuel to the nozzle holder body. Tighten the nozzle cap nut to a torque of 50 foot-pounds. Be careful not to overtighten as this may cause distortion and needle seizure.

Install the spindle assembly (8), spring (7), spring cap (6), new copper washer (4) and lock nut (5). See Illust. 54.

Adjustments and Final Testing

1. Connect the nozzle to the hand operated test pump as previously described.

2. Start with the spring cap screwed well out.

3. Thoroughly flush the nozzle assembly.

4. Slowly increase the opening pressure by screwing the spring cap clockwise while continuing the flushing. (Illust. 67.) This gradual buildup, to the specified opening pressure, aids in establishing a good sealing surface.

5. If the opening pressure is satisfactory, check the seat leakage, atomization and dispersion, and back leakage as previously described in the initial testing.

6. If the nozzle proves satisfactory complete the assembly by installing a new washer and nozzle holder cap nut.

Illust. 67. Adjusting nozzle opening pressure.

7. If the nozzle is to be stored, smear the orifice end of the valve body lightly with vaseline before packing.

8. Refer to GSS-1242 for proper installation of the nozzles.

SERVICE BULLETIN RECORD

Important: Information in this manual section is subject to change or supplementing from time to time as a result of field experience and engineering modifications. As Service Bulletins are received, record them on this page for handy reference whenever this manual is to be used... Print entries in ink.

Bulletin No.	Date Issued	Book No.	Topic or part of machine involved.

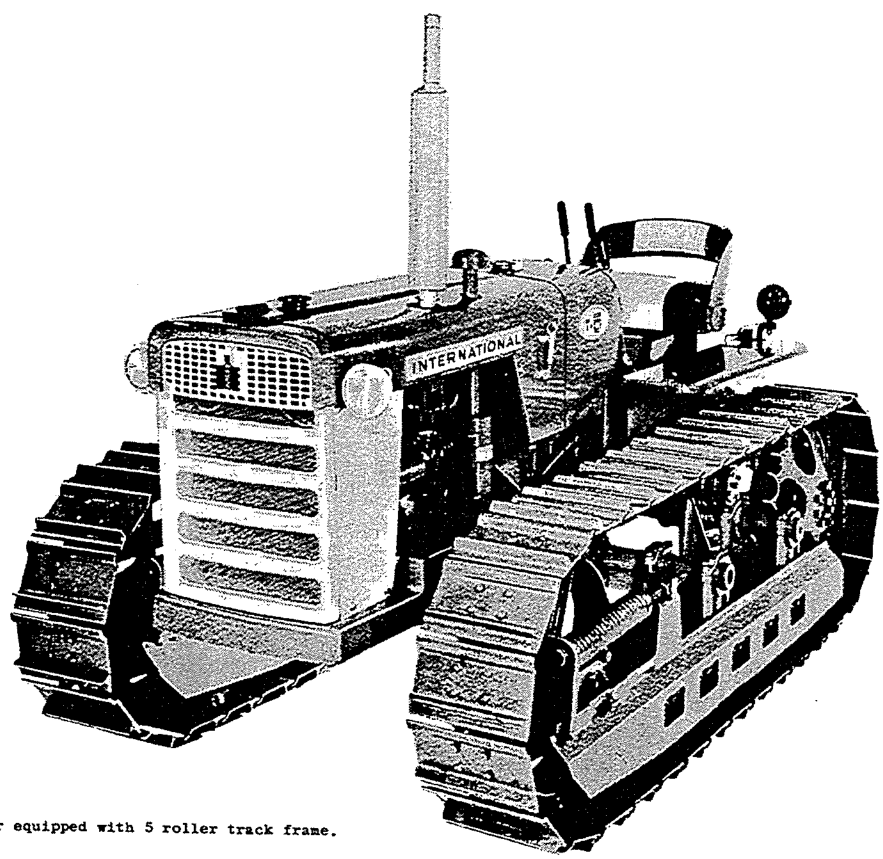
Specifications

Chassis: T4, T5 and TD5 Tractors
Engines: C 123, C 135 and BD 144-C

Form GSS-1231

File in Tractor Service Manual Binder

CONTENTS:



Illust. 1. T5 tractor equipped with 5 roller track frame.

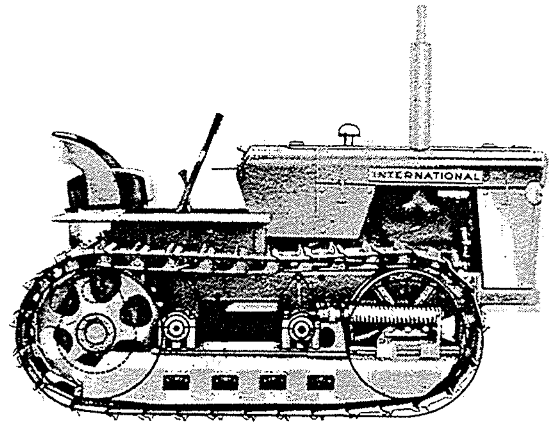
GENERAL INFORMATION

The T4, T5 and TD5 tractors are small, rugged crawler tractors designed to meet the requirements of the farmer or contractor who requires this type of power for his particular operation.

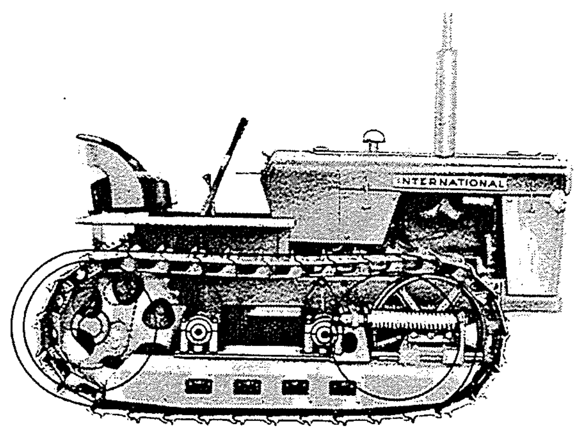
The frame consists of a casting which houses the transmission, bevel gear and pinion. Channel members extending forward from this housing constitute the middle and forward section of the frame. The engines are mounted on these channel members. The track frames are of the rigid type, secured to the channel members in such a manner that they may be moved forward or back from their normal position, thereby making the tractor particularly adaptable to front or rear mounted equipment. The front idler may be lowered from its normal position to bring the track in contact with the ground at that point. An extended 5 roller track frame is also available. Tractors are available with three track gauges, and a selection of pads and grousers of different widths and types.

The tractors are of basically simple design which lends to ease of servicing. Features such as torque amplifier, reverser and power take-off are the same in principle and design as are used on wheel tractors. No special tool equipment is required for servicing. If the tractor is equipped with torque amplifier, the same set of tools, ED3291-A used on wheel tractors will serve the crawler tractors as well.

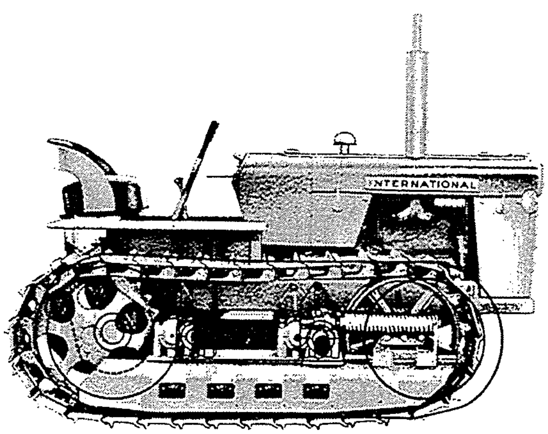
The main clutch and the service brake are foot operated. Steering is effected by individual clutches in the final drives. The clutches as well as the steering brakes are operated by the steering levers.



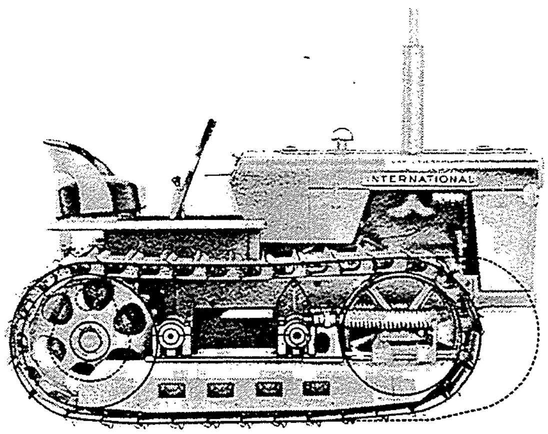
Illust. 2. Four roller track frame in normal position. The lines indicate the outline of the track with the front idler lowered.



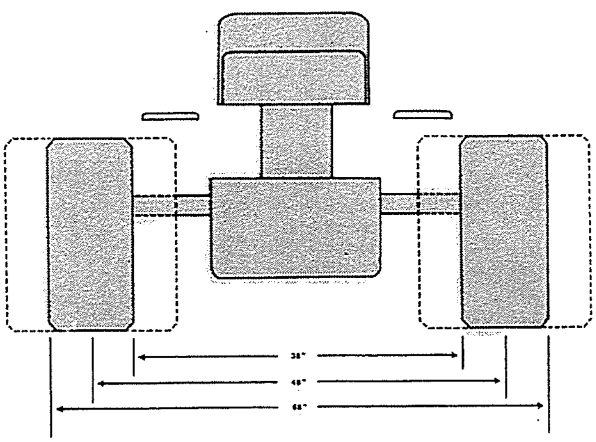
Illust. 3. Lines indicate position of the track in relation to normal, with track frame moved to the rear position.



Illust. 4. Lines indicate position of the track in relation to normal, with track frame moved to the front position.



Illust. 5. Lines indicate the position of the track in relation to normal, with the extended (five roller) track frame.



Illust. 6. Three different gauge widths are available.

Steering

Steering is accomplished by multiple disc clutches located in the main frame housing. Individual track brakes are of the external contracting band type, actuated by the steering levers. When properly adjusted, pulling the steering lever back half way will disengage the steering clutch. If the steering lever is pulled back further, the brake will apply to that side effecting a pivot turn.

Transmission

A sliding spur gear transmission is used in each tractor which provides five forward speeds and one reverse. If torque amplifier is also used, the speeds are doubled, hence ten speeds forward and two reverse.

A full reverse transmission is available. The full reverse mechanism is installed in the space the torque amplifier is also mounted in. Therefore the application of the full reverse transmission is limited to tractors not equipped with T.A.

Hitch

A swinging draw bar is regular equipment on all three model tractors. A three point hydraulically controlled hitch is available which enables the use of three point category 1. mounted implements. Types of allied equipment are available which will adapt to this hitch as well. The three point hitch may be used without removing the regular draw bar, therefore tractors so equipped may be used for either draw bar work or three point implement mounting without any changing or removing hitch parts.

Power Take-Off

Power take-off is available in standard transmission; transmission type and constant running PTO. With standard transmission and transmission type power take-off, the PTO operates only when the main clutch is engaged. It is necessary to stop the motion of the tractor in order to stop, or start the PTO. However, the operator can, by pulling both steering levers back, stop forward (or reverse) motion without effecting the drive to the transmission and thus the PTO will continue to run. This provides a type of live power takeoff.

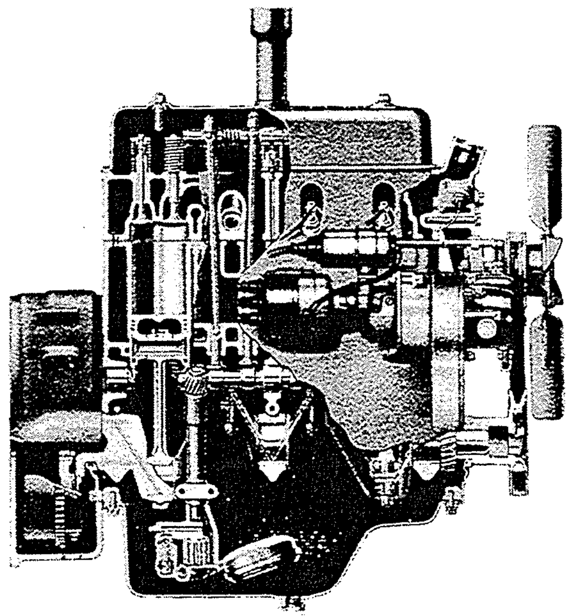
Power Take-Off Cont'd

Constant running power take-off is provided by a two stage clutch in the flywheel. The first stage of this clutch operates the transmission. The second by means of a hollow shaft running outside the transmission drive shaft, drives the PTO. This feature is limited to tractors equipped with Torque Amplifier or Reverser. The single foot operated clutch pedal operates both of these clutches in two different stages. The first 1/2" of clutch pedal movement disengages the transmission drive clutch, enabling the operator to stop, start, and shift gears. If the clutch pedal is depressed further the clutch operating the PTO is also disengaged. It is therefore possible to stop and start the forward (or reverse) motion of the tractor, and also shift gears without stopping a PTO driven machine. It will however be necessary to stop the motion of the tractor to stop or start the PTO.

It will be noted that these two types of PTO are NOT independent as are the PTO's on wheel tractors such as the 340, 460, 560 etc. In the case of IPTO, stopping and starting forward (or reverse) motion of the tractor, and shifting gears is completely independent of the PTO. Either PTO starting and stopping or, tractor motion and gear shifting may be done without regard for one another.

T4 & T5 Engines, Carbureted

T4 and T5 tractors are equipped with C-123 and C-135 engines respectively. Both of these engines are four cylinder, wet sleeve, valve in head engines. The primary difference in them is cylinder bore and stroke. Each is equipped with an up-draft carburetor, battery ignition, and a variable speed mechanical type governor.



Illust. 7. Engines as used in the T4 and T5 crawler tractors.

ENGINE SPECIFICATIONS

Tractor Model	T4	T5
Engine Model	C-123	C-135
No. of Cylinders	4	4
Flywheel H.P.	34.0	40
Type	4 Cycle	4 Cycle
Fuel	Gasoline	Gasoline
Cylinder type	Wet Sleeve	Wet Sleeve
Cylinder diameter	3-1/8"	3-1/4"
Stroke	4"	4-1/16"
Piston displacement	123 cu. in.	135 cu. in.
Compression ratio	6.8 to 1	7.4 to 1
Compression pressure (cranking motor at sea level)	160	175
Firing order	1-3-4-2	1-3-4-2
Engine Speeds		
Low idle	425 approx.	425 approx.
High idle	2200 "	2200 "
Rated load	2000 "	2000 "

Cylinder Head

Valve Guides	Replaceable cast iron	Replaceable cast iron
Length	2-11/16"	2-11/16"
Inside diameter	.343 - .344"	.343 - .344"
Valve Seats		
Replaceable inserts	No	No
Seat angle	44-1/2° from vertical	44-1/2° from vertical
Seat width, intake	5/64"	5/64"
exhaust	5/64"	5/64"
VALVES		
Face angle	45°	45°
Stem diameter, intake	.3405" - .3415	.3405" - .3415
Stem diameter, exhaust	.3405" - .3415	.3405" - .3415
Stem clearance in guide, intake	.0015" - .0035	.0015" - .0035
Stem clearance in guide, exhaust	.0015" - .0035	.0015" - .0035
VALVE SPRINGS		
Without Rotor, Exhaust & Intake		
No. of coils	11	11
Free length	2-47/64	2-47/64
Test length	2"	2"
Test pressure	34 - 38 lbs.	34 - 38 lbs.
Exhaust - with Rotors		
No. of coils	10.3	10.3
Free length	2-1/4	2-1/4
Test length	1-27/32	1-27/32
Test pressure	34 - 38 lbs.	34 - 38 lbs.
VALVE LEVERS		
Tappet clearance, engine hot	.014"	.014"
Rocker shaft diameter	3/4"	3/4"
Clearance on shaft	.002" - .004	.002" - .004

VALVE TIMING	T4	T5
Intake opens before TDC	15°	15°
Intake closes after BDC	45°	45°
Exhaust opens before BDC	45°	45°
Exhaust closes after TDC	10°	10°

Camshaft and Bearings

Drive	Helical gears	Helical gears
Backlash in drive gears	.003" - .006	.003" - .006
Cam lobe lift	.240 ± .002	.240 ± .002
Journal diameter		
Front	1.811 - 1.812"	1.811 - 1.812"
Second	1.577 - 1.578"	1.577 - 1.578"
Third	1.499 - 1.500"	1.499 - 1.500"
Bearings		
Bearing clearance	.0015 - .0040"	.0015 - .0040"
Thrust taken by	thrust plate	thrust plate
End clearance	.003 - .012"	.003 - .012"

Tappets

Diameter	9/16"	9/16"
Length	2-5/16"	2-5/16"
Clearance on bore	.0005 - .003"	.0005 - .003"

Cylinder Sleeves

Type	Wet	Wet
Height above crankcase	.000 - .006"	.000 - .006"

Piston

Piston material	Aluminum alloy	Aluminum alloy
Clearance in sleeve (taken at skirt) 90° from pin	.0011 - .0019"	.0011 - .0019"
Piston pin type	Full floating	Full floating
Pin diameter	59/64"	55/64"
Pin length	2.483 - 2.493"	2.738 - 2.753"
Pin clearance in rod	.0003 - .0008"	.0002 - .0006"
Pin clearance in piston (with pin at 70°F. and piston at 160 - 180°F.	.0000 - .0005"	.0000 - .0005"

PISTON RINGS

Top compression ring, width	.0930 - .0935"	.0930 - .0935"
gap	.010 - .020"	.010 - .020"
Clearance in groove	.003 - .0045"	.003 - .0045"
Second compression ring, width	.093 - .0935"	.093 - .0935"
gap	.010 - .020"	.010 - .020"
Clearance in groove	.0015 - .003"	.0015 - .003"
Oil ring, width	.2485 - .249"	.186 - .1865"
gap	.010 - .020"	.010 - .018"
Clearance in groove	.0015 - .003"	.0015 - .003"

Engine Cont'd

Connecting Rods

	T4	T5
Type	"I" Beam	"I" Beam
Bolt Size	3/8 x 2-5/16 UNF	3/8 x 2-5/16 UNF
Bearing type	Precision	Precision
Clearance, bearing on journal	.0009 - .0034"	.0009 - .0039"
Bearing end clearance	.005 - .014"	.005 - .014"

Crankshaft

No. of main journals	3	3
Main journal diameter	2.124 - 2.125"	2.244 - 2.245"
Crank pin diameter	1.749 - 1.750"	1.809 - 1.810"
Main bearing type	Precision	Precision
Main bearing clearance	.0009 - .0039"	.0009 - .0039"
Thrust bearing location	Rear main bearing	Rear main bearing
Thrust bearing, end clearance	.006 - .010"	.006 - .010"

Lubrication System

Oil pump type	Spur gear	Spur gear
Screen	Floating	Floating
Drive from	Camshaft	Camshaft
Clearance between body and drive pinion	.030"	.030"
End clearance of gears	.0035 - .0065"	.0035 - .0065"
Gear to body clearance	.007 - .013"	.007 - .013"
Pump shaft diameter	1/2"	1/2"
Shaft clearance in bore	.001 - .0025"	.001 - .0025"
Body gear backlash	.003 - .006"	.003 - .006"
Idler gear running clearance on shaft	.0015 - .0035	.0015 - .0035

OIL FILTER

Type	Metered flow	Metered flow
Element	Radial fin	Radial fin
Element material	Treated paper	Treated paper

PRESSURE REGULATING VALVE

Location	In pump body	In pump body
Valve clearance in bore	.003 - .007	.003 - .007
Valve diameter	.745 - .743	.745 - .743
Regulating valve spring		
Length	2-13/32"	2-13/32"
Test load	24 lbs.	24 lbs.
Test length	1-11/16"	1-11/16
Oil pressure at 1800 R.P.M.	45 - 55 lbs.	45 - 55 lbs.

Fuel System (Carbureted)

Type	Updraft	Updraft
Size	7/8"	7/8"
Make	Zenith	Zenith

Zenith Carburetor	T4	T5
Float height (bottom of float to bottom of throttle body)	1-5/32"	1-5/32"
Venturi Number	16	17
Main jet size	.041	.049
Main jet number	.21	.25L
Discharge nozzle size	40 (.100")	40 (.100")
Discharge nozzle number	50	50
External adjustments	Idle mixture and speed	Idle mixture and speed

Governor

Type	Mechanical Variable speed	Mechanical Variable speed
External adjustments	High idle Anti-surge	High idle Anti-surge

Air Cleaner

Type	Oil bath	Oil bath
Oil cup capacity	7/8 pint (approx.)	7/8 pint (approx.)
Type of Oil	Engine Oil	Engine Oil

Cooling System

General

Type of system	Liquid	Liquid
Coolant circulation	Centrifugal pump	Centrifugal pump
Capacity of system	2.5 gallons	2.5 gallons

Coolant Pump

Drive	Belt	Belt
Shaft bearing lubrication	Sealed	Sealed
Shaft seal type	Packless	Packless

Radiator

Type	Flat tube	Flat tube
Core	Integral	Integral
Cap	Pressure, 4 lbs.	Pressure 4 lbs.

Thermostat

Starts to open at	165° F.	165° F.
Wide open at	195° F.	195° F.

Torque Data

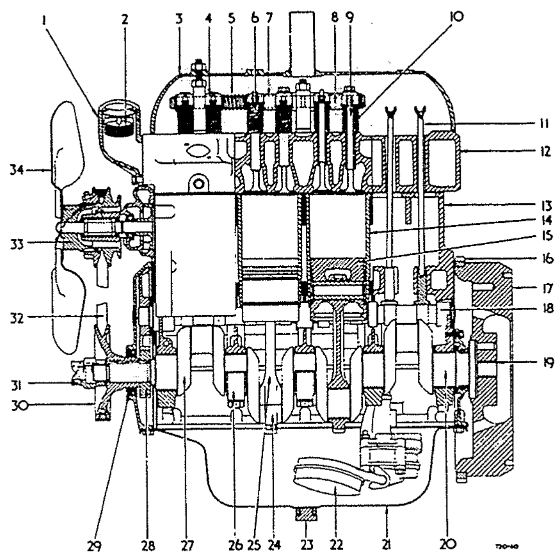
Cylinder head bolts	65 ft. lbs.	65 ft. lbs.
Connecting rod bolts	45 ft. lbs.	45 ft. lbs.
Main bearing bolts	75 ft. lbs.	75 ft. lbs.
Manifold studs	30 ft. lbs.	30 ft. lbs.
Tappet adjusting screw nut	20 - 25 ft. lbs.	20 - 25 ft. lbs.

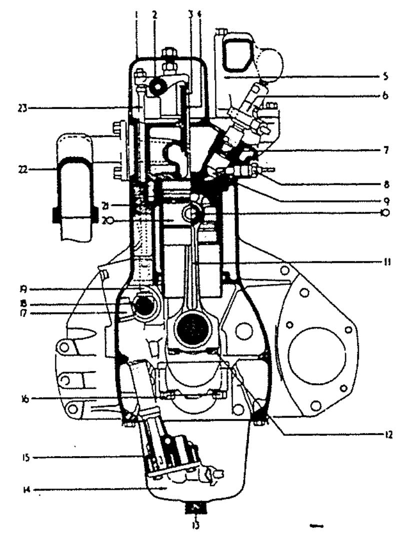
ENGINE SPECIFICATIONS TD5

TD5 Engine, Diesel

The TD5 tractor is equipped with BD-144-C four cylinder, valve in head diesel engine. Pintle type nozzles inject the fuel into a pre combustion chamber. The fuel pump is CAV four plunger with mechanical governor.

Starting is accomplished by the use of glow plugs which enter directly into the pre combustion chamber of each cylinder. The crankshaft is carried on five precision type main bearings. The rear main bearing also serves as a thrust bearing.





Illust. 8. BD-144-C engine, used in the TD5 crawler tractor.

Longitudinal Section of the Engine

1. Thermostat Housing
2. Thermostat
3. Valve Housing Cover
4. Valve Lever
5. Valve Lever Spring
6. Valve Spring
7. Valve Lever Spacer
8. Valve Lever Shaft
9. Valve
10. Valve Guide
11. Valve Push Rod
12. Cylinder Head
13. Crankcase
14. Cylinder Sleeve
15. Piston
16. Flywheel Ring Gear
17. Flywheel
18. Camshaft
19. Clutch Pilot Bearing
20. Crankchaft Rear Main Bearing
21. Crankcase Pan
22. Lubricating Oil Pump Screen
23. Crankcase Pan Drain Plug
24. Connecting Rod Bearing Cap
25. Connecting Rod
26. Crankshaft Main Bearing Cap
27. Crankshaft
28. Crankshaft Gear
29. Crankshaft Front Oil Seal
30. Fan Drive Pulley
31. Starting Crank Nut
32. Fan Belt
33. Water Pump
34. Fan

End Section of the Engine.

1. Valve Housing Cover
2. Valve Lever Shaft
3. Valve Spring
4. Valve Guide
5. Intake Manifold
6. Injection Nozzle Holder
7. Injection Nozzle
8. Glow Plug
9. Pre-combustion Chambers
10. Piston Pin
11. Connecting Rod
12. Connecting Rod Bearing Cap screws
13. Crankcase Pan Drain Plug
14. Crankcase Pan
15. Lubricating Oil Pump
16. Crankshaft Bearing Cap Screw
17. Lubricating Oil Pump Drive Pinion
18. Camshaft
19. Tappet
20. Piston
21. Cylinder Sleeve
22. Exhaust Manifold
23. Push Rod

Tractor Model	TD5
Engine Model	BD 144-C
No. of Cylinders	4
Flywheel H.P.	37.0
Type of cylinder	Wet Sleeve
Cylinder diameter	3-3/8"
Length of stroke	4"
Total displacement	144 cu. in.
Compression ratio	19.3 to 1
Compression pressure at 1750 R.P.M.	475 - 525 lbs. □"
Firing order	1-3-4-2
Engine Speeds	
Low idle	500 R.P.M.
High idle	2150 R.P.M.
Rated R.P.M.	2000 R.P.M.

Cylinder Head

Valve Guides	
Intake	
Length	3-1/4"
Inside diameter	.344 - .345"
Set height of guide (top of head)	15/16"
Exhaust	
Length	3"
Inside diameter	.344 - .345"
Set height (top of head)	15/16"
Valve Seats	
Replaceable inserts	No
Seat angle, intake and exhaust	45°
Valves, Intake	
Stem diameter	.341 - .342"
Stem clearance in guide	.002 - .004"
Valve face angle	45°
Valves, Exhaust	
Stem diameter	.341 - .342"
Stem clearance in guide	.002 - .004"
Valve face angle	45°
Valve Springs, Intake and Exhaust	
Outside diameter	.993 - 1.00"
Free length	2-17/32 $\pm$ 3/64"
Test length	1.43/64"
Test load	40 - 45 lbs.
Valve Levers	
Tappet clearance	.020"
Rocker shaft diameter	.748 - .749"
Valve lever bushing (replaceable) diameter (inside)	.751 - .752
Valve lever running clearance on shaft	.002 - .004"
Valve Timing	
Intake opens before TDC	10°
Intake closes after BDC	42°
Exhaust opens before BDC	42°
Exhaust closes after TDC	10°

Camshaft and Bearings

Drive	Helical gears
Backlash of gears	.0011 - .0045"
Cam lobe lift	.190 $\pm$ .005"
Journal diameter	
Front	1.811 - 1.812"
Second	1.577 - 1.578"
Third	1.499 - 1.500"
Bearing clearance	.0015 - .0035"
End clearance	.008 - .017"

Timing Gears

Backlash	.0011 - .0045"
Idler gear to shaft clearance	.001 - .0023"

Tappets

Diameter	1.00"
Length	2-5/16"
Tappet clearance in bore	.0005 - .003"

Cylinder Sleeves

Type	Wet
Diameter, inside	3.375 - 3.3762"
Length	7-1/16"
Height above crankcase	.003 - .007"

NOTE: Sleeve must not be less than .003" above top surface of crankcase.

Piston

Material	Aluminum Alloy or Die Cast
Length overall	3.897"
Skirt clearance bottom (measured 90° from pin hole)	.0048 - .0056
Number of rings per piston	3 or 5
Width of ring grooves	
Compression - top	.0963 - .0969"
Compression - 2nd	.0967 - .0973"
Compression - 3rd	.0959 - .0965"
Scraper - 4th	.1877 - .1883"
Scraper - 5th	.1877 - .1883"
Ring gaps	
Compression - top	.012 - .018"
Compression - 2nd	.012 - .018"
Compression - 3rd	.012 - .018"
Scraper - 4th	.015 - .045"
Scraper - 5th	.012 - .018"
Ring clearance in groove	
Compression rings - top	.0028 - .0039"
2nd	.0032 - .0043"
3rd	.0024 - .0035"
Oil control rings	.0012 - .0023"
Piston pins	
Length	2.898 - 2.902"
Diameter	1.1023 - 1.1021"
Pin clearance in piston (with pin at 70°F. and piston at 160 - 180°)	.0002 - .0004"

Connecting Rods

Type	"I" Beam
Length	2"
Diameter	3/8"
Bushing (bore)	1.1028 - 1.1031"

Crankshaft

No. of main journals	5
Main journal diameter	2.124 - 2.125"
Crank pin diameter	1.749 - 1.750"
Main bearing type	Precision
Main bearing clearance	.0011 - .0041"
Thrust bearing location	Rear main bearing
End clearance	.004 - .008"

Lubrication System

Oil pump type	Spur gear
Screen	Floating
Drive from	Camshaft
Clearance between body and drive pinion	.002 - .004"
End clearance of gears	.0035 - .006"
Gear to body clearance	.0053 - .0083"
Pump shaft diameter	.4945 - .4955"
Shaft clearance in bore	.001 - .0035"
Body gear backlash	.003 - .006"
Idler gear running clearance on shaft	.0053 - .0083"

OIL FILTER

Type	Full Flow
Element	Radial fin
Element material	Treated paper

PRESSURE REGULATING VALVE

Location	In pump body
Regulating valve spring	
Length	2-11/32"
Test load	3.7 lbs.
Test length	1.92"
Oil pressure at 1800 R.P.M.	25 - 35 lbs.

Torque Data

Cylinder head bolts	75 - 80 foot lbs.
Connecting rod bolts	30 - 35 foot lbs.
Main bearing bolts	70 - 75 foot lbs.
Flywheel bolts	40 - 45 foot lbs.
Manifold stud nuts	25 - 30 foot lbs.
Nozzle body stud nuts	30 - 35 foot lbs.
Crankshaft pulley nut	225 - 250 foot lbs.
Tappet adjusting screw nut	20 - 25 foot lbs.
Lubricating oil filter case to base bolt	10 foot lbs.

Fuel System

Injection pump	
Make	C.A.V.
Model	BPE 4A 70 R 320S 6393
Type	Solid fuel injection
Pump speed	1/2 crankshaft
Drive	From crankshaft pinion through idler gear
Pump rotation (viewed from drive end)	Clockwise
Transfer pump	
Type	Plunger
Pressure	8 - 10 lbs.
Governor	
Make	C.A.V.
Type	Mechanical

Nozzles	
Type	Pintel
Make	C.A.V.
Opening pressure	2150 - 2200 lbs.
Pintel back leakage	Pressure drop from 2200 lbs. to 1450 lbs. in less than 6 seconds

No face leakage for 10 seconds at 2000 lbs. pressure.

Fuel Filter	
Number used	1
Element	Radial fin
Element material	Treated paper

Air Cleaner

Type	Oil bath
Oil cup capacity	1 Imp. pint
Type of Oil	Engine Oil

Cooling System

General	
Type system	Liquid
Coolant circulation	Centrifugal pump
Capacity of system	2-1/4 imperial gallons
Coolant pump	
Drive	Belt
Shaft bearing lubrication	Sealed
Shaft seal, type	Packless
Radiator	
Type	Fin and flat tube
Core	Integral
Cap	Pressure - 4 lbs.
Thermostat	
Starts to open at	175° F.
Wide open at	190° F.
Radiator hose connections	
Radiator end, inside diameter	1-3/4"
outside diameter	1-7/8"
Thermostat end, inside diameter	2-1/2"
Radiator outlet, inside diameter	1-3/8"
outside diameter	1-3/4"
Fan	
Type	Suction
Number of blades	4
Drains, two	Radiator, lower right Block, left side, centre

CLUTCH SPECIFICATIONS T4, T5 & TD5

Engine Clutch

Two clutches are used in the T4, T5 and TD5 tractors, depending on the equipment on the tractor. When the tractor is equipped with Constant Running Power Take-off, a two stage clutch replaces the regular clutch. Specifications are the same regardless of the tractor model.

Standard Clutch (use in all models with transmission type P.T.O.)

Type -	Single plate, spring loaded, dry disc
Size -	10"
Springs:	
Number used -	9
Free length -	2.582"
Length at test load - - - - - - - - - - - - - - - -	1.747"
Wire diameter -	.162"
Test load -	140 - 145 lbs.
No. of coils -	9
Adjustments:	
Pressure plate to back plate measurement for adjustment of levers - - - - - - - - - - -	.356"
Release lever height from pressure plate - - - -	1.644"
Allowable run out of release lever height - - - -	.031"
Bearings	
Clutch shaft pilot - - - - - - - - - - - - - - - - -	Pre-lubricated ball bearing
Clutch release bearing - - - - - - - - - - - - - -	Ball thrust bearing
Free pedal (at operators foot pad) - - - - - - - - - -	1 - 1-1/4"

Two Stage Clutch (used in all models with Constant Running Power Take-off or Reverser (only))

Type:	
Main clutch -	Single plate, spring loaded, dry disc
C.R.P.T.O. -	Single plate, spring loaded, dry disc
Size:	
Main clutch -	11"
C.R.P.T.O. -	9"
Springs:	
Number used -	Two
Type -	Bellville washers. NOT INTERCHANGEABLE
Adjustments:	
Pressure plate to back plate measurements for adjustment of levers - - - - - - - - - -	.819"
Release lever height from pressure plate - - - -	3.475"
Release lever height from back plate - - - - - -	2.656"
Allowable run out of release lever height - - - - - -	.020"
Bearings:	
Clutch shaft pilot - - - - - - - - - - - - - - - -	Pre lubricated ball bearing
Release -	Ball bearing
Movement of first stage pressure plate before contact is made with second stage pressure plate	.090"

Torque Amplifier Clutch (all model tractors with T. A.)

Type -	Spring loaded, single plate, dry disc
Size -	7"

Clutch Cont'd

Springs:	
Number used	6
Free length	2.031
Length at test load	1.250
Test load	155 - 165 lbs.
Allowable run out of release finger height	.020"
Adjustment:	
Lever height from rear surface of carrier	3.562"
Bearings:	
Release bearing	Pre lubricated ball thrust

Steering Clutches (all models)

Type	Multiple, spring loaded, dry disc
Size	9"
Springs:	
Number used	6
Free length	2.0"
Length at test load	1-7/16"
Wire diameter	.187"
No. of coils	6-7/8 Total - 4-7/8 Active
Test load	230 lbs.
Adjustments:	
Pressure plate to back plate measurement for adjustment of levers	.851"
Release lever height from pressure plate	2.367
Bearings:	
Clutch shaft	Bushings
Release bearing	Pre-lubricated ball thrust
Free steering lever movement	1.0" free play at hand grips

TRANSMISSION

Standard Unit without TA

Type	Selective sliding gear
Number of speed forward	5
Number of speed reverse	1

Transmission with Torque Amplifier

Type	Selective spur gear and planetary transmission
Number of speeds forward	10
Number of speeds reverse	2

Full Reverse Transmission

Type	Selective, sliding spur gear, with reverse ahead of transmission drive shaft
Number of speeds forward	6
Number of speeds reverse	6

Speed Chart:

Gear	Std Transmission M.P.H.	Torque Amplifier M.P.H.	Reverse (reverse) M.P.H.
1st	1.48	1.00	1.81
2nd	2.26	1.53	2.76
3rd	3.58	2.42	4.37
4th	4.79	3.23	5.84
5th	6.54	4.31	7.98
Reverse	2.12	1.43	2.59 (forward)

Bevel Gear and Pinion

Matched gears, not serviced separately

Bevel gear, number of teeth	44
Bevel pinion, number of teeth	9
Backlash	Stamped on bevel gear

Location of pinion in setting bevel gear drive:
The required distance from machined end of pinion shaft to centre line of bevel gear shaft is stamped on the machined end of bevel pinion.

Diameter of bevel gear shaft	2-1/2"

Lubrication

Type	IH Hy-Tran fluid
Capacity	
Standard w/o TA	4 Imp. gallons
With TA	5 Imp. gallons
With reverser	5 Imp. gallons

FINAL DRIVE

Type	Spur gear
Gear reduction	4.46 : 1
Lubrication	Oil bath
Lubricant	Transmission Oil SAE 80 or 90

POWER TAKE-OFF

Types	1. Standard transmission drive 2. Transmission type TA or reverser 3. Constant running TA or reverser
Speed	989 at 2000 Eng.R.P.M.
PTO shaft	1-3/8" involute serration

BRAKES

Type	External contracting band
Location	On steering clutch
Actuated by	Steering levers and/or foot pedal.
Brake drum diameter	10-3/4"
Friction area	67 sq. in.
Pedal adjustment	1/8 - 3/16" free movement of brake actuating lever
Steering lever	3/8" clearance between adjusting screw & brake actuating lever - with actuating lever at rest on pedal adjusting screw

CHASSIS

Dimensions

Weight (approx.)	T4 & T5 - 4900 lbs. TD5 - 5100 lbs.
Height at hood	47-1/2"
Height to top of muffler	74"
Total length	102"
Width	48 - 82" (dependant on gauge and shoes)
Ground clearance	14-1/2" max.
Draw bar height	17"
Lateral movement at pin	13.5"

Track Frames

Type	Rigid mount
Number of track roller (on one side)	4 Standard 5 Special
Number of top idlers	4 Roller frame - none 5 Roller frame - one
Front idler	Spring mounted
Track chain adjustment	Front idler moves on mount
Stone guard	Built into track frame
Positions of track frame on chassis	3 (adjustable forward of back of central location)
Track chain guide	Available as attachment

Tracks

Type	Drop forged steel links with removable pins and bushings
Track pin diameter	1"
Track bushing diameter	1.47"
Track shoe bolts	7/16"
Length of track on ground (standard)	56" standard 68"special 5 rollers
Gauge of track (centre to centre)	38", 48" and 68"
Number of shoes	31 standard 4 roller frame 35 special 5 roller frame
Width of shoes	10" only with 38" gauge 10, 12 and 14" with 48 and 68" gauge
Height of grouser	2"
Area of contact with 10" shoes	1120 sq.in. with standard 4 roller frame 1360 sq.in. with special 5 roller frame
Track driving sprocket pitch diameter	24.047"

Capacities

Cooling system	2.5 Imp. gallons
Fuel system	13.0 Imp. gallons
Engine lubrication including filter	4 Imp. quarts
Transmission case w/TA or reverser	5 Imp. gallons
Transmission case w/ Hydraulic	6.5 Imp. gallons
Transmission case less TA or reverser	4 Imp. gallons
Transmission case w/ TA (reverser) & Hydraulic	8 Imp. gallons
Final drives (each) approx.	1 Imp. quart
Air cleaner (approx.)	3/4 Imp. pint

HYDRAULIC EQUIPMENT

	T4 & T5	TD5
Hydraulic Pump		
Type	Gear pump	Gear pump
Drive	Off timing gears	Off timing gears
Manufacturer	Pesco	Plessey
Capacity at rated engine RPM	7.5 Imp. gals.	5.7 Imp. gals.
Operating pressure	1800 p.s.i.	1800 p.s.i.
Hydraulic fluid	IH Hy-Tran fluid	IH Hy-Tran fluid
Reservoir	Transmission housing	Transmission housing
Filter	In inlet line	In inlet line
Valves	Single or double acting.	Single or double acting
Number of valves	1, 2 or 3 as required	1, 2 or 3 as required

ELECTRICAL, T4 & T5 TRACTOR

Battery Ignition Distributor

	T4 & T5	TD5
Voltage	6	6
Mounting	Horizontal	Horizontal
Drive	Timing gear	Timing gear
Distributor identification	X	X
Distributor rotation (from drive end)	Counterclockwise	Counterclockwise
Firing order	1-3-4-2	1-3-4-2
Breaker point gap	.020"	.020"
Breaker arm tension at points	21 - 25 ozs.	21 - 25 ozs.
Spark advance (automatic)		
Engine speed 400 r.p.m.	0°	0°
800 r.p.m.	10°	10°
1200 r.p.m.	18°	18°
1600 r.p.m.	26°	26°
1800 r.p.m.	30°	30°
2150 r.p.m.	30°	30°

Spark Plugs

Size	18MM	18MM
Gap	.023 - .028"	.023 - .028"

Current Voltage Regulator

Model (D-R)	1118780	1118780
Cutout relay		
Air gap	.020"	.020"
Closing voltage		
Satisfactory range	5.9 - 7.0 volts	5.9 - 7.0 volts
Adjust to	6.4 volts	6.4 volts
Regulator		
Air gap	.075"	.075"
Voltage setting		
Satisfactory range	6.6 - 7.2 volts	
Adjust to	6.9 volts	
Polarity, battery ground	Positive	

Generator

Model (D-R)	1100042	1100042
Rotation, viewed from drive end	Clockwise	Clockwise
Brush spring tension	28 ozs.	28 ozs.
Field current (80° F.)		
Amperes	1.85 - 2.03	1.85 - 2.03
at		
Voltage	6.0	6.0
Cold output		
Approx. speed	2650	2650
Amperes	35	35
at		
Volts	8	8

Storage Battery

Type (Auto-Lite)	1MS-85R	1MS-85R
Number used	1	1
Voltage	6	6
Capacity (at 20 hr. rate)	85 amp. hrs.	85 amp. hrs.
No. of plates	15	15

ELECTRICAL, TD5 TRACTOR

Voltage of Electrical System	-12

Current Voltage Regulator

Model (D-R)	1118791
Cutout Relay	
Air gap	.020"
Closing voltage	11.8 - 14.0 volts
adjust to	12.8 volts
Regulator	
Air gap	.075"
Voltage setting	
Satisfactory range	14.0 - 15.0 volts
adjust to	14.4 volts

Generator

Model (D-R)	1100370
Rotation, viewed from drive end	Clockwise
Brush spring tension	28 ozs.
Field current (80° F.)	
Amperes	1.58 - 1.67
at	
Voltage	12.0 volts
Cold output	
Approx. speed	2300 r.p.m.
Amperes	20
at	
Volts	14

Battery

Make	Auto-Lite
Model	1MS-85R
Voltage	6
Number used	2
Capacity (at 20 hr. rate)	85 ampere hrs.

STANDARD TORQUE DATA FOR NUTS AND BOLTS

Recommended torque, in foot pounds, for all Standard Application Nuts and Bolts, provided:

A. All thread surfaces are clean and dry.

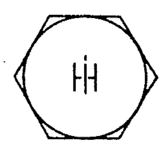
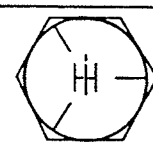
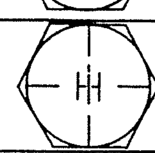
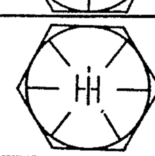
B. Standard height nuts are used or tapped holes contain an equivalent number of threads.

C. Special height or heat treated nuts are used for Type III and IV bolts or equivalent for tapped holes.

Bolt Size	Type - 4		Type - 3		Type - 2*		Type - 1	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1/4	14	16	13	15	10	11	6	7
5/16	30	33	27	31	20	23	12	14
3/8	52	59	49	55	35	40	21	24
7/16	84	95	78	88	56	63	34	38
1/2	130	145	120	135	85	95	52	59
9/16	185	210	170	190	125	140	75	84
5/8	250	290	240	260	170	190	105	120
3/4	420	470	390	440	280	320	170	190
7/8	670	750	620	700	440	490	270	300
1	1010	1130	940	1050	660	740	400	450

*Standard type for hex head when not otherwise specified.

BOLT TYPE IDENTIFICATION CHART

IH Type	S.A.E. Grade	DESCRIPTION	BOLT HEAD ** MARKING
1	Equivalent 1 or 2	WILL HAVE OUR STANDARD MONOGRAM IN THE CENTER OF THE HEAD Low or Medium Carbon Steel Not Heat Treated	
2	5	WILL HAVE AN I.H. AND 3 RADIAL LINES Quenched and Tempered medium carbon steel	
3	6	WILL HAVE AN I.H. AND 4 RADIAL LINES Quenched and Tempered carbon maganese steel	
4	8	WILL HAVE AN I.H. AND 6 RADIAL LINES Quenched and Tempered special carbon or alloy steel	

** The center marking identifies the bolt manufacturer.

Form GSS-1253

Hydraulics

T4, T5, TD5, TC5 and TDC5

CRAWLER TRACTORS

CONTENTS

GENERAL DESCRIPTION

The hydraulic systems may differ somewhat on these tractors, depending on the equipment used. The basic hydraulic system is the same however in each case. The pumps may be 7, 9, 12 or 17 gallon per minute capacity. The selector valves are either single acting, double acting or combinations of both. The transmission lubricant is used for hydraulic fluid in most cases, the only exceptions being cases where allied equipment complete with its own hydraulic system including a reservoir is installed on the tractor.

The hydraulic pumps in each case are spring loaded gear type pumps. For standard requirements, the T4 and T5 tractors may be equipped with a 9 gallon pump, driven off the timing gears. The TD5 has a similar pump rated at 7 gallons per minute. These pumps are satisfactory for operating remote control farm implements, and other equipment of relatively light nature. If heavy equipment is used that requires large capacity cylinders, and several of them to operate the machine, a larger pump, either 12 gpm or 17 gpm can be used. These larger pumps are front mounted and driven directly off the crankshaft.

The hydraulic fluid (hy-tran) is taken off the transmission housing at a point immediately behind the dividing wall between the transmission and bevel gear compartments, on the lower right of the tractor main frame casting. See illustration 1. The oil passes through a wire mesh filter before entering the pump. From the pump the oil passes under pressure directly to the selector valve unit which contains a built-in pressure relief valve. The pressure in the line between the pump and the valve unit is dependent of the resistance offered to the flow of oil. This resistance may be zero as is the case when the selector valve(s) is in neutral position. In this case the oil free-circuits through the system, back into the transmission housing. If a selection is made with a valve, the resistance is then built up to the pressure required to perform the service selected. The pressure relief valve is incorporated as a safety factor which limits the build-up of pressure developed by the pump to a safe maximum. This valve will come into operation when the system is overloaded either by imposing a load on it that the cylinder (s) is not capable of lifting with the maximum pressure of the hydraulic system, or, if the cylinder(s) comes to the end of the stroke before the selector valve returns to neutral.

Once the selector valve is returned to neutral, two things occur: the hydraulic system goes into free-circuit, and is no longer operating under pressure; and, secondly, the pressure developed by the cylinder(s) is held by the spool in the selector valves. Here the pressure is also imposed on the hydraulic lines between the cylinder(s) and the valve. This pressure is capable of reaching proportions higher than that imposed by the pump, as the relief valve is isolated from this side of the system. For this reason hydraulic valves and hoses must be capable of withstanding pressure somewhat in excess of the normal relief valve opening pressure.

When the tractor is equipped with three point hitch, a unit attaches over the bevel gear compartment which contains the rockshaft, and a single acting cylinder for operating it. These units are dealt with in detail under a separate heading in this book.

PUMPS

The gear type pumps used on these tractors are basically the simple type of gear pump such as is used for lubricating pumps in many engines. The pump is self lubricating, depending on the small amount of leakage of hydraulic fluid through the minute spaces between the mating surfaces. This leakage is also used to seal the pumps. Pressure built up within the pump housing will force its way through spaces between the gears and the thrust plates at the ends of the gears. For this reason the thrust plates on one side of the pump are located in such a manner that spring and oil pressure acting behind them will keep the end clearance to an absolute minimum. In the 7 and 9 gpm pumps the bushings are sealed with "O" rings and pressure behind the bushings forces them inward against the gears. In the 12 and 17 gpm pumps a special gasket and a movable plate serve the same purpose. This feature does not only reduce this end clearance to a minimum, but also automatically adjusts for wear at these points.

Another point in the pump which requires close fitting of parts is between the ends of the gear teeth and the body of the pump. This clearance is less critical. There is no means of compensating for wear at these points. The fact that there is a small clearance built into the pump at these points, and no actual metal to metal contact, eliminates normal wear.

These close tolerances are important for good pump operation. The principal cause of pump failure is dirt or foreign matter getting into the hydraulic oil. Damage to the highly polished surfaces of the gear ends and their mating parts makes it possible for oil under pressure to leak at these points. This will cause the pump to lose its ability to develop pressure and reduce the pump volume. Foreign matter getting between the gear teeth ends and the polished inner surfaces of the pump housing can create damage which can cause leakage at these points, again affecting the pump pressure and volume. In extreme cases this foreign matter can bring about failure of the bushings carrying the oil pump gears, allowing the gear teeth to contact the pump body.

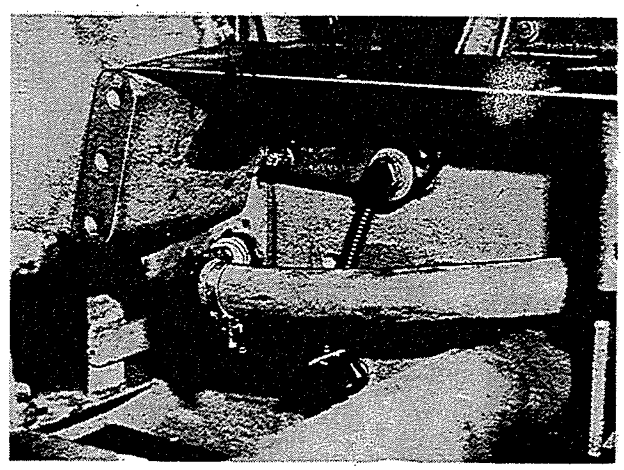
Another operating condition which can bring about pump failure which will appear very much as either of the two mentioned above is operating with a restricted flow of oil to the pump. This is most commonly brought about by failure to keep the hydraulic oil filter clean. If the pump cannot get a full supply of oil, the pump will damage just as if contaminated oil is circulated through it.

The cause of pump failure thus can be traced down in almost every case to dirty hydraulic fluid, either by failure to keep the filter clean, or by using oil that is contaminated. Hydraulic oil will take on impurities over a period of time that the filter will not remove. It is therefore essential that the oil be changed periodically as recommended by the manufacturer of the equipment. In many cases it is advisable to change the oil more often than recommended, dependent on operating conditions.

Installation:

The hydraulic pump supplied as regular equipment for the T4 and T5 tractors is rated at 9 gpm. It is flange mounted to the rear of the timing gear housing and is driven off the camshaft gear. In the case of the TD5, the hydraulic pump differs from that used on the T4 and T5, but is also flange mounted and is driven directly off the camshaft gear.

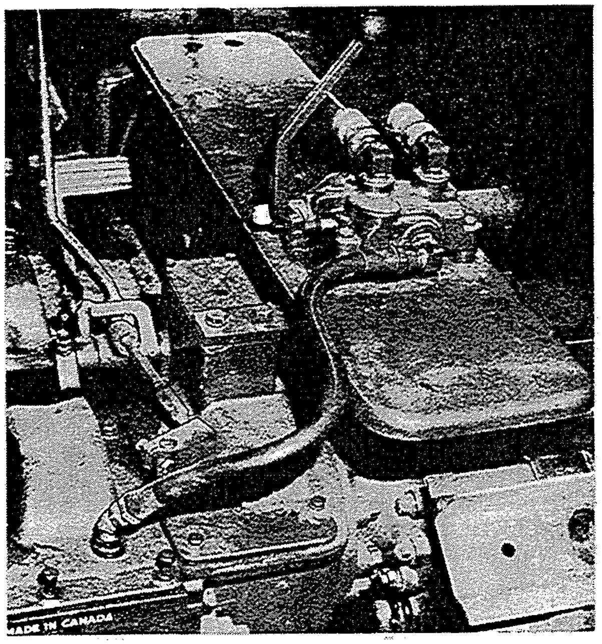
In each case the hydraulic oil suction line comes directly from the filter to the pump. A line runs from the filter rearward, and enters the mainframe casting (see illust.1). The pressure line goes directly from the pump to the selector valve, which con-



Illust. 1.

Hydraulic suction line.

tains the pressure relief valve. A line from the return side of the selector valve returns the oil from the hydraulic system back into the bevel gear housing through a fitting in the cover. Illus tration 2 shows the line as used without the three point hitch. When the three



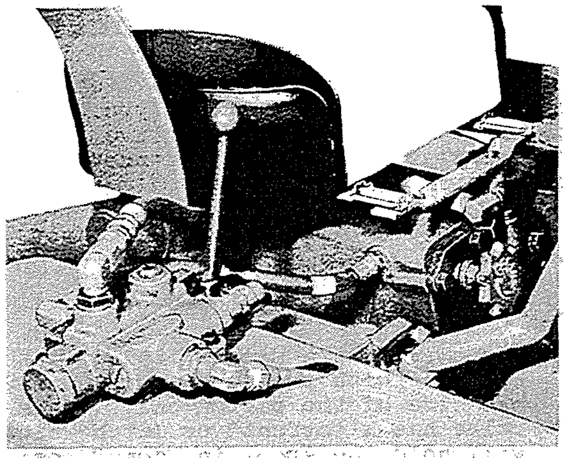
Illust. 2.

Hydraulic oil return line.

point hitch is installed the method is the same, the hose entering a fitting in the side of the three point hitch housing.

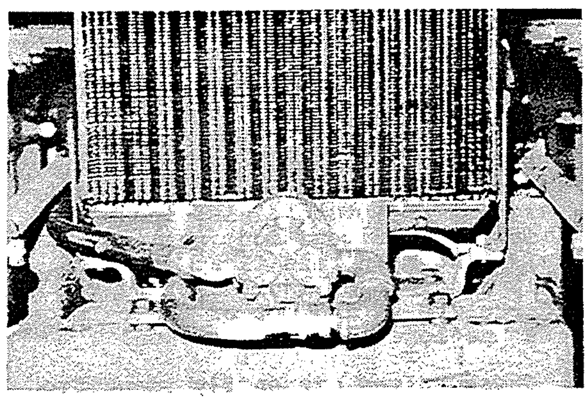
If the equipment involved requires a hydraulic pump of greater capacity, a 12 or 17 gpm pump may be mounted on the front of the tractor, and driven directly off the crankshaft. These pumps are mounted in the same manner and are connected to the same inlet filter as is used with the 7 and 9 gpm pumps. The pressure line goes directly to the selector valve which contains the relief valve. The same valves are used with all pumps. The return from the valve to the bevel gear housing is the same as shown in illustration 2.

In some cases the 12 and 17 gpm pumps and connections as shown in illustrations 4 and 5 are used with machines having their own lines, valves etc. In these cases, the systems from here are described in the manual for that machine.



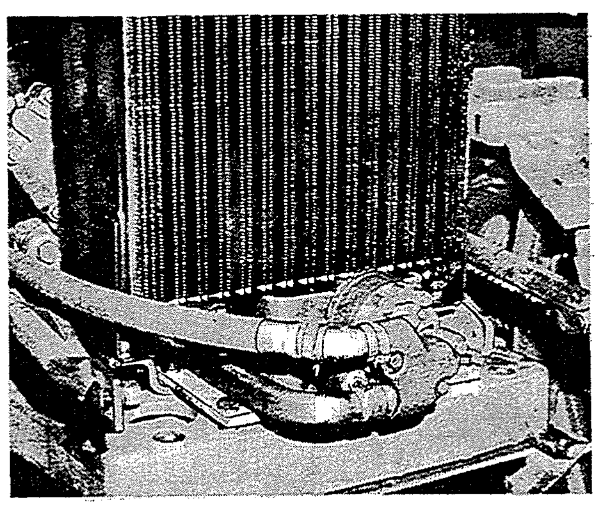
Illust. 3.

Hydraulic oil return line with three point hitch.



Illust. 4.

12 gpm pump and connections.



Illust. 5.

17 gpm pump and connections.

SELECTOR VALVES

The hydraulic selector valves used on these tractors are spool type. The spools and bores are a selective fit, and for this reason spools cannot be interchanged between bores.

There are basically three valves available:

1. Single acting valve (3 way)

   For operating a single acting cylinder with pressure acting on one side of the piston only. This valve has a "detent" or latch which will hold the spool in "down" position thus providing a float feature.

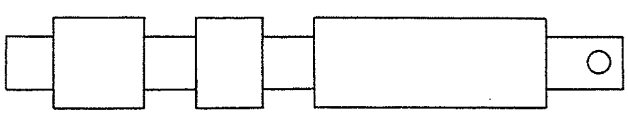
2. Double acting (4 way)

   For operating double acting cylinders, with pressure acting on both sides of the piston.

3. Double acting (4 way) with a float position and detent.

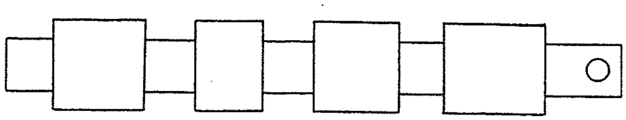
   For operating double acting cylinders, with pressure acting on both side of the piston, also incorporating a float position, retained with a detent. In this float position, oil under no pressure is free to circulate in and out of the cylinder as the load moves the piston.

These valves are easily identified by the shape of the spools. The spools



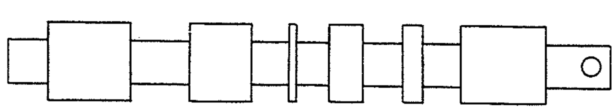
Illust. 6.

Single acting spool.



Illust. 7.

Double acting spool.



Illust. 8.

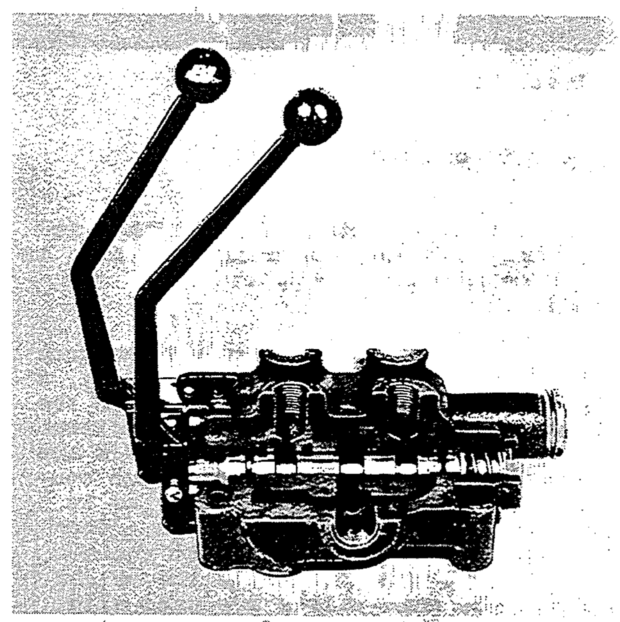
Double acting spool with float position.

do not have to be removed from the valve body, but may be checked through the port openings.

The presence of a detent can be determined by forcing the spool inward from the lever end. If the centralizing springs return the valve to neutral, no detent is present. Also, valves with a detent can be identified by a metal fitting threaded into the housing at the end of the spool opposite the lever end. Valves with no detent are covered with a metal disc held in place with a snap ring. A rubber cap fits over the end of the body in each case.

Other valves are available consisting of combinations of two or more of the three valves described above. Each valve unit contains its own pressure relief valve unit.

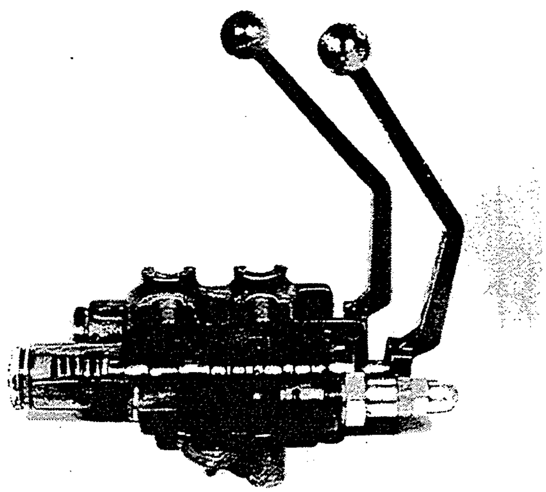
In the case of a three spool valve it is possible to connect another valve behind it to operate an additional service. In this case the second valve may be set at a lower operating pressure.



Illust. 9.

Double spool valve showing view of double acting spool.

Illustrations 9 and 10 show cutaway views of a double spool valve. Illustration 9 shows the double acting spool, and illustration 10 shows a double acting spool with float position and detent. The schematic view shown



Illust. 10.

Double spool valve showing view of double acting spool with float and detent.

in illustration 11 shows the oil passages, pressure relief valve and other details.

A. Double acting valve.

B. Double acting valve with float.

C. Inlet port (from pump).

D. Return port (oil to reservoir).

E. Relief valve assembly.

F. Ball check valves.

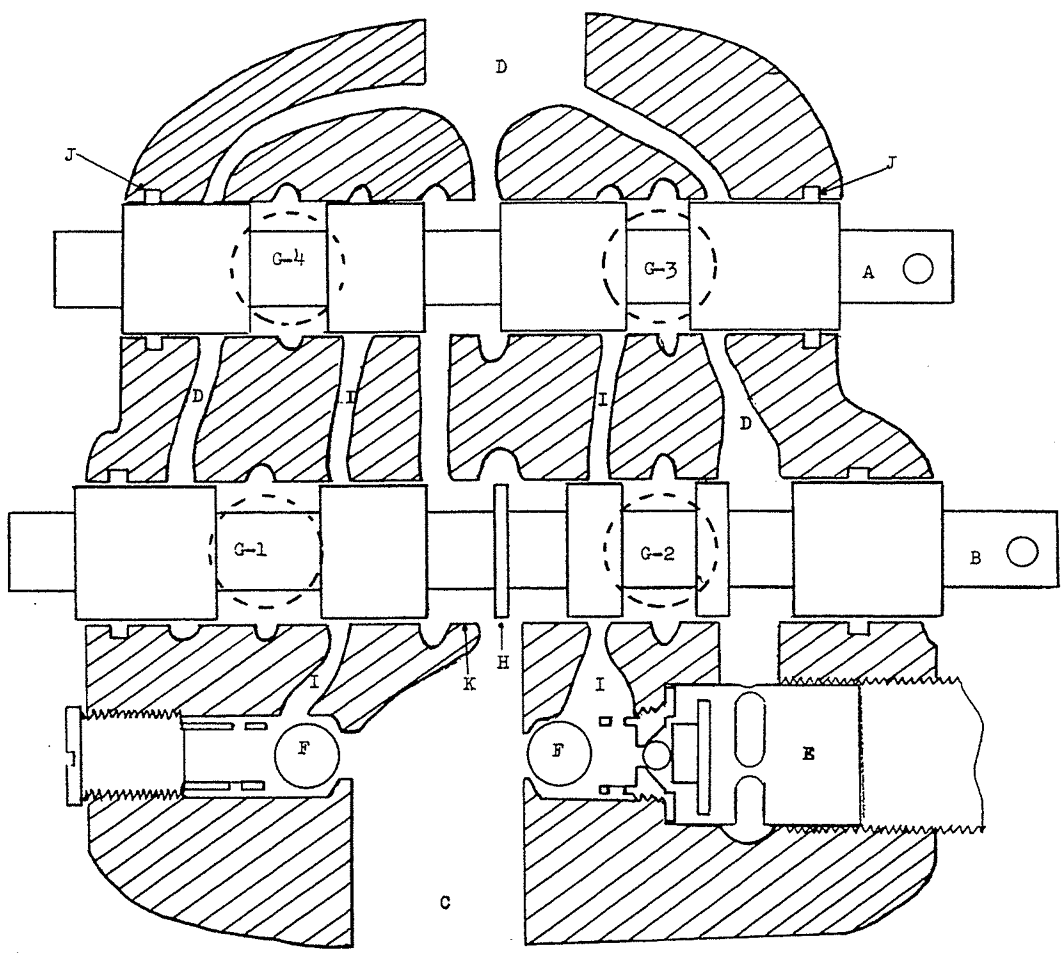
G. Valve outlet ports (pressure to cylinders).

H. Valve land (spool).

I. Pressure passages in valve body.

J. Cup type oil seals.

K. Valve land (body).



Illust. 11.

Schematic of the two spool valve shown in illustrations 9 & 10.

Valve Operation:

Oil from the pump enters the valve body at port "C". With the valve in neutral position, the oil passes through the body under no pressure to port "D", and is returned to the hydraulic reservoir. This is a free circuit. When the valve spool "B" is moved to the right (illust.11) the spool will close off the free circuit forcing oil through the ball check valves "F", into the pressure passages "I". Oil under pressure enters port "G-1" and from there goes to one side of a double acting cylinder. Oil from the other side of the cylinder piston returns through port "G-2", and escapes back to the reservoir through passage "D". When the valve returns to neutral, the lands of the spool close off ports G-1 and G-2, thus sealing oil in both sides of the cylinder.

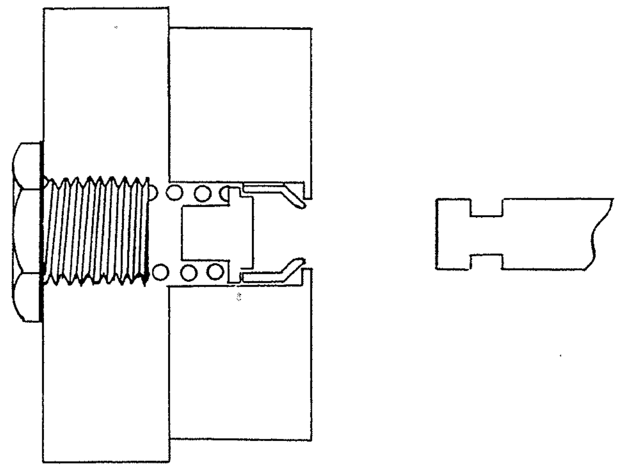
When valve spool "B" is moved to the left, land "H" on the spool closes the free circuit, forcing oil under pressure into the passages "I" as before. If the valve spool is forced hard over to the left (into the detent) land "H" passes through the body land "K", allowing oil to free-circuit the same as it does when the valve is in neutral. At the same time ports G-1 and G-2 are opened, thus allowing oil to flow in and out of the cylinder under no pressure. This is the float position.

Valve "A" works in the same manner as valve "B" except that no float position is incorporated.

The pressure relief valve is a simple type of spring loaded ball valve. An adjustment is provided so the pressure may be altered from outside the valve itself. Note that the relief valve is always exposed to oil coming into the valve from the pump. It can be seen that if the valve is connected backwards, the inlet line from the pump connected to the valve outlet port, the pressure relief valve will be inoperative, and damage to the valve, pump, or both can result.

The ball check valves "F" are located in the pressure circuit of the valve so they will close when oil from the cylinder backs up against the pump. These valves are installed to prevent a momentary drop in line pressure between the time a selection is made with the selector valve, and the time the pump has reached operating pressure.

When a detent is incorporated in the valve, a fitting as shown in illustration 12 is threaded into the end of the spool. This button snaps into the spring loaded clamp and holds the spool until it is released by pressure from the valve lever.



Illust. 12.

Valve detent.

Return springs will always return the valve spool to the neutral position unless the spool is held by a detent. (Illustrations 9 & 10). If it becomes necessary to remove a spool for any reason, this spring assembly must first be removed. This can easily be accomplished by removing the rubber cap, and the end plate or detent, whichever is installed. The spool may then be removed by pushing from the handle end only far enough to permit removing the cup seal from the housing at that end. Pull the spool out from the valve lever end taking care not to scratch the spool or the bore. If the valve has more than one spool, tag the spools so they can be reinstalled in the same bore.

Clean the seal grooves thoroughly.

When replacing the spool, enter it in the lever end of the valve housing being sure that the end having the centering spring bolt hole enters the housing first. Push the spool into the housing until the spool end meets the seal groove. Install the new seal with the lips of the seal toward the center of the spool. When the seal has been properly placed in the groove, straighten it by running a smooth rod around the exposed surface until it is a perfect fit. This can be determined by feel.

Insert the tool shown in illustration 19 into the bore, taking care not to damage the seal. Holding the tool against the spool, force the spool away from the lever end only sufficient to pass over the seal. Move the valve only enough to expose the seal groove at the other (lever) end of the spool, install a new seal, and repeat the process as before.

Lubricate the spool with hy-tran oil before installing. Use a twisting motion when entering the spool into a seal area. This will reduce the possibility of damaging a seal during installation of the spool.

Install the centering spring assembly and the stop disc and snap ring, or detent. Install the rubber cap.

When mounting the valve on the tractor note that it is held at three points, the object being to prevent distortion of the valve body when mounting. It is possible however to distort by overtightening the bolts in some cases. The body can be forced out of shape to a point where the spool will not return to neutral under the normal pressure of the centering springs. If this occurs, check the mounting using washers if necessary to obtain better alignment between the valve body and the mounting points. Also, do not overtighten the mounting bolts.

To adjust the pressure regulating valve, use a pressure gauge that will read up to 3000 psi. Install this gauge in any outlet port. Run the engine at approximately 600 rpm, and adjust the pressure regulating screw until a pressure of 1800 psi is arrived at. Speed the engine up to high idle (2150 rpm) and check again. With the oil at normal operating temperature the pressure will remain relatively constant. If the oil is cold, pressure will go somewhat higher. If the pressure exceeds 1850 psi at 2150 rpm, re-adjust to bring it down to not more than 1800 psi. Using the low rpm for initial adjusting will reduce the possibility of damage to the pump and other components of the hydraulic system should the pressure be too high initially.

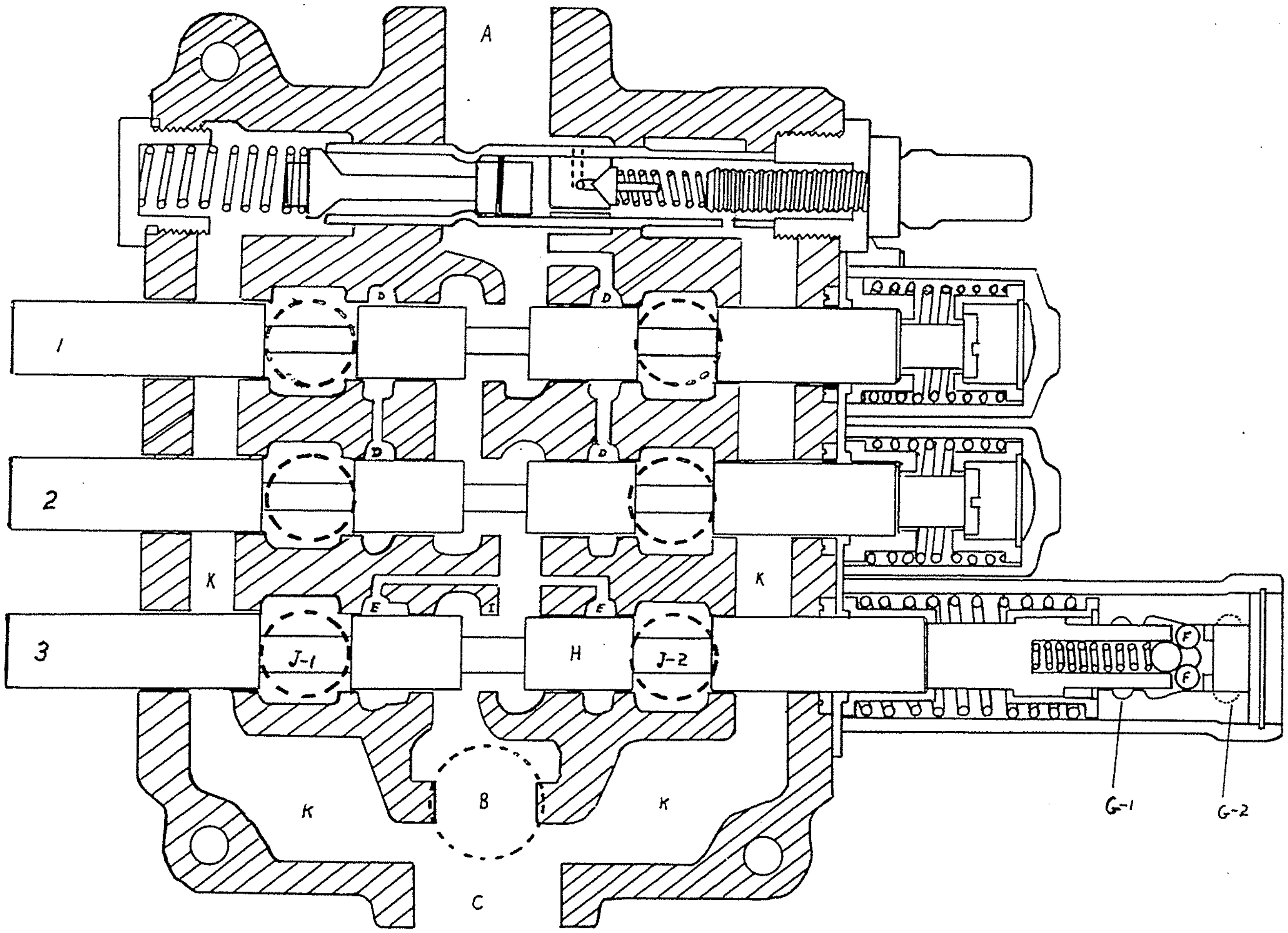
Three Spool Valve:

The three spool valve is basically the same in operation as the one or two spool double acting valves. All the spools are double acting, and the one farthest from the pressure relief valve has a float position and a detent which will hold it in the float position until released by hand. The three spool valve used on Drott equipment has two detents on the float spool, one to hold the spool in float position and the second at the other end of the spool travel holds the spool in "up" position. In the case of the #10 dozer, only the one detent is used for float position.

Port "A" illustration 13, is the inlet port through which the oil is delivered to the valve from the pump. The relief valve assembly shown in illustration 14 is located at this point in the valve body. Thus the inlet oil is exposed directly to the relief valve.

With all the spools in neutral position, the oil continues through the center section of the valve body, out port "B", to port "C", and is returned to the reservoir. This is a free circuit. If either of the spools 1 or 2 are moved to a position other than neutral, the free circuit is closed and oil passages "D" are pressurized. Thus these two valves are operative at the same time, delivering pressure to two services simultaneously. It follows that the greater volume of oil will pass to the cylinder doing the least work. Spool 3 is the spool with the float position. It does not operate if either of the other (1 & 2) spools are in a selective position. When this spool is moved to either side of neutral, the free circuit is closed thus pressurizing oil passages "E". If the spool 3 is moved hard to the left (illust.13) the spring loaded balls "F" drop into groove "G-1" and hold the valve in this position. At the same time the spool land "H" will pass completely through land "I" of the body, and open the free-circuit. Also, valve ports "J-1" and "J-2" will be opened to passage "K" and thus allow the cylinder to float.

It will be noted that oil returning from the open side of a cylinder during operation enters oil passage K, and flows on through port C to the hydraulic reservoir. Also, in this application, free-circuit oil from port B also flows through port C to the reservoir. If an additional valve is required behind the three spool valve as is the case when mounting a remote control on a Drott machine or a #10 dozer, a line is connected into port B which carries oil to the inlet port of the added (remote control) valve. The remote control valve in turn must have its own independent return line to the reservoir. Port C must still be connected to the reservoir to return oil that will accumulate in passage K. It follows that the remote control valve will not operate if any of the spools of the three spool valve are in a selective position. However, the two double acting spools



Illust. 13.

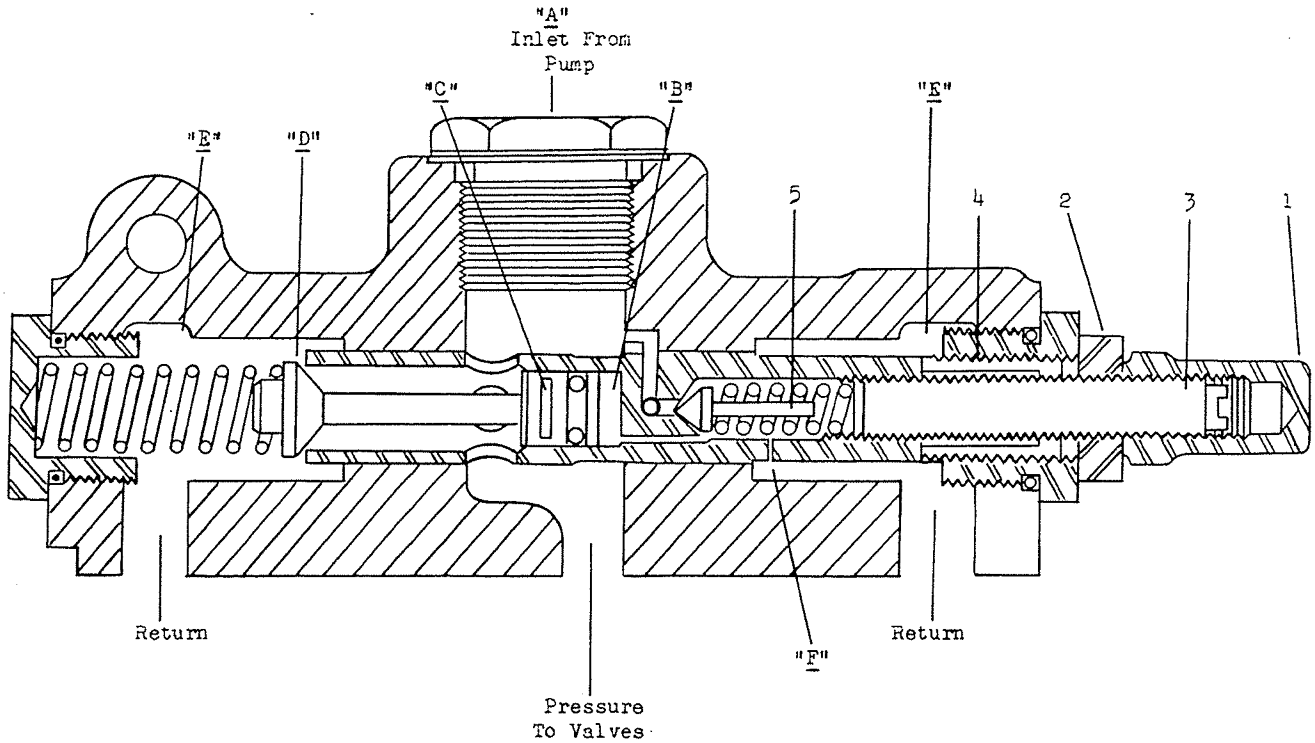
Schematic of three spool valve.

of the three spool valve, or the remote control valve, will operate in a normal manner if the float spool is in float position.

The groove indicated by the dotted line G-2 is present in the three spool valve used for Drott equipment. This enables the operator to select an "up" position for the loader, which will be held by this detent until neutral is selected by the hand lever.

The pressure relief valve in this three spool valve is shown in illustration 14. This valve is different in operating principle, and requires a more detailed pressure setting than does the pressure relief valve on single or double spool valves used on these tractors. The operation of this relief valve is described below.

Port A is the port through which oil from the pump enters the valve. With all the spools in neutral, oil free-circuits around the spools to the hydraulic reservoir under no pressure. When a selection is made with one or more spools, pressure builds up which is directed to the valve 5, (illust.14) which is held on its seat by a spring. The pressure of this spring is adjustable by means of screw 3. When pressure reaches the desired maximum (2000 psi) valve 5 lifts off its seat allowing oil to enter the chamber behind it and passes into area B where it acts on piston C. Piston C is directly connected to valve D. Pressure on C therefore opens valve D allowing a large volume of oil under pressure to bypass into the return port E, back to the reservoir. Restricted port F allows oil to leak, permitting piston C to move back and close valve D after a pressure drop has allowed valve 5 to close by spring pressure. The sleeve can be forced to the left (illust.14) by nut 4, thus increasing or decreasing the tension of the spring on valve D.



Illust. 14.

Pressure relief valve used in the three spool selector valve.

Adjustment:

1. Remove nut 1.

2. Remove lock nut 2.

3. With a screwdriver tighten adjusting screw 3 until it is snug against the pilot valve 5. DO NOT OVERTIGHTEN. If this adjusting screw is over-tightened, the whole sleeve may turn, making it difficult to loosen the screw again.

4. Using the special tool, illustration 15, insert it over the adjusting screw 3, and set the main relief valve pressure by regulating the pressure on the spring which holds valve D in place, via adjusting screw 4.

   A. Engine to be run at approximately 600 rpm.

   B. Use a pressure gauge (3000 psi capacity) in any one of the valve outlet ports. Make the appropriate valve selection to pressurize the gauge. Adjust to 2200 psi.

5. Remove the special tool.

6. Loosen valve adjusting screw 3 several turns. With the engine at high idle (2150 rpm) adjust pressure to 2000 psi with screw 3.

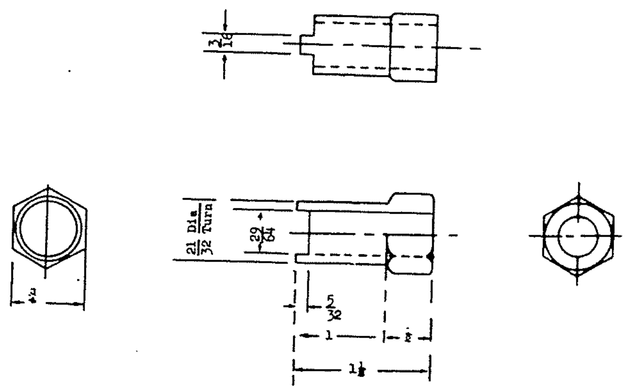
7. Replace the lock nut 2 and nut 1. Re-check pressure setting.

NOTE: Always make the 2200 psi setting first, with the engine running not more than 600 rpm. This will prevent damage to the pump and other components of the hydraulic system should the initial pressure setting be too high. Do not increase the engine speed until operation 6 is carried out.

The inlet side of the three spool valve is equipped with two fittings, one on the top of the valve housing and one on the side. A pressure test may be taken from whichever of these ports that is not normally used.

(Port A of illustration 13).

The outlet side of the valve also has two ports, but these differ from the inlet side. The port on the side of the valve body compares with C of illustra-



Illust. 15.

Pressure relief valve adjusting tool.

tion 13. The port on the top is that shown in B of illustration 13. The two are interconnected for normal operation by a hole threaded to receive a 1/2 inch pipe plug. When a remote control valve is mounted, it is necessary to install a plug in this inter-connecting passage, thus directing the oil from the free-circuit up through the top fitting, and into the remote control valve.

When installing a plug in the inter-connecting passage in the three spool valve, always use a flush type plug, and ensure that it is turned into the valve body until it is flush. Also, it is possible to turn a fitting into port C (illust.13) until the fitting closes off the return from oil passage K by contacting or nearly contacting the face of the casting at port B.

The spools are all a selective fit in the bores of the valve housing. If the spools have to be removed for any reason, tag them so they can be installed in the bores they were removed from. Also, if the spools and relief valve are removed it may be difficult to establish which end the spools enter from. Keep this in mind when servicing the valve. New seals are not difficult to install. No special tools are required if care is taken. It is advisable to remove the seals before removing the spool, and replace the spool and then the seal. Use a new seal each time a spool is removed. Seals should in every case be installed with the cup side of the seal toward the middle of the spool.

THREE POINT HITCH

Description:

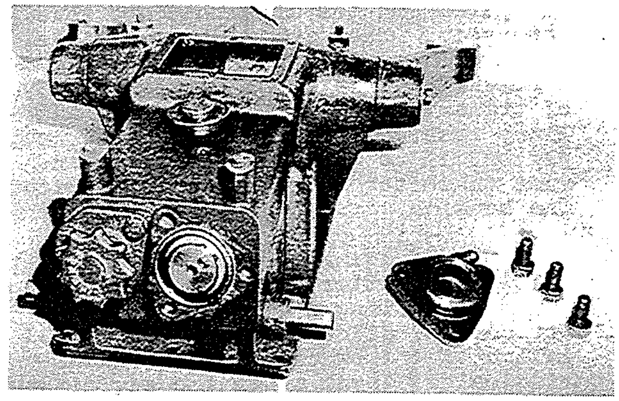
The three point hitch attachment consists of the top housing which contains the rock shaft, and the operating mechanism, and the lower linkage.

The rockshaft is actuated by a single acting cylinder which is controlled by a single acting spool valve with a float position. The float position enables the operator to allow a machine to trail free, following the contour of the ground. If so desired, the attitude or depth of a machine may be controlled with the hydraulic system or with a mechanical depth control, adjustable by a hand wheel, (illust.17) situated at the right front of the housing. This hand wheel, through a spring loaded plunger can be set to maintain a desired position of a mounted machine in relation to the tractor. It is important that this mechanical control is never used for carrying heavy machines in transport.

The rockshaft arms may be lifted by pulling the hydraulic control lever toward the seat. When the lever is released it will return to neutral. The rockshaft will be held in this position by a hydraulic lock. If it is desired to lower the rockshaft the lever is moved away from the seat until the required position is reached. The lever will again return to neutral by itself, holding the rockshaft in this position. However, if a floating position is required, the valve lever is pushed hard away from the seat forcing the spool into the detent. The spool will remain in this position allowing oil to pass from the cylinder into the reservoir whenever pressure is exerted on the piston by the linkage. The rockshaft and arms are free to move to any position. The fact that the piston does not move back with the linkage lets the rockshaft work up and down freely.

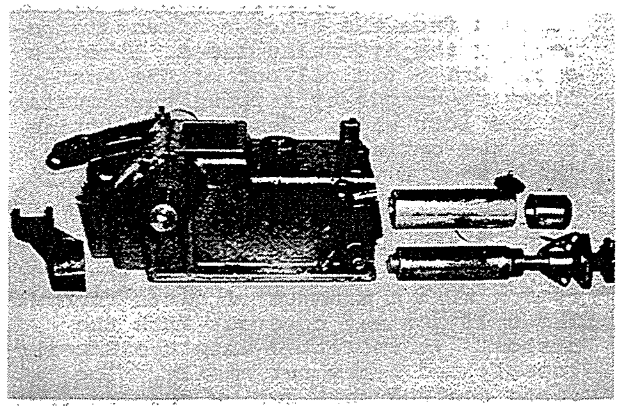
The piston is fitted with a pressure relief valve. This valve comes into operation only when a pressure build-up resulting from an increase in oil temperature occurs with the piston at the end of its travel.

The moving parts of the unit may all be removed as shown in illustration 17. The rockshaft may be driven out after first removing the lock bolts from the inside arms: (illust.18). The



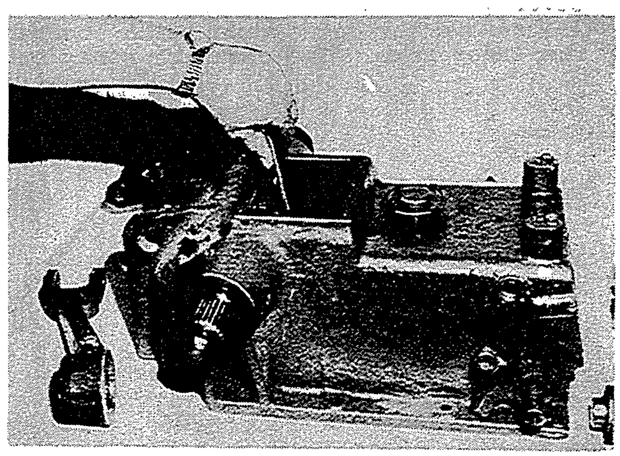
Illust. 16.

Three point hitch, Front view.



Illust. 17.

Hydraulic piston and mechanical depth control removed.



Illust. 18.

Remove the set screws before driving the rockshaft out.

casting contains an auxiliary reservoir which holds approximately one gallon of oil. The oil returned from the hydraulic system empties directly into this reservoir. When the reservoir fills, oil overflows into the bevel gear compartment, and into the regular supply of transmission lubricant. This auxiliary reservoir assures a constant supply of oil to act as a lubricant and rust inhibitor for the mechanism within the housing.

When filling the transmission with oil, either after complete overhaul, or after installing a three point hitch attachment, allow for this additional gallon of oil by checking the transmission oil level after the engine has been run a few minutes.

Removal:

The rear rockshaft housing can be removed from the tractor after disconnecting the hydraulic lines, linkages etc. Drain the oil out of the auxiliary reservoir by tipping the housing on its left side. Remove the fitting from the cylinder opening (illust.16). The piston may be removed by turning a bolt into the threaded holes, and pulling. The fact that it is not secured to the connecting rod makes it easy to remove the piston for any reason with a minimum of parts removal. The cylinder may come out with the piston. It is fitted into the housing loosely and comes out easily. The depth control unit can be removed from the front without any further removing of parts.

If it is necessary for any reason to remove the rockshaft, remove the top cover and through this opening (illust. 18) remove the set screws which locate the inner arms. The shaft then may be driven out of the housing from either end. The bushing and oil seal will drive out ahead of the shaft shoulder. They will be unsatisfactory for further use, and must be replaced. It is good economy to replace both bushings and oil seals at this time.

Inspection:

1. Check the condition of the wearing surfaces of the piston and sleeve.
2. Check the condition of the piston oil seal.
3. Remove the pressure relief valve from the piston and check the condition of the spring, ball rider, the ball seat and the ball seat "O" ring
4. Remove the breather and wash.
5. Check the condition of the bushings in the housing.
6. Check the general condition of the rockshaft, linkage, etc.

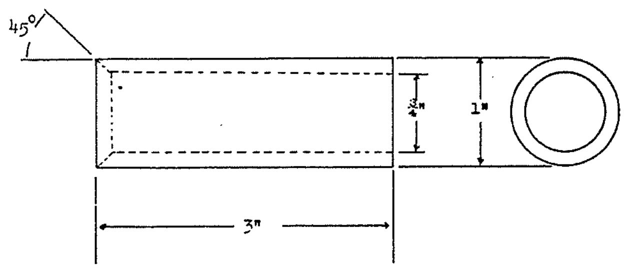
Assembly:

Assembly is in general the reverse of disassembly. Care should be taken when installing bushings not to damage the ends. Oil seals can be slipped into place over the splined rockshaft with the use of shimstock to act as a protector. Replace all the gaskets and "O" rings. The oil seal on the piston may be re-installed if no signs of wear appear on the seal, piston or cylinder sleeve.

When the unit is mounted on the tractor and the hydraulic lines connected, start the engine and allow it to run a few minutes. Check the level of the oil in the transmission and top up as necessary.

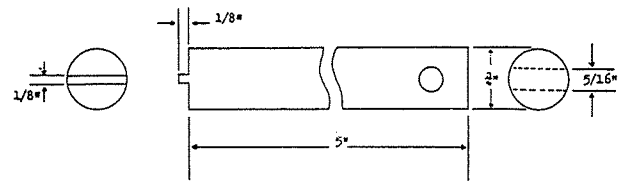
SPECIAL TOOLS

The valves and hydraulic system of these tractors can for the most part be serviced with standard tools. Below two tools are shown which will be required for servicing the one and two spool valves, should it become necessary to remove the pressure relief valve seat or install new seals on the spools. These tools are available by ordering as shown from the address below.



Illust. 19.

Seal replacing tool.



Illust. 20.

Pressure relief valve seat replacing tool.

T9 Seal replacing tool (illust.19)

T33 Pressure relief valve seat replacing tool. (illust.20)

The above tools may be ordered from:

Gresen Manufacturing Company
405 - 35th Avenue
Minneapolis 18, Minnesota, U.S.A.

ACCESSORIES AND APPLICATIONS

Below is a list of parts used in various hydraulic applications. By cross-refering the parts may be determined in relation to the requirement For example; column D contains the parts required for the three point hitch on the T4 and T5 tractors. Column F contains the parts used for a remote control attachment. Therefore if a remote control is required for a T4 or T5 tractor that is already equipped with three point hitch, only the part that appears in column F that do not appear in column D will be required.

				T4-T5- W/3 PT HITCH	TD5 W/3 PT HITCH	T4-T5 REMOTE CONTROL	TD5 REMOTE CONTROL	T4-T5- 3 PT HITCH AND REMOTE CONTROL	TD5- 3 PT HITCH AND REMOTE CONTROL	T4-T5 NO'S 11 & 15 BLADES W/12 G.P.M. PUMP	TD5 NO'S 11 & 15 BLADES W/12 G.P.M. PUMP	T4-T5 NO'S 11 & 15 BLADES AND REMOTE CONTROL 12 G.P.M. PUMP	TD5- NO'S 11 & 15 BLADES AND REMOTE CONTROL 12 G.P.M. PUMP	T4-T5- DROTT SKID SHOVEL	TD5- DROTT SKID SHOVEL	T4-T5 DROTT SKID SHOVEL AND REMOTE CONTROL	TD5 DROTT SKID SHOVEL AND REMOTE CONTROL	T4-T5- NO.280 WAGNER LOADER	TD5- NO.280 WAGNER LOADER	T4-T5- NO.280 WAGNER LOADER AND REMOTE CONTROL	TD5- NO.280 WAGNER LOADER AND REMOTE CONTROL
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
HYDRAULIC PUMPS	1	704 330 R92	Hydraulic Pump 7 G.P.M.		1		1		1												
	2	704 331 R1	Pump Drive Pinion 7 G.P.M.		1		1		1												
	3	368 894 R92	Hydraulic Pump 9 G.P.M.	1		1		1													
	4	350 709 R1	Pump Drive Pinion 9 G.P.M.	1		1		1													
	5	124 543 R1	Woodruff Key	1		1		1													
	6	351 818 R1	Washer	1		1		1													
	7	114 494	Nut	1		1		1													
	8	635 868 R91	Hydraulic Pump 12 G.P.M.							1	1	1	1					1	1	1	1
	9	635 703 R91	Hydraulic Pump 17 G.P.M.											1	1	1	1				
PUMP MOUNTINGS & DRIVES	10	610 395 R1	Pump Mounting Spacer							2	2	2	2	2	2	2	2	2	2	2	2
	11	635 707 R91	Bracket Assembly - Pump Mounting							1	1	1	1	1	1	1	1	1	1	1	1
	12	635 949 R91	Coupling Assembly - Front P.T.O. Drive							1	1	1	1	1	1	1	1	1	1	1	1
	13	635 956 R91	Coupling Assembly - Front P.T.O. Drive							1	1	1	1								
	14	106 751	Woodruff Key							1	1	1	1	1	1	1	1	1	1	1	1
	15	635 705 R1	Shaft - Drive							1		1		1		1		1		1	
	16	635 706 R1	Shaft - Drive								1		1		1		1		1		1
	17	635 952 R11	Adapter Assembly							1	1	1	1	1	1	1	1	1	1	1	1
	18	635 955 R11	Adapter							1		1		1		1		1		1	

VALVES	19	635 605 R91	Valve- 1 Spool-Single Acting W/Float	1	1																
	20	635 867 R91	Valve- 1 Spool-Double Acting W/Float			1	1														
	21	635 877 R91	Valve- 2 Spool 1-Single Acting W/Float 1-Double Acting W/Float					1	1												
	22	635 878 R91	Valve- 2 Spool 1-Double Acting 1-Double Acting W/Float									1	1								
	23	635 704 R91	Valve- 3 Spool 2-Double Acting 1-Double Acting W/Float											1	1	1	1				
FILTER & FITTINGS	24	635 585 R92	Filter Assembly	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	25	635 648 R1	Fitting - Filter Inlet	1	1	1	1	1	1												
	26	635 743 R1	Fitting - Filter Inlet (Outlet)							2	2	2	2	2	2	2	2	2	2	2	2
	27	128 003	Reducer Bushing	1	1	1	1	1	1												
	28	635 584 R1	Fitting - Filter Outlet	1	1	1	1	1	1												
PUMP MANIFOLDS & FITTINGS	29	635 593 R11	Pump Manifold - Inlet		1		1		1												
	30	9 410 203	Connector Manifold - Outlet		1		1		1												
	31	635 602 R11	Manifold Assembly	1		1		1													
	32	144 034	Reducer	2	2	3	3	3	3	3	3	3	3	1	1	2	2	4	4	4	4
	33	121 208	Nipple - Manifold - Outlet											1	1	1	1				
	34	635 547 R1	Manifold - Pump Outlet		1		1		1												
HI HOSE--PRESSURE	35	635 600 R91	Hose - Pump To Valve	1	1	1	1	1	1												
	36	635 866 R91	Hose - Pump To Valve							1	1	1	1					1	1	1	1
	37	636 006 R91	Hose - Valve To Cylinder	1	1			1	1												
	38	635 752 R91	Hose - Pump To Valve											1	1	1	1				
		635 583 R1	Hose - Reservoir to Filter	1	1	1	1	1	1												
	39	635 592 R1	Hose - Filter To Pump	1	1	1	1	1	1												

HOSE - LOW PRESSURE

HOSE CLAMPS

40	635 744 R1	Hose - Reservoir To Filter							1	1	1	1	1	1	1	1	1	1	1	1
41	635 991 R1	Hose - Filter To Pump							1	1	1	1	1	1	1	1	1	1	1	1
42	636 007 R91	Hose - Valve To Reservoir			1	1			1	1	1	1								
43	635 750 R91	Hose - Valve To Reservoir											1	1						
44	635 594 R92	Hose - Valve To Reservoir	1	1			1	1												
45	636 010 R91	Hose - Valve To Reservoir																	1	1
46	636 011 R91	Hose - Valve To Reservoir																	1	1
47	635 985 R1	Hose - Inlet - 17 G.P.M. Pump													1	1				
48	274 086 R91	Clamp	2	2	2	2	2	2	4	4	4	4					4	4	4	4
49	311 394	Clamp											4	4	4	4				
50	39 104 H	Clamp	2	2	2	2	2	2							2	2				
51	636 162 R1	Clamp											1	1	1	1				
52	636 053 R1	Clamp	1	1	1	1	1	1	1	1	1	1								
53	635 998 R1	Clamp															1	1	1	1
54	636 013 R1	Clamp															2	2	2	2
55	635 710 R91	Elbow Assembly - Return Line	1	1	1	1	1	1												
56	635 745 R91	Elbow Assembly - Return Line							1	1	1	1	1	1	1	1	1	1	1	1
57	9 403 022	Pipe Tee																	1	1
58	9 402 710	Connector 5/8 Tube - 1/2" Pipe																	1	1
59	9 411 105	Elbow - Connector - Outlet	1		1		1													
60	141 621	Elbow - 90°							2	2	2	2					2	2	2	2

HOSE FITTINGS	61	635 715 R1	Elbow - 45°							1	1	1	1					1	1	1	1
	62	9 402 866	Elbow - 90°	2	2	3	3	2	2	3	3	3	3							1	1
	63	119 095	Elbow - 45°											1	1	1	1				
	64	635 768 R91	Elbow											2	2	3	3				
	65	9 410 977	Elbow - 90°	1	1			1	1												
	66	635 596 R1	Elbow - 90°	1	1	2	2	3	3	2	2	4	4			2	2			2	2
	67	635 983 R11	Elbow													2	2				
	68	9 403 023	Pipe Tee													1	1				
	69	444 701	Pipe Plug 1/2"													1	1				
	70	9 402 828	Elbow - 3/4 Pipe - 3/4 Tube 45°											1	1						
	71	9 402 867	Elbow - 90° - 3/4 Pipe - 3/4 Tube													2	2				
	72	9 402 827	Elbow - 5/8 Tube - 1/2" Pipe - 45°															1	1	2	2
"O" RINGS	73	252 728 R1	"O" Ring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	74	350 429 R1	"O" Ring		1		1		1												
	75	570 828 R1	"O" Ring	1	1	1	1	1	1												
	76	355 965 R1	"O" Ring	2		2		2													
	77	297 459 R1	"O" Ring											2	2	3	3				
HYDRAULIC LINES	78	635 881 R21	Line - Pump Inlet	1						1	1	1	1					1	1	1	1
	79	635 758 R92	Line - Pump Inlet											1	1	1	1				
	80	636 062 R11	Line - Valve To Valve													1	1				
	81	635 599 R11	Line - Pump To Valve	1	1	1	1	1	1	1	1	1	1								
	82	635 982 R11	Line - Assembly													1	1				

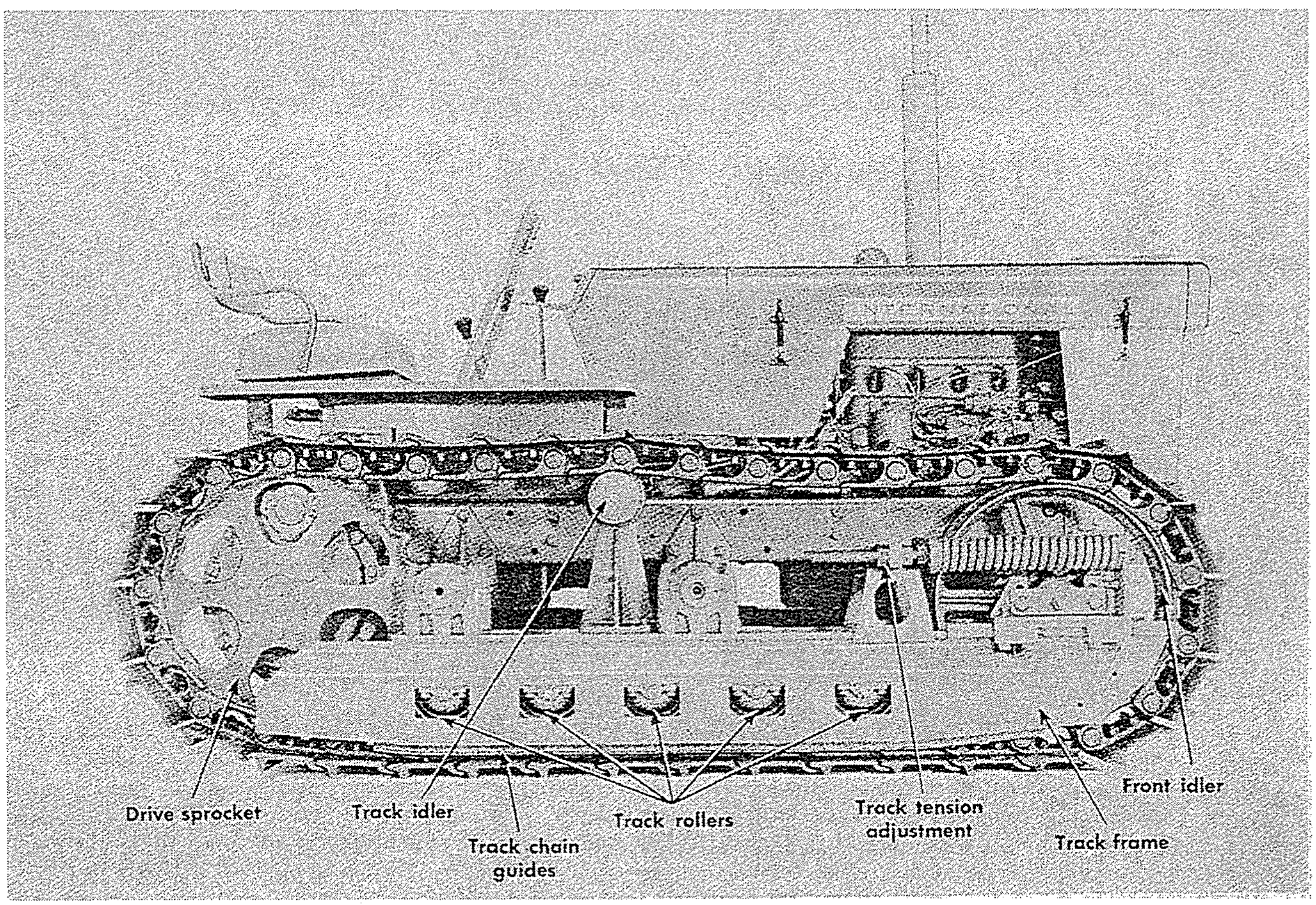
METAL	83	635 751 R11	Line - Valve To Reservoir											1	1						
	84	635 753 R11	Line - Pump To Valve											1	1	1	1				
	85	600 192 R1	Spacer	3	3	3	3	3	3	3	3	3	3							3	3
VALVE LEVERS	86	635 980 R1	Spacer													1	1				
	87	615 926 R1	Spacer													3	3				
	88	636 038	Lever	1	1	1	1	2	2	1	1	2	2							1	1
	89	635 984 R1	Lever													1	1				
	90	635 714 R91	Link	1	1	1	1	2	2	1	1	2	2			1	1			1	1
	91	Q 771	Pin - 1/4" x 1 1/4"	1	1	1	1	2	2	1	1	2	2			1	1			1	1
	92	364 679 R91	Breather	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	93	635 625 R91	Fuel Pump - Electric	1		1		1													
ELECTRIC FUEL PUMP	94	635 622 R11	Fuel Line - Pump To Carb.	1		1		1													
	95	635 624 R11	Cable - Coil To Fuel Pump	1		1		1													
	96	35 252 D	Fuel Line Connector	2		2		2													
	97	29 710 D	Cover	1		1		1													
	98	42 124 D	Gasket	1		1		1													
	99	636 255 R11	Fuel Line - Tank to Pump	1		1		1													
	100	636 211 R91	Sediment Bowl - Assembly	1		1		1													
	101	24 847 H	Fuel Line Elbow	1		1		1													
	102	636 212 R11	Fuel Line - Tank To Sediment Bowl	1		1		1													
	103	374 783 R11	Self Sealing Coupling	Use As	Required																
	104	373 220 R1	Dust Cap (For Self Sealing Coupling)	" "	"																
	105	635 907 R11	Flow Restrictor	" "	"																

T4,T5,TD5,
TC5 & TDC5

Tracks & Track Frames
Crawler Tractors

GSS-1254

CONTENTS



Illust. 1. Track and Track Frame Assembly.

DESCRIPTION

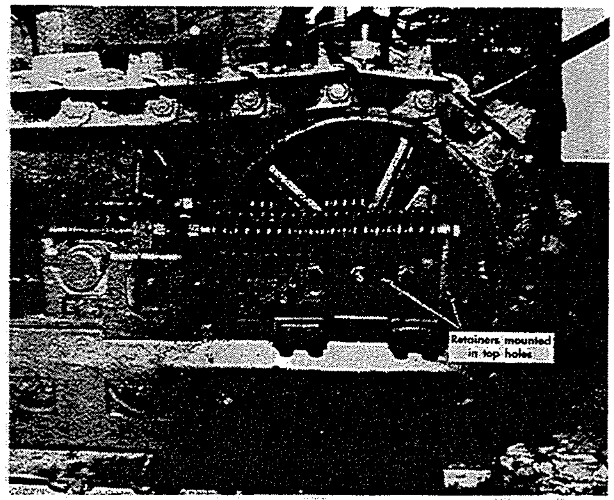
The T4, T5, TD5, TC5 and TDC5 Crawler Tractors may be equipped with either four or five roller track frames. The four roller frame is basically the same as the five roller track frame shown in Illustration 1, except that it is approximately 12 inches shorter, having one less roller, and does not have a top idler. All the component parts such as rollers, front idlers, track tension springs etc. are common to both and completely interchangeable.

The four roller track frame is used for drawbar work where little or no front mounted equipment is involved. This frame will provide all the traction and floatation required for such an operation.

The five roller track frame is used with heavy front mounted equipment such as loaders, thus giving greater stability to the front of the tractor and loader combination. The additional length of the five roller track frame requires more power for turning than does the four roller frame, everything else being equal. However, this is off-set in loader operation by using the 3 bar low profile track shoes. Traction that may be lost by not using grouser type shoes is compensated for to a large extent by the additional weight of the mounted equipment.

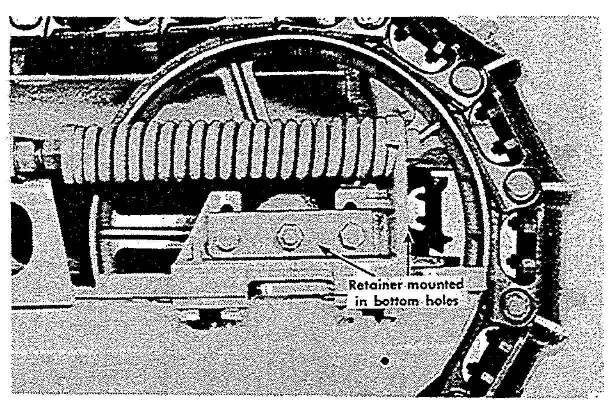
In addition to the extended (five roller) track frame there are two other features relative to tractor front end stability:

1. The front idler may be mounted in either of two positions. In the "upper" position, see Illust. 2, the idler does not support any of the tractor weight when the track is on level ground. This is the position best suited for drawbar work. In this position all the weight of the tractor is carried on the track rollers. The front idler provides a climbing action for the tracks.



Illust. 2. Front idler in "Upper" position.

When the front idler is lowered to the position shown in Illust. 3, the idler carries tractor weight as well as the track rollers. The tractor is thus supported at a point further forward and the possibility of tipping is reduced. This change of front idler positions is not difficult and can be done in the field. The operator that uses his tractor for general work and occasional loader operation will utilize this feature.



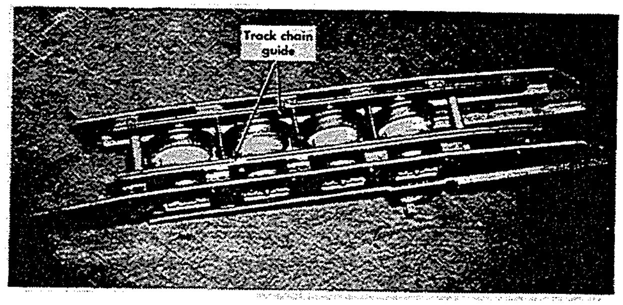
Illust. 3. Front idler in "Lower" position.

2. The track frames may be set forward or rearward from their regular central position. This change requires a few new parts and a considerable amount of work, and cannot be classed as a field operation. Tractors purchased for use with heavy front mounted equipment are usually ordered from the factory equipped for same and the tracks will be located accordingly. Should it be necessary to make this change in the shop, complete instructions are contained in this book.

These features can be used to great advantage when properly applied. By combining the features of extended track frame, lowered front idler, and track frame set forward, this tractor is capable of performance comparable to larger tractors. Setting the track frames to the rear may be desirable in some cases. With three-point-hitch farm equipment the weight involved is not sufficient to necessitate change of track settings. It is recommended that the regular central position be used for all such work.

The above features apply equally to four and five roller track frames.

The track frames are of welded construction incorporating a built-in stone guard, provided by the low skirts of the track frame. A track chain guide is available as an attachment for either four or five roller track frames. See Illustration 4. These track chain guides are not common for both four and five roller frames but must be ordered accordingly. The track chain guide prevents the track chain becoming displaced when making pivot turns under the most adverse conditions, even if the track chains may be excessively slack. They may also be useful for continued side-hill operation, particularly with five roller track frames. These guides are recommended when tractors are used with front mounted equipment. Normal drawbar work on relatively level terrain should not require them.



Illust. 4. Track chain guides.

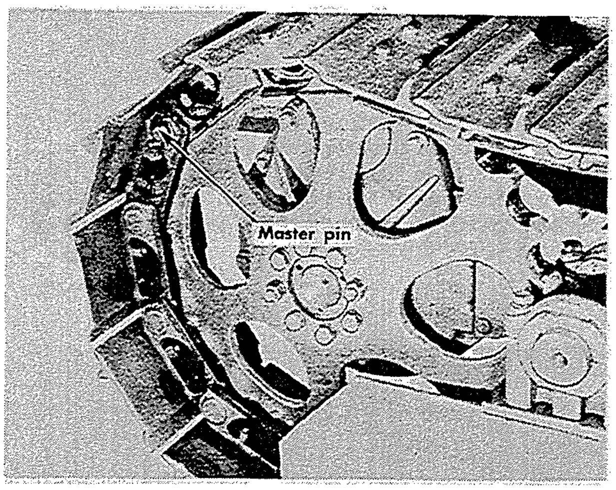
The front idler, top idler and track rollers are fitted with bronze bushings and run on steel shafts. These are dealt with in greater detail in a following section of this book.

The track frames are tied together by two gauge bars, making a rigid undercarriage for the tractor. The chassis is mounted on these gauge bars making a compact, easily serviced unit. Track frames may be removed individually if necessary. Positioning the chassis on the gauge bars and resultant sprocket-chain alignment is important. See details regarding this in this book.

TRACK CHAINS

Description:

The track chains consist of drop forged, heat treated steel links held together by pins and bushings to form a continuous chain. The bushings and pins are a press fit in the links. The left and right track chains are identical and interchangeable. These track chains are easily removed. Each chain has a master pin identified by a lock pin. See Illust. 5. Track shoes are attached to the track links by bolts and nuts.



Illust. 5. Master pin.

Maintenance:

Track links have only one wearing surface which contacts the track rollers, front idlers and top idlers. It usually becomes necessary to replace pins and bushings before the links wear out and it is a matter of judgment then whether the links are good enough to justify a new set of pins and bushings. Only the wear on the outside of the bushings is visible. Wear on the pins and interior of the bushings is indicated by track "stretch", (forward adjustment of the front idler).

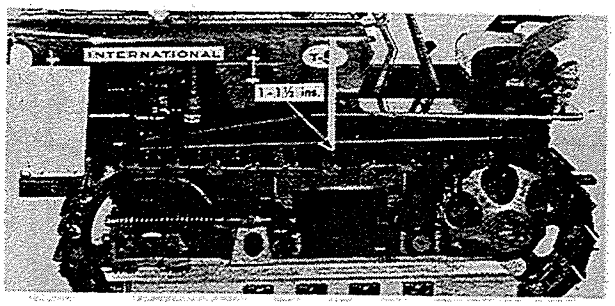
The amount of wear in the pins and bushings can be determined by measuring the pitch length of the track chain (distance between centers of pins) under tension and comparing this with the new length of 5.990 inches. Maximum permissible pitch length is 6.187 inches.

Contributing wear on the sprockets must also be considered in conjunction with track chain wear. Wear of the sprocket teeth decreases the pitch length of the sprocket while wear of the pins and bushings increases the pitch length of the track chain. The result is, the pitch length of the sprocket and track chain become more and more out of phase. The bushings ride higher on the sprocket teeth with eventual spinning of the sprockets. Combined wear of sprocket and chain should not be allowed to reach this point as spinning of the sprocket may cause damage.

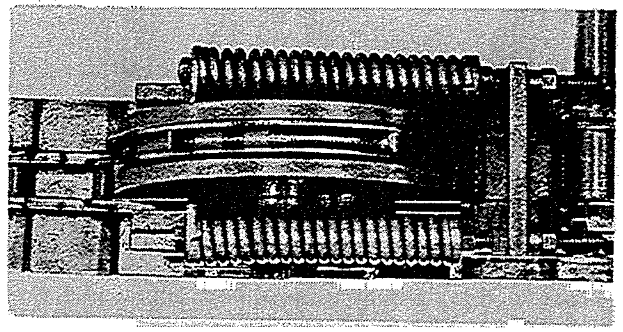
Whenever track chains are rebuilt, or new installed, the sprockets should also be replaced or interchanged to present the better side of the teeth to the bushings. Never should one link be removed to bring a "stretched" track again within range of the adjusting screws. A track worn badly enough to take up the length of one link will be so far out of pitch that the increased wear on the sprocket will far more than off-set the saving obtained by the small addition to the life of the track chain.

Checking Track Tension:

To check the track chain tension place a block under the foremost track shoe lug. Drive the track forward until the track just starts to climb the block, thus removing all the slack along the bottom of the track, and bringing it to a point between the sprocket and the front idler. Then apply and lock the brake and stop the engine. Jacks placed under the track front and back will serve the same purpose. Place a long straight edge on top of the track shoes so that the straight edge rests on the track over the sprocket and front idler. See Illust. 6. Measure the clearance between the bottom of the straight edge and the top of the track shoe cleat nearest to the point midway



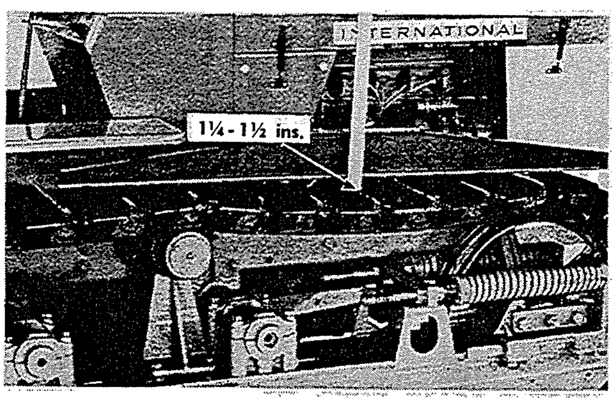
Illust. 6. Checking track tension on four roller track frame.



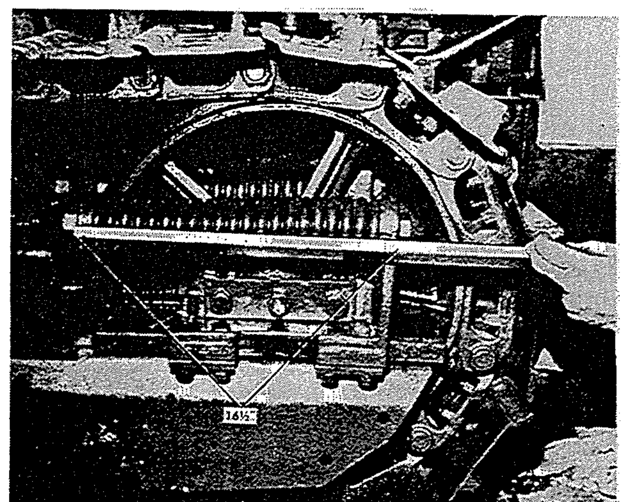
Illust. 8. Checking front idler alignment.

between the front idler and the drive sprocket. This clearance should be 1 1/4" - 1 1/2". On tractors equipped with five roller track frames the clearance should be measured between the front idler and the top idler, with all the slack in the track chain taken at this point. See Illust. 7. This clearance should be 1 1/4" - 1 1/2".

When adjusting the track chain check the compressed length of the track tension springs. See Illust. 9. The measurement here should be 16 1/2 inches measured from the bearing faces of the bolt head and nut.



Illust. 7. Checking track tension on five roller track frame.

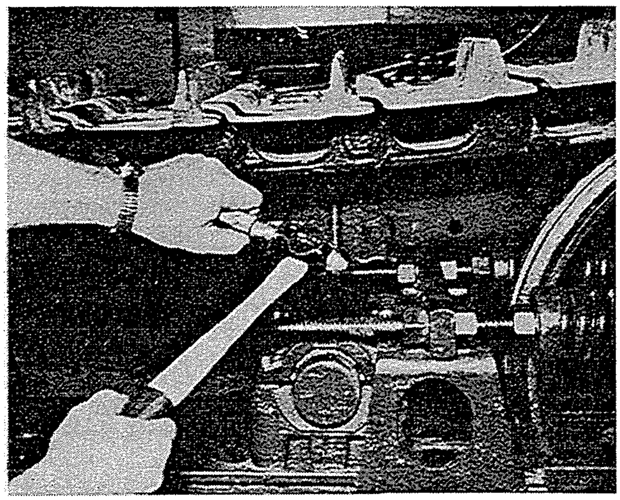


Illust. 9. Check compressed length of springs. 16 1/2 inches.

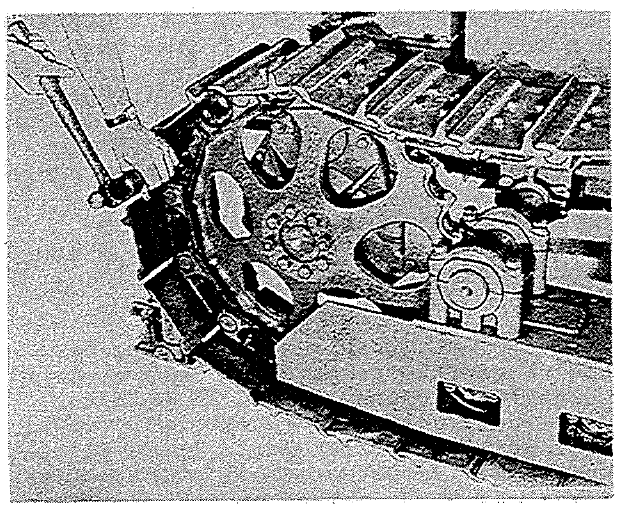
Tension is adjusted by means of the adjusting nuts. See Illust. 1. It is important that the inner and outer adjustment be set equally, thereby maintaining proper front idler alignment. See Illust. 8.

Track Chain Removal:

To remove the track chain from the tractor locate the master link over the sprocket as shown in Illust. 11. In some cases it may be found easier to break the chain over the front idler, but generally it is easier to work as illustrated. Removing the lock pin from the master pin is also easier if done before finally positioning the master link. See Illust. 10.

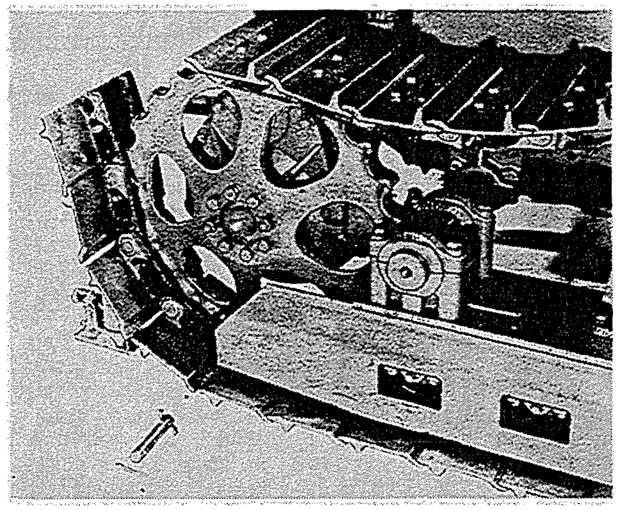


Illust. 10. Removing lock from master pin.

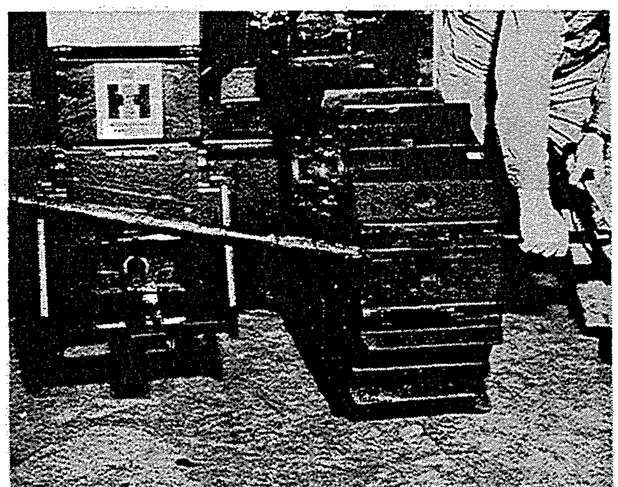


Illust. 11. Drive out master pin.

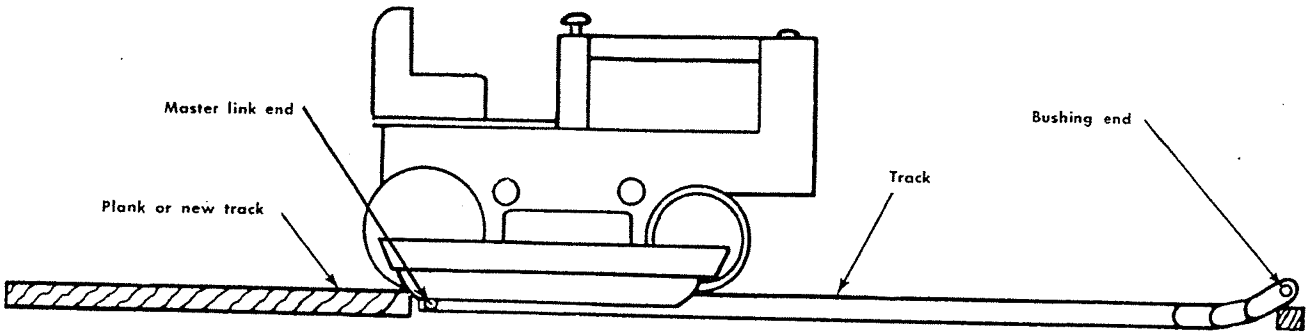
Loosen the track chain tension and place a jack under the shoe as shown in Illust. 12. The jack will serve to take tension off the pin and permit easier removal. Support the master link from the inside of the track frame with a bar and drive out the master pin. See Illust. 13. Pull the track over the front idler and lay it flat. When both tracks are in this position the tractor may be backed off on a plank, or a new chain.



Illust. 12. Support master link while driving out pin.



Illust. 13. Back-up master link while driving pin out.



Illust. 14. Tractor may be run off on a plank or another chain.

NOTE: The track chains may be equipped with either of two master pins. The pins differ only in the size of hole provided for the locking pin. Illust. 12 shows a pin using a lock made of mild steel. Some master pins are fitted with a spring steel Spirolox roll pin. The hole in the illustrated pin is smaller than that provided for the Spirolox pin, so it will not be possible to use the roll pin here. If a master pin with a Spirolox lock is used to replace a pin such as illustrated, it may be necessary to remove a small amount of metal from the groove in the master link.

Track Chain Repair:

To repair or replace worn track pins, bushings or links, a hydraulic track press will be necessary. The operation and procedure instructions for track presses will vary. Specific instructions for each will be supplied by the manufacturer of the particular press.

As internal and external wear on the track pins and bushings develops the track actually gets longer and the separation between the parting edges of the links becomes greater. This gradual wear in time produces excessive "stretch" in the track assembly and requires that the idler be adjusted to maintain the proper track tension. Improperly adjusted tracks, either too tight or too loose affect the rate of wear on all the track components.

Since wear occurs on one side of the pins and bushings, they may be reversed to obtain additional service from the track chain. To do this, remove the row of bolts from the adapter side. Leave all the bolts intact on the ram side but check the bolts for looseness. Press out all the track pins and bushings, turn them each 180° (one half turn) and reinstall. By doing this the unworn surface of each pin is operating against the unworn surface in its bushing, and the unworn outside surface of the bushing contacts the sprocket. Install all the track shoe bolts and nuts and torque to 90 foot pounds.

Installation:

The tractor may be run off a supporting plank or the old track on the new or repaired track. Locate the tractor so the track when lifted will come into place as shown in Illustration 12. The forward end of the track may easily be carried over the front idler. Locate a jack under the track as shown in Illustration 12 and apply sufficient pressure to take up enough slack in the track chain to enable installation of the master pin. Locate the master pin and lock. Adjust track tension.

In installing the track take care not to get the track chain on backwards. See Illustrations 10, 11, 12 & 14 for correct direction of track chain travel. If installing track shoes, these illustrations will serve to get started right. Track chains or track shoes that are on backward will not perform satisfactorily.

FRONT IDLERS:

Description:

The front idlers provide a free rotating guide for the track chains and also give stability to the front end of the tractor. Being spring mounted they take up shock at this point. The idlers are fitted with bronze bushings and run on steel shafts. These bushings are replaceable. The replacement bushings are reamed to size and when carefully pressed into place require no fitting. The two ends of the shafts are held in brackets which are free to slide on the track frame. Locking nuts hold the shaft in position and also prevent it turning.

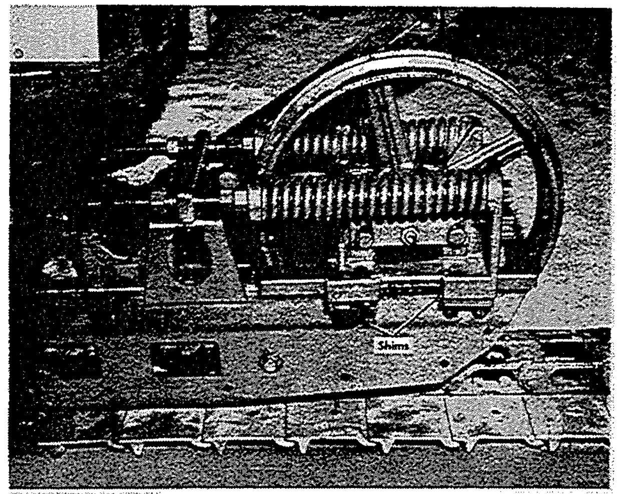
The brackets supporting the front idlers slide on runners on the track frame. Shims are provided for taking up wear. The normal position of these brackets is maintained by the track tension adjusting bolts. See Illustration 1. Proper tension of the track tension springs must be maintained. The springs are compressed to a length of 16 1/2 inches (see Illustration 9) measured from the bearing faces of the bolt head and nut.

Lubrication is provided by external means through grease fittings in the ends of the drilled idler shafts. A reservoir in the hubs of the idlers maintain a reserve of lubricant. Lubricant is sealed in with bellows type oil seals, identical to those used in the track rollers and the top idlers. For details of these seals see the section covering same in this book.

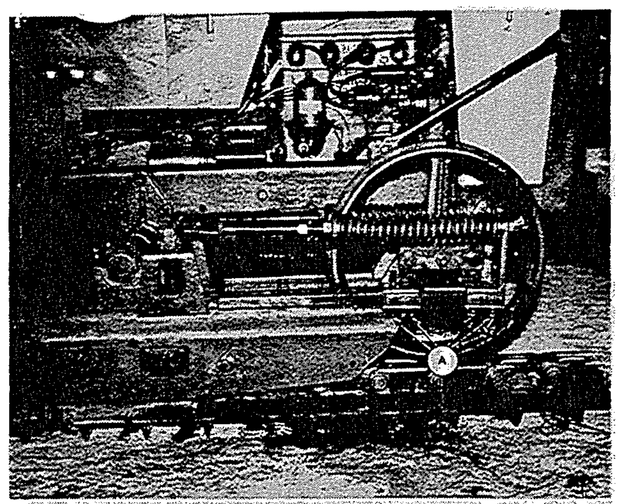
Alignment of the front idlers is dependent on the proper and even adjusting of the track tension adjustment. See Illustration 8.

Removal:

To remove the front idler as a unit, remove the track chain as described in the preceding pages. Remove the two nuts and washers from the track tension adjusting bolts and pull the unit forward, See Illustration 16. It will be easier to pull the unit forward if the bolts indicated "A" are first loosened, inside and out. When removing the front idler from



Illust. 15. Shims are provided to take up wear.



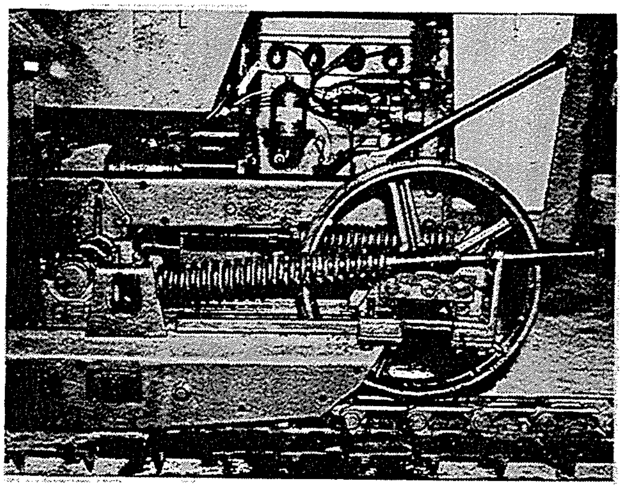
Illust. 16. Slide the front idler unit forward to remove.

a four roller track frame it will be necessary to back the nuts off and slide the unit forward before the nuts can be removed. Interference between the nuts and the front gauge bar caps make this necessary.

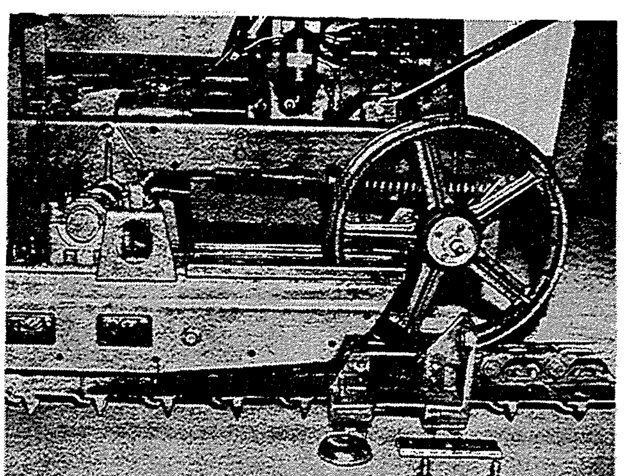
It will be noted that some components of this unit may be removed and replaced if necessary without removing the unit from the track frame. It will be found advantageous in most cases to remove the track chain.

Disassembly:

The tension springs are easily removed and replaced simply by removing the track tension adjusting bolts. Inside the spring is a length of tubing. See Illustration 17. This is provided to prevent the spring bucking under compression. The retainer bracket may be removed by first removing the nut from the shaft, then remove the two caps screws and the bracket will come off. Also, the front idler cover will come off at this time. Note the number of shim used, see Illustration 19, between the bracket and the cap. The oil seal under the cover will be exposed and may be lifted off. See Illustration 18.



Illust. 17. Removing track tension spring.



Illust. 18. Cap removed revealing oil seal.

Inspection:

Inspect the following parts of the front idler and idler assembly for the following:

Excessive wear on the outer faces of the idler.

Broken or damaged surfaces where the chain contacts the idler.

Check hub and spokes for cracks.

Check for cracked or broken tension springs.

Check for damaged or bent track tension adjusting bolts.

Check condition of front idler shaft. Shaft may in some cases become loose and move in the retainer bracket. This movement will soon create enough wear to make it difficult to keep the shaft tight. If the holes in the retainer bracket are worn out-of-round replace the retainer as well as the shaft. Also check shaft and bushing for fit. Replace if necessary. Check thread on shaft for burring or stretching.

Check the condition of the oil seals (see section on Oil Seals).

Check runners on track frame for wear. Wear at this point is the natural result of operation. Excessive wear is not common. Worn runners may be built up and ground to their original shape if wear is considered sufficient to interfere with free movement of the mounting brackets.

Check idler mounting brackets for wear. Wear here can be compensated for by the removal of shims unless it has been allowed to reach extreme proportions. Keeping this shim adjustment correct, see Illustration 15, will serve to reduce wear on both the runners and the idler mounting brackets.

Check thrust plates on both sides of the idlers for wear, both inside and outside. If signs of galling appear between the shaft and the plates, polish both surfaces with fine emery cloth, or replace if galling is severe.

Assembly:

When assembling the front idler in

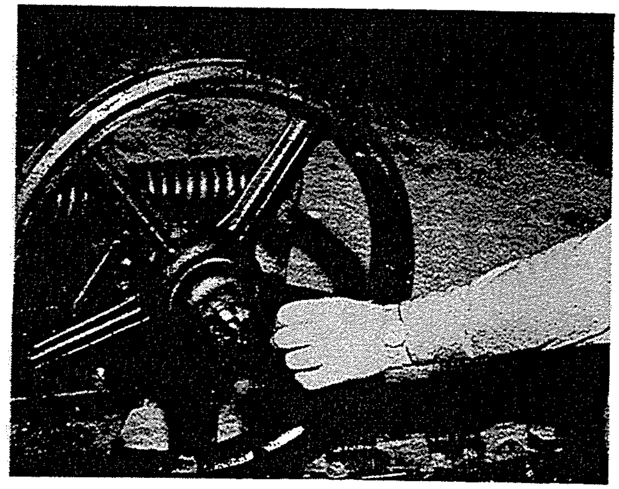
the track frame it is easiest if both tension springs are off. This way the idler shaft can be installed and the oil seals, covers and retaining brackets may be put in place with the shaft nuts tightened enough to hold the assembly together. The unit may then be lowered into place. Tighten the cap screws holding the retainer brackets to the idler mounting bracket, then tighten the shaft nuts. The following illustrations show a precedure which may be more commonly used because of the fewer parts that need to be removed. Illust. 18 shows the idler removed ready to take out the shaft. It will also be seen by studying this illustration along with Illustration 3 that the shaft may be removed from the front idler without removing the tension springs. With the shaft out the idler may be lifted out with no further removal of parts, and replaced by reversing the procedure.

When installing the shaft and thrust plates in the front idler check for end clearance of the shaft after the thrust plates have been tightened into place. The amount of end clearance is not critical but there should be sufficient to permit free turning of the shaft in the hub. Additional gaskets may be used, see Illustration 37, to obtain free movement. It is desirable to keep this end movement between .010" and .020". Gaskets are .010" thick.

For additional information on shafts, seals and bushings, see the section on Track Rollers and Idlers. Also section on Oil Seals.

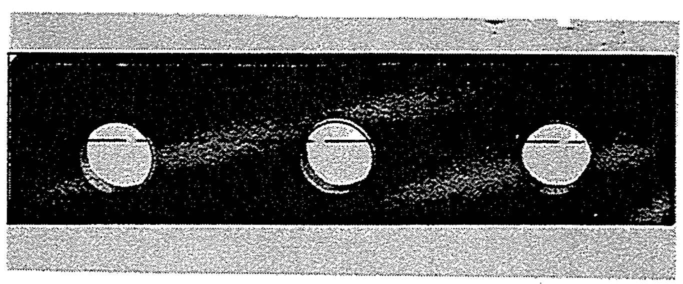
Notice when installing the retainer brackets, the holes in the bracket are not on the center line, but off-set slightly. Install the brackets with the wide section to the top. See Illust. 20. If they are installed upside down no harm will result until an attempt is made to install the front idler in the "lower" position. In this case the holes in the retainer bracket will not line up with the threaded holes in the mounting bracket.

When the front idler is installed in the idler mounting brackets slide the complete unit on the track frame.

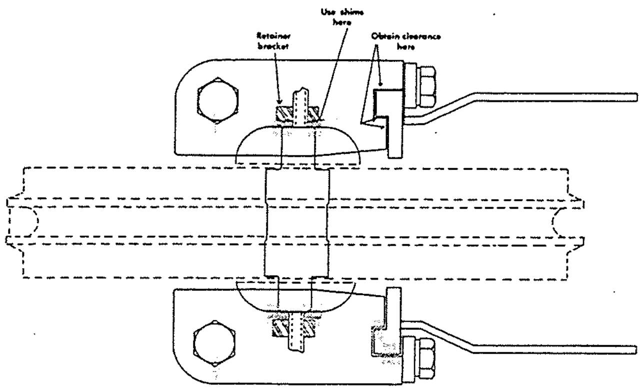


Illust. 19. Location of shims on front idler shaft.

Tighten the cap screws and check the clearance as shown in Illustration 21. Shims as shown in Illustration 19 may be added or deleted to correct relationship of the guide channels in the front idler mounting brackets to the runners of the track frame. Do not put all the shims on one side of the idler. Balance the number of shims used equally between the two sides thus keeping the idler in the middle of the track frame. At this time shims should be added or deleted as required to adjust the plate, see Illustration 15, to obtain a minimum of clearance, yet permit free movement of the mounting brackets on the track frame runners.



Illust. 20. Holes in the retainer bracket are below the center line.



Illust. 21. Use shims shown in Illust. 19 to obtain clearances indicated here.

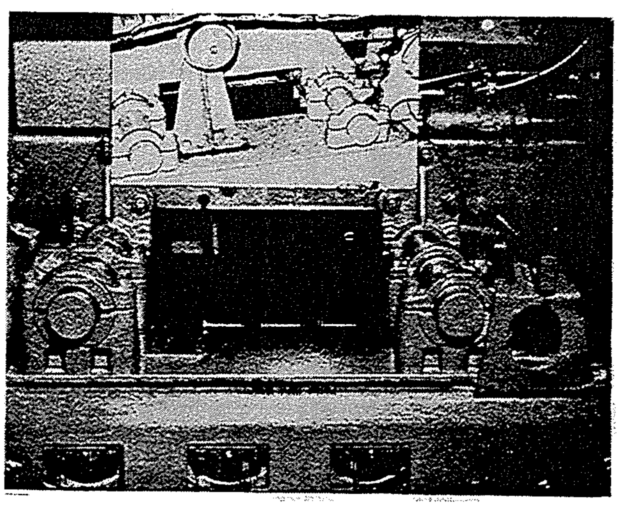
When arriving at these adjustments keep in mind that these are not machined surfaces, and mating surfaces cannot be fitted to very close limits. The object however is to permit movement of the front idler mounting bracket on the track frame runner with a minimum of slack. It may be found difficult to slide the bracket without the use of a small bar when the fitting is completed. If the fitting is too tight the idler will not return under the pressure of the track tension springs and in operation this may be the cause of a track coming off. Excessive slack on the other hand will permit wobbling of the front idler and promote wear to the idler, mounting brackets, track frame runners etc. Keeping these factors in mind a satisfactory adjustment is not difficult to arrive at.

TRACK FRAMES

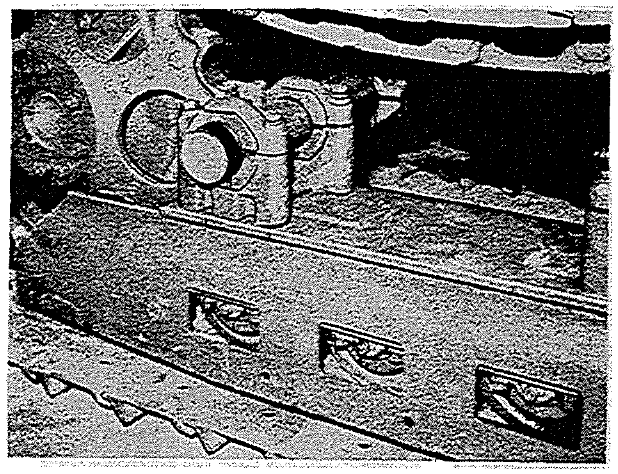
Description:

The track frames are of welded box type construction and for this reason maintenance of the frames themselves is of an absolute minimum. The fact that they are easily removed facilitates servicing of track rollers and may be the only reason for taking them off the chassis. It is not difficult to remove a single roller without removing the track frame. This does however require removing the track chain and the track chain guides if the tractor is so equipped. It will be found advantageous to remove the track frame complete and invert it on the floor if more than one roller is to be removed. Generally, when it becomes necessary to overhaul one roller it is good economy to remove and check them all.

A few of the early models of tractors are fitted with 2 3/4" gauge bars. Of these, some will have rubber spacers where the gauge bars rest in the mounting pads on the track frame. Heavy duty front mounted equipment brought about the use of 3" gauge bars. Since then all tractors have been equipped with these larger size bars. See inset in Illustration 22.



Illust. 22. 2 3/4" gauge bar mounting on track frame.

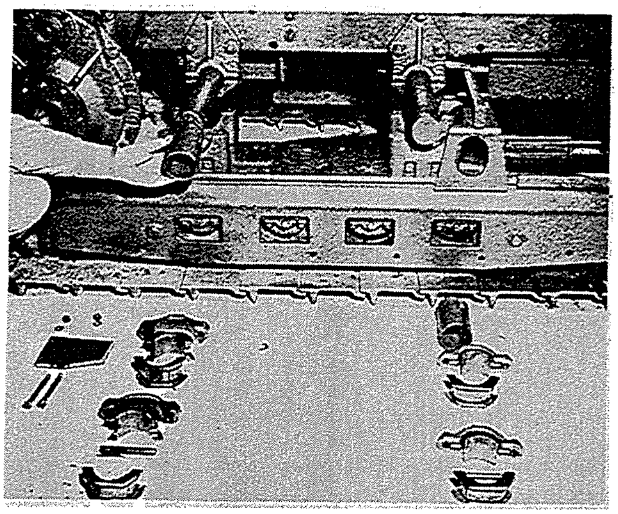


Illust. 23: Spacer for outside mounted equipment.

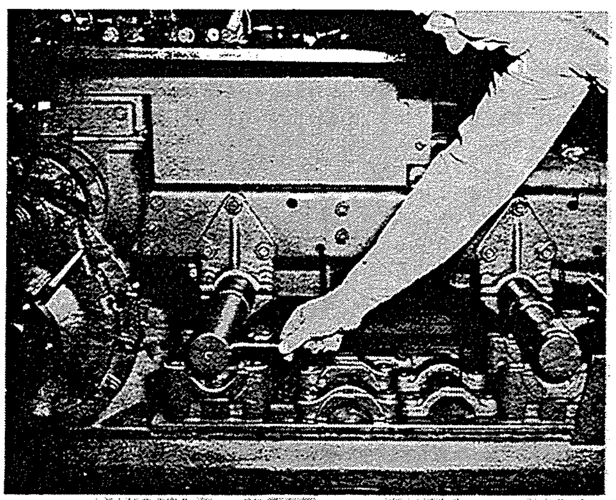
Illustration 22 shows the 2 3/4" gauge bars. Note that no spacers are used with the 3" gauge bars. It will be observed that in the event of mounting equipment on these tractors with the 2 3/4" gauge bars some additional parts will be required. For this reason the 2 3/4" gauge bars will be dealt with in the following paragraphs. The only difference in the tractors is confined to the gauge bars, mounting pads where they are secured to the track frames and the mounting brackets where they are attached to the channel of the tractor frame.

When installing mounted equipment on a tractor equipped with 2 3/4" gauge bars, 635 911 R91 Package Assembly, will be required. If the tractor is fitted with rubber spacers these are replaced with spacers of cast iron provided in the package. See Illustrations 22 and 24. The fact that all allied equipment is designed to accommodate the 3" bars it is necessary to bring the outside diameter of the bar up to 3" where the machine is attached. Illustration 24 shows the spacer which is fitted inside the track frame for "inside" mounted equipment. Illustration 23 shows the spacer provided for "outside" mounted equipment. These spacers are both supplied in package 635 911 R91.

With the exceptions noted above, the details of assembly, disassembly etc. are the same for tractors regardless of the size of gauge bar.



Illust. 24. Spacer for inside mounted equipment.

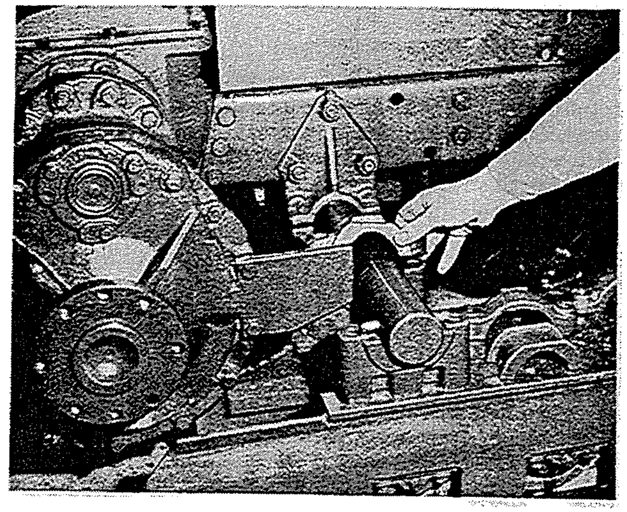


Illust. 25. Gauge bar aligning pin.

In each end of the gauge bars a pin, see Illustration 25 is provided which serves to locate the track frame on the gauge bar.

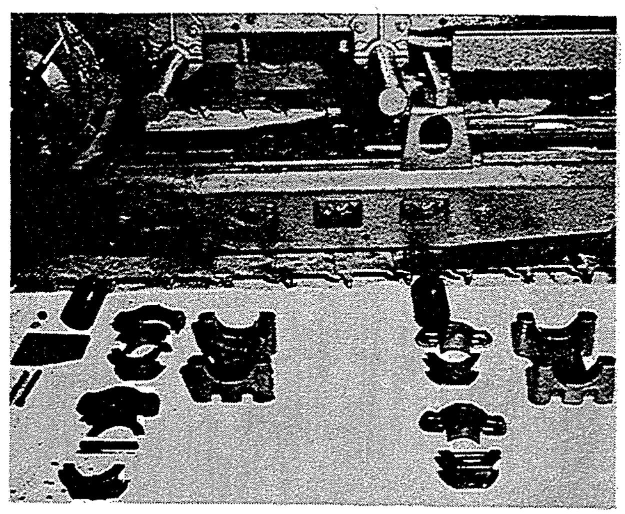
Removal:

To remove the track frame, break the track chain and lay it on the floor. Remove the caps from the gauge bars mounting pads. Jack the tractor up by placing jacks under the gauge bars. Raise only high enough to permit removal of the mounting pads. The pads will

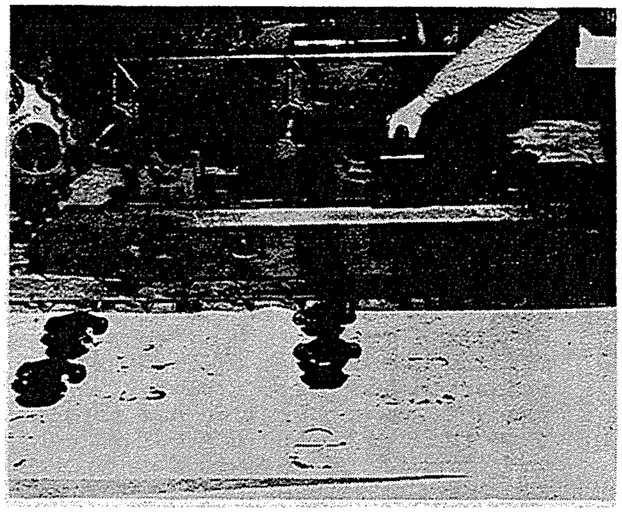


Illust. 26. Remove the caps from the gauge bar mounting pads.

come out easily by first removing the pins (see Illust.25). The inside of the pad will have to be lifted approximately 1/4 of an inch to clear the locating strip welded to the top of the track frame. With a four roller track frame interference will occur between the track tension adjusting bolts and the front gauge bar caps. It is not necessary to remove the bolts, but by taking the mounting pads out as described the track frame can be removed with the front idler in place. Roll the track frame forward on the track as shown in Illustration 28 using

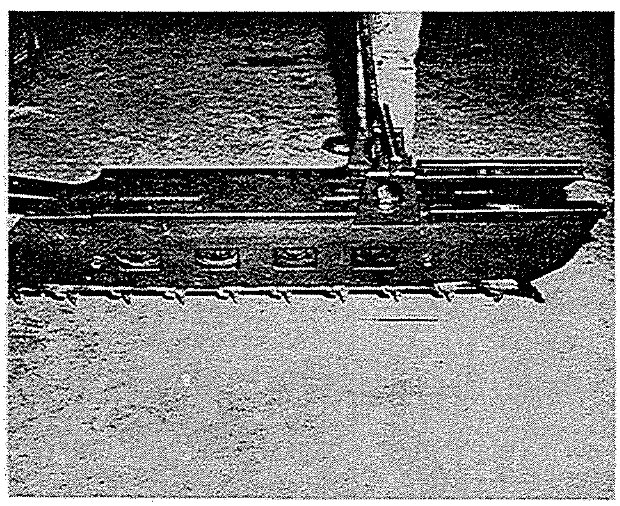


Illust. 27: Track frames stripped for removal.



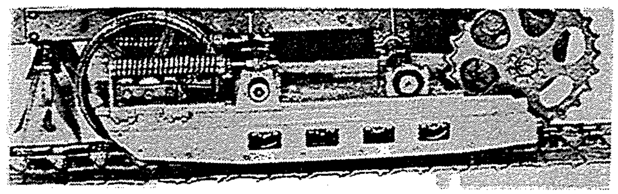
Illust. 28. Roll track frame forward on track.

the track as a rail. Be sure the tractor is securely blocked up before removing the track frame. The track may be upset if required for further work.

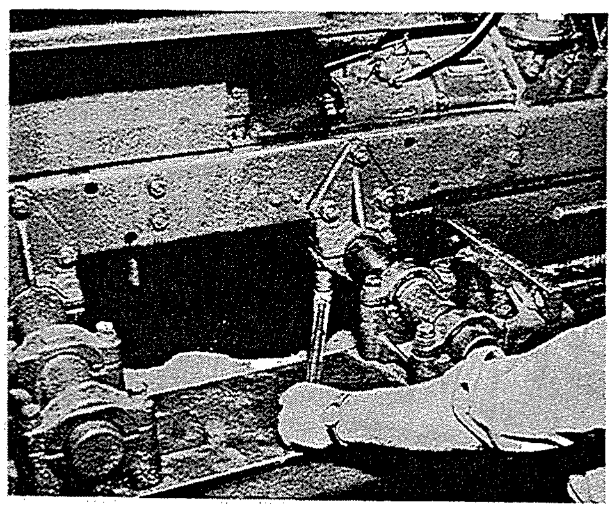


Illust. 29. Track frame may be rolled over.

There is one exception to the procedure outlined this far. In the case of a tractor with a four roller track frame which is mounted in the rear position, the front gauge bar will not permit the track frame being pulled out as shown in Illustration 28. If this problem is encountered, support the tractor as shown in Illustration 30. Loosen the bolts shown in Illustration 31 and slide the gauge bar inward far enough to permit track frame removal. When the gauge bar is thus moved, it is important to

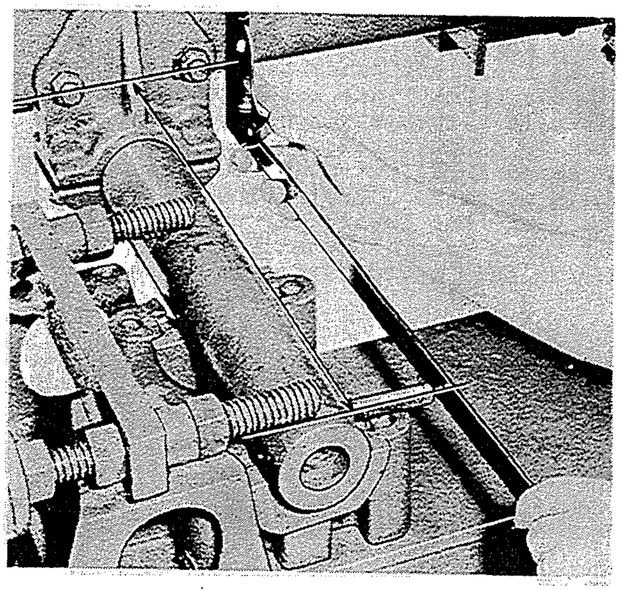


Illust. 30. Position of the front gauge bar when four roller track frame is set in rear position.



Illust. 31. Loosen bolts holding cap.

check it as shown in Illustration 32 when re-installing the track frame. The front gauge bar should extend an equal distance from each side of the chassis frame.



Illust. 32. The front gauge bars should extend an equal distance on each side.

Inspection:

Inspect the track frame for the following items:

Check the condition of the threads in the holes the gauge bar mounting bolts turn into. NOTE: It can happen that these threads may be damaged as a result of using a bolt of insufficient length for mounting some pieces of allied equipment. If the threads are damaged a plate may be welded to the under side of the track frame and drilled and tapped from the top to the correct size and thread. If this is done, replace the regular bolt with one of sufficient length to obtain a full thread contact.

Check for failure at welds.

Check for general condition.

Assembly:

Assembly of the track frame is the reverse of removal. Refer to the section on Torquing of Bolts for correct torque specifications.

TRACK ROLLERS & IDLERS

Description:

The track rollers, front idler and top idler are all of basically the same construction with regard shafts and bearings. The bronze bushings fitted are all common parts. The shafts of necessity are different in design. Oil seals are also common. The track rollers and front idlers are lubricated through a fitting in the outer end of the shaft. Lubricant passes through a drilled passage in the shaft directly into a reservoir in the hub section. The top idler shaft has only one end exposed, the other is covered by a cap. The lubrication fitting is mounted in the cap in this case. The shaft is drilled here again to permit lubricant to pass directly into the reservoir of the idler.

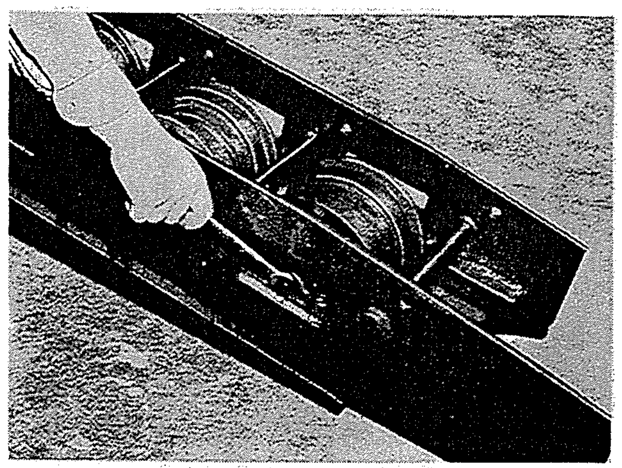
Bellow type seals keep the lubricant in, and keep foreign matter out of the bearing surfaces. Each seal is covered with a protecting cap which prevents large objects reaching the seal. The seal will however be exposed to fine particles, and water when the tractor is working in these conditions. These seals properly installed will function properly for a long period of operation. There are some points to watch for and for that reason seals will be dealt with under a separate section in this book.

Lubrication of the rollers and idlers is the principal factor in determining their useful life. Lubricant should be sufficiently free flowing to provide proper lubrication during the coldest conditions it will be subjected to. This is important for another reason. As can readily be understood, the rollers do not necessarily turn all the time. When the tractor is working on uneven terrain only those rollers that are carrying weight will be turning. The weight of the track will pull the track chain away from the rollers where it can and the roller may momentarily stop. When pressure of the chain comes on the roller again, the roller is put into motion by the friction of the chain against it. A heavy lubricant will increase the friction required to start the roller, which increases the wear on the roller and the track chain. This condition is perhaps most obvious on the top idler of the five roller track frame. Rollers and idlers must turn freely at all times, otherwise flat spots can develop. When this happens, the roller or idler should be replaced.

When such a light lubricant is used operators will sometimes complain of the oil seals leaking. Be sure the oil seal is at fault before going to all the work of changing it. See the following section on Oil Seals.

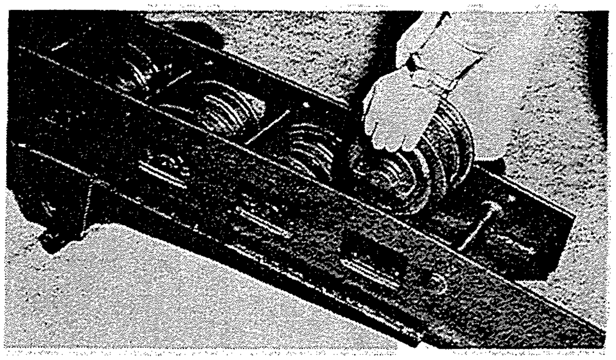
Removal:

Track rollers may be individually removed by removing the track chain and blocking the tractor up high enough to permit removal of the roller under the stone guard. Chain guides will have to be removed if the tractor is so equipped. If all the rollers are being removed it is good economy to remove the track frame as described in the section under that heading, and invert the frame as shown in Illustration 4. With the track chain guides removed and the grease fitting removed from the end of the shaft, remove the four cap screws which



Illust. 33. Remove the grease fitting before lifting out the roller.

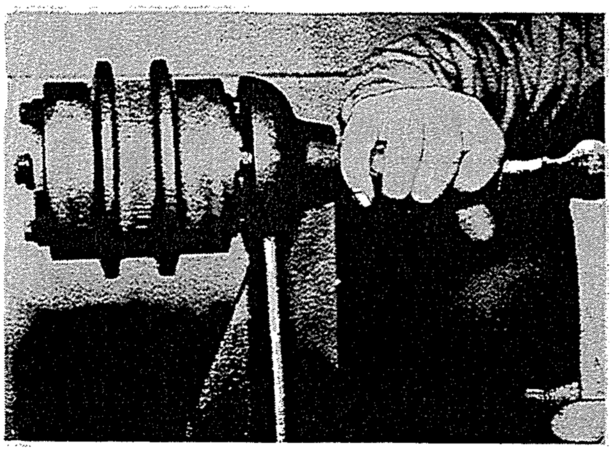
hold the shaft to the track frame. The roller complete with the shaft, brackets and oil seals may be lifted out of the frame. See Illustration 34.



Illust. 34. Roller lifted out of frame.

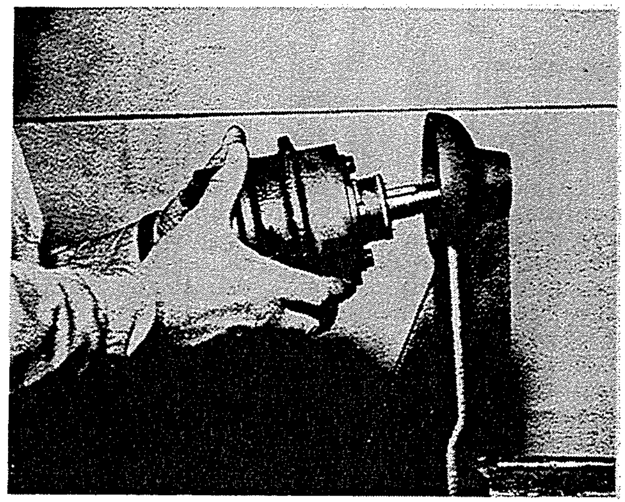
The top idler may be removed from its support without removing the support from the track frame. Here again in many instances it will be found advantageous to remove the support, particularly in the event of a complete track frame overhaul. Whether or not the support is removed the procedure is the same.

Remove the nut and lock washer from the inside end of the shaft. Drive the shaft out using a soft hammer or a soft drift. It sometimes happens that the



Illust. 35. Drive shaft out using a soft hammer or a soft drift.

inside of the hole in the support is wedged in by the action of the lock washer. DO NOT attempt to turn this shaft out. It is located with a key, See Illustration 36.



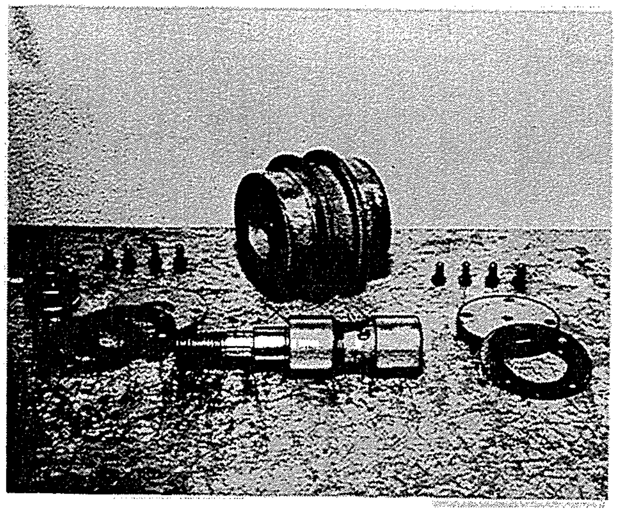
Illust. 36. Top idler and support.

Inspection:

Check the wearing surfaces of the shafts and bushings. Check for wear or galling at the ends of the shaft and the endplates. If signs of galling exist, polish the surfaces with emery cloth, or replace the parts if necessary. Check the outer circumference for flat spots in the areas where the track chain makes contact. Replace if there are any well defined flat spots. Check the condition of the oil seals and check the shaft for tightness of fit in the support.

Assembly:

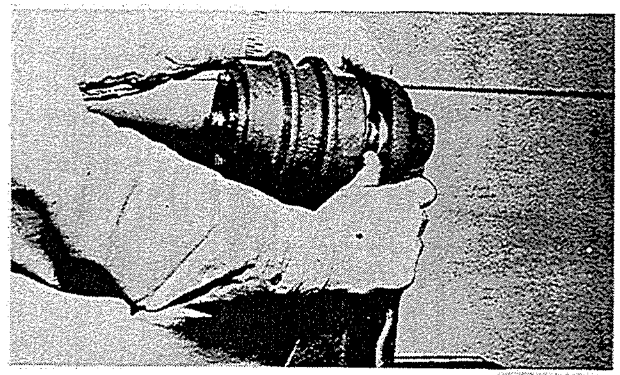
Assembly of the rollers and idlers is generally the reverse of removal. Lubricate the contact surfaces of the bushings and the shaft with light engine oil when installing the shaft. If any binding is detected at this time it must be eliminated before going further. If new bushings have been pressed into the rollers or idlers, high spots may develop which can cause binding. Such high spots can be removed in most cases by pushing the shaft into place (use hand pressure only) and with a soft hammer, tap the shaft from all sides. If more than hand pressure is required to force the shaft into place, the bushing should be removed and replaced with a new one.



Illust. 37. Components of top idler.

When assembling the thrust plates gaskets may be added or deleted to arrive at the proper end clearance of .010" to .020". Gaskets are .010" thick. The setting is not critical, but it is important that the shafts turn freely in the bushings when the end plates are torqued down. (20 - 23 ft. lbs.)

When assembling the top idler, a little heavy grease on the sealing surface of the seal will help hold it in place. Assemble the unit as shown in Illustration 38. With the unit assembled this way the seal can be



Illust. 38. Locate the oil seal.

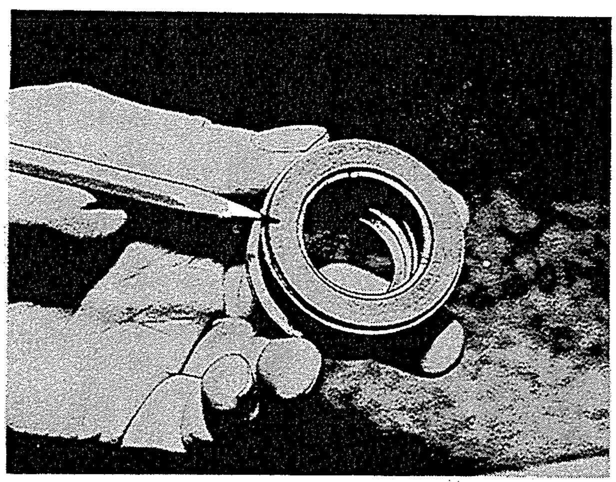
located with the fingers and will stay while the shaft and roller are pushed into place. If the support has been removed from the track frame, it may be placed on its side on a bench, the seal when dropped into place will remain that way during assembly.

Installing the rollers in the track frame is the reverse of removing. The track roller shaft brackets (caps) can be properly installed on a bench with the seals in place. The caps can then be forced together by hand and the unit thus set in place in the track frame. Install the four cap screws and torque to 85 - 95 ft. lbs.

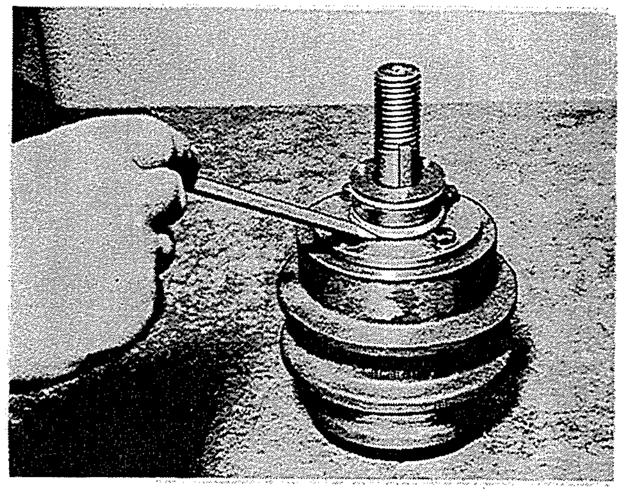
OIL SEALS

The oil seals used in the track rollers, front idlers, and top idlers are all the same part and interchangeable. Oil seals are dealt with separately not because they present any particular problem but because what applies to these seals in one place also applies in others. A little time spent studying their function and operation may save a great many hours of unnecessary work later.

The oil seal has two sealing surfaces; the one, see Illustration 39 is of leather and is held against the thrust plates under spring pressure. This is the only part of the seal that meets with friction and normally the only part that will wear. With lubricant constantly present and the relatively slow movement of the thrust plate across this surface, these seals are good for many hours of use.

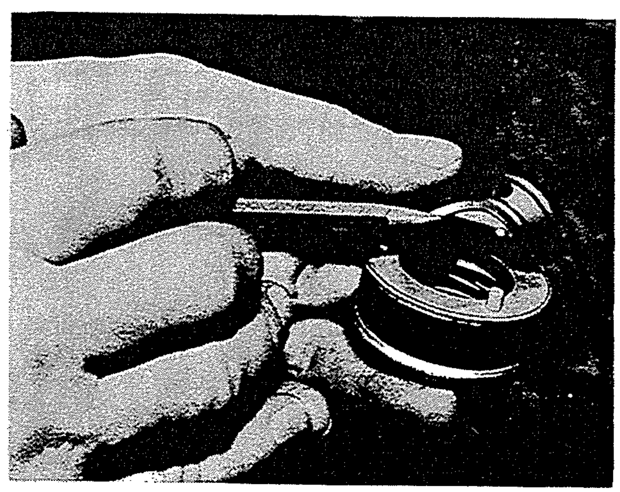


Illust. 39. Sealing surface.



Illust. 40. Sealing surface contacts thrust plate.

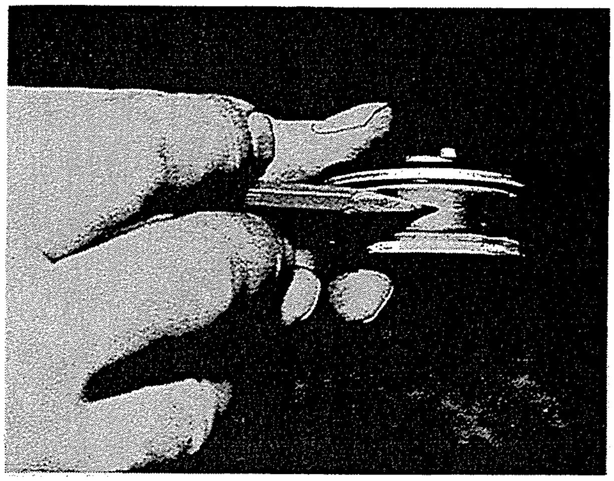
The second sealing surface is not exposed to friction so once properly installed there is little possibility of failure. See Illustration 41. This neoprene back-up washer serves two



Illust. 41. Neoprene back-up washer.

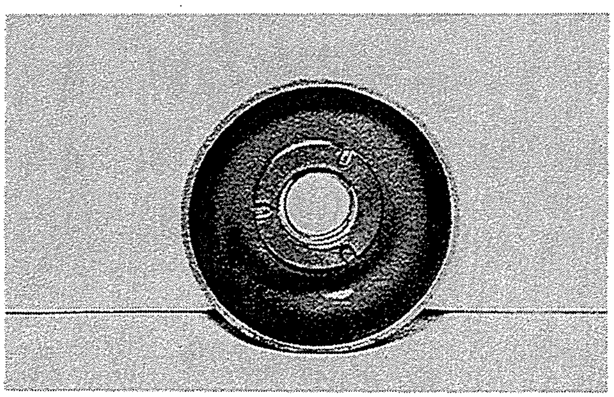
purposes; it acts as a gasket between the seal and the outer cap which the seal is located in and also serves as a relief valve when pressure becomes excessive during lubrication. As a relief valve it closes to prevent foreign matter from entering by the same route.

Between these two surfaces is a coil spring which applies pressure to load both. The spring is covered and sealed by a neoprene bellows. This bellows keeps lubricant in and dirt out without interfering with the action of the spring.

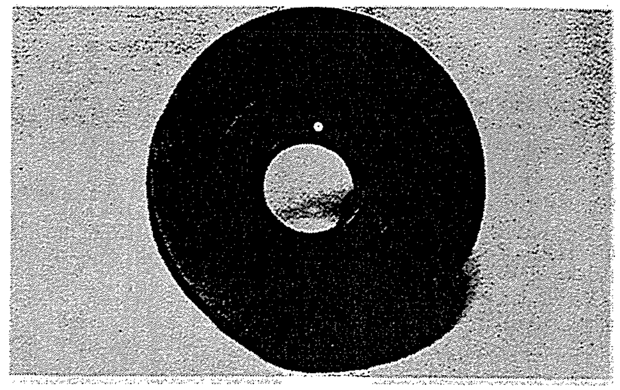


Illust. 42. Bellows keeps lubricant in and dirt out.

The back-up washer side of the seal has three dowels. These dowels must be properly located in the holes provided, shown in Illustrations 43 and 44.

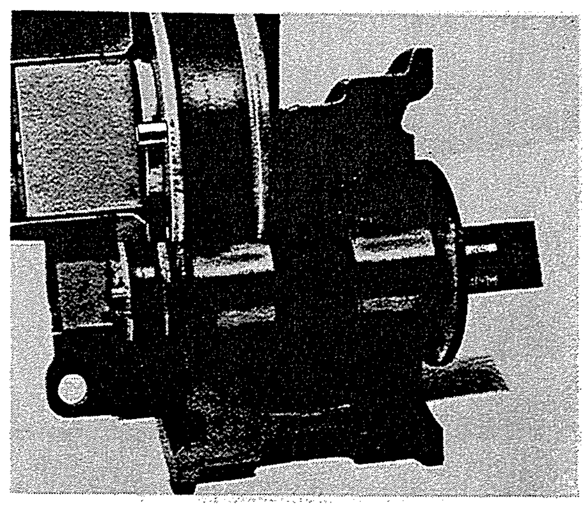


Illust. 43. Inside view of front idler cover.



Illust. 44. Inside view of track roller shaft bracket.

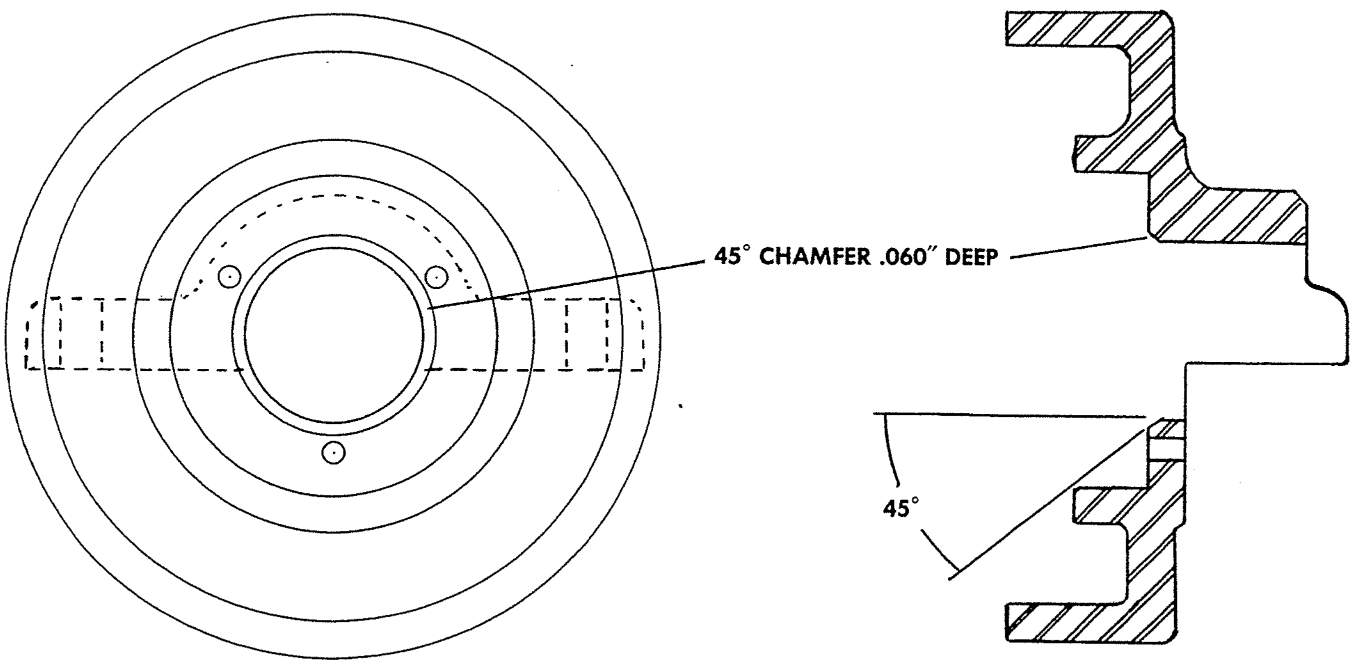
The back-up washer (Illust. 41) must be installed with the ribs contacting the seal and the flat smooth side out against the locating surface. Also note how the knife edge of the seal (Illust. 41) seals against the shaft (Illust. 45). It will be noted in Illustrations 44 and 45 that



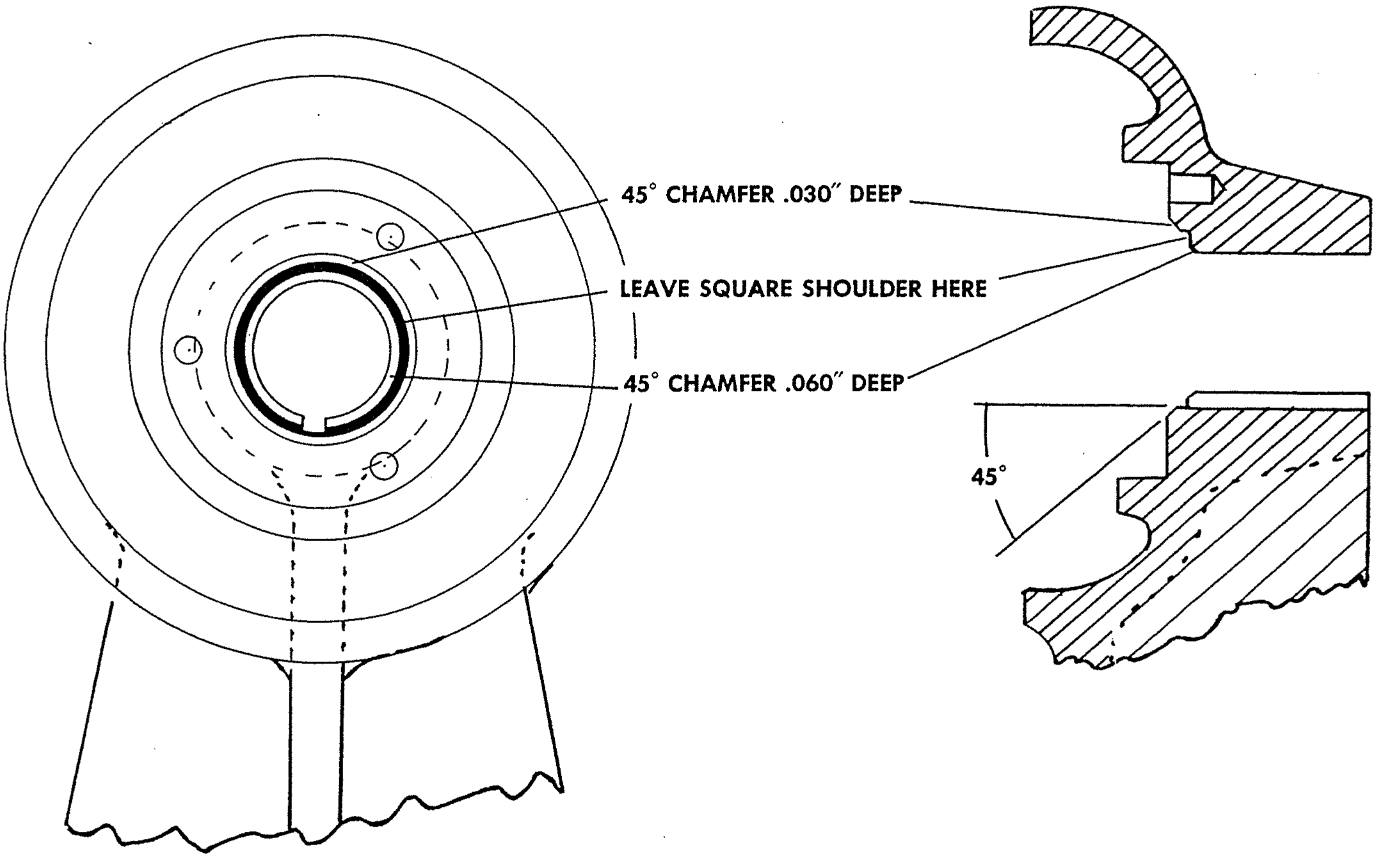
Illust. 45. Cross section of a track roller showing seal, shaft, bracket and oil reservoir.

the track roller shaft bracket has a chamfer. Also notice in Illustration 43 that this cover is also relieved at this point. This feature is not included in the track roller or top idler assemblies of early tractors. If it were possible to install a seal and know after it was on that the knife edge had not been damaged on the back-up washer there would be no real need for this chamfer. However, once the seal is in place there is no way of telling what condition it is in. Also, this chamfer improves the unloading characteristics of the knife edge, reducing the possibility of imposing excessive pressure on the seal when lubricating. The operator in the field may find that some seals will leak when lubricating the rollers etc. and others won't. Immediately he can get the impression that the leaking seals are damaged and require replacing. With the chamfer in the caps all the seals will leak if over-lubricated, and leakage at the time of lubrication will be natural. It should be kept in mind that in some cases an operator may be able to force lubricant in faster than it can get out, particularly in cold weather. These are things over which we have no control but trust that the operator when properly instructed will use good judgment.

On these early tractors it is recommended that the rollers shaft brackets be re-worked as shown in Illustration 46, and the top idler support be re-worked as shown in Illustration 47. This may be done with a round or half-round file or a suitable power grinder.



Illust. 46. Roller shaft bracket re-working diagram.



Illust. 47. Top idler support re-working diagram.

TRACK FRAME SETTINGS

The changing of track frame settings and the reasons for doing so are mentioned earlier in this book (page 3). Should it be necessary to make this change the following paragraphs describe the details. Additional parts will be required. The chart below will be found helpful in determining the requirements.

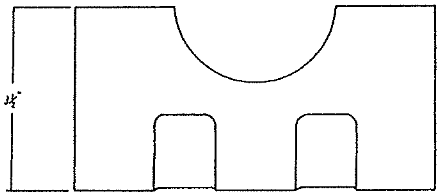
Parts are required as indicated to set track frames as follows?		A	B	C	D	E	F	G	H	I
		635 639 R1	635 640 R1	635 046 R1	635 045 R1	109 270	179 891	635 081 R1	635 082 R1	635 083 R1
FROM	TO									
Regular	Forward		4		16		4		2	
Forward	Regular	4		16		4		2		
Regular	Rear		4		16		4			2
Rear	Regular	4		16		4		2		
Rear	Forward								2	
Forward	Rear									2
See these illustrations for identification of parts.		48	49	50	51	52	53	54	55	56

NOTE: For tractors equipped with rubber spacers in the gauge bar mounting pads substitute items in "A" and "B" as follows:

"A" use 635 204 R1

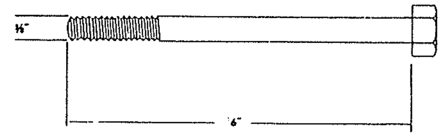
"B" use 635 205 R1

The numbers in the lettered columns indicate the number of the particular items required for changing the track frame settings on one tractor.

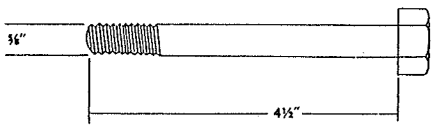


Ill.48. Gauge Bar Mounting Pad.

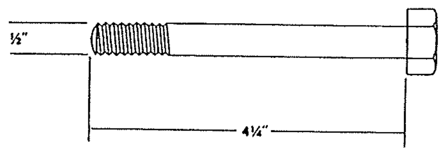
Ill.49. Gauge Bar Mounting Pad.



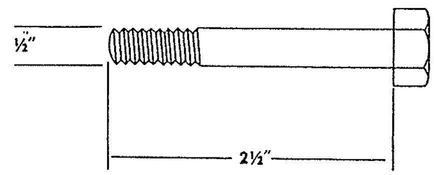
Ill.50. Cap Screw.



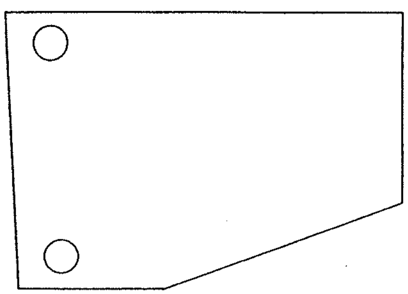
Ill.51. Cap Screw.



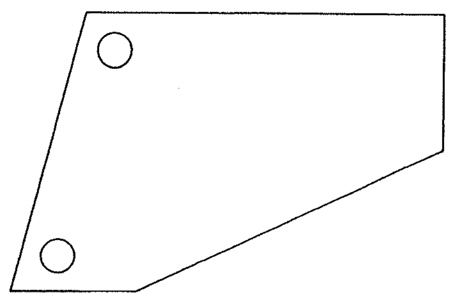
Ill.52. Cap Screw.



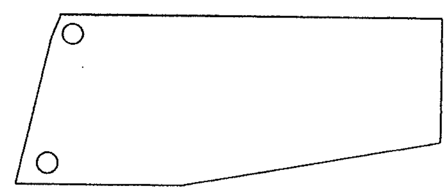
Ill.53. Cap Screw.



Ill.54, Final Drive Gauge Bar Stop.



Ill.55. Final Drive Gauge Bar Stop.

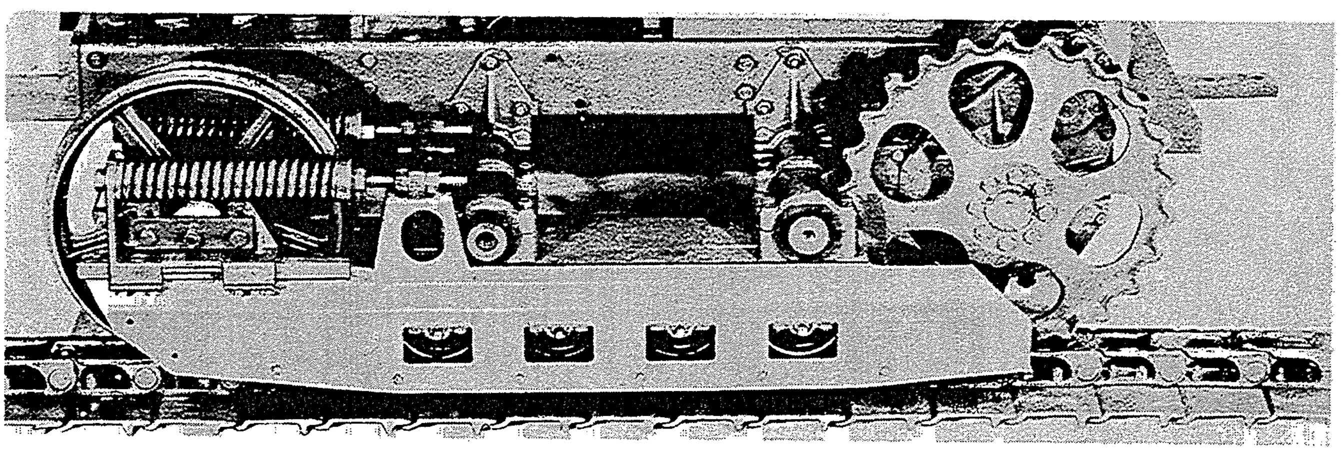


Ill.56. Final Drive Gauge Bar Stop.

To set Track Frames in FORWARD POSITION:

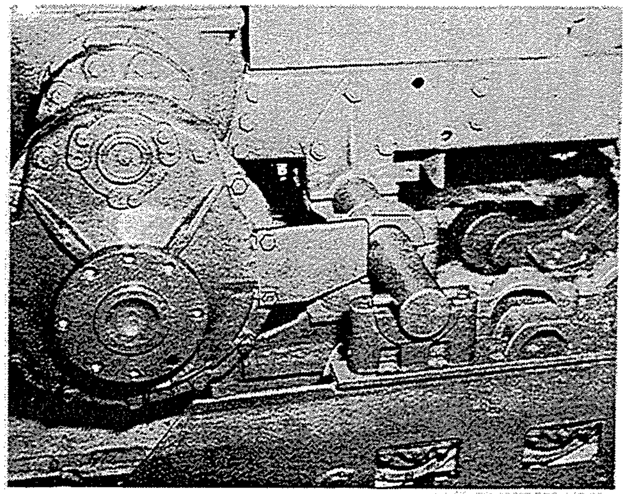
1. Loosen track chain tension and break the track.
2. Remove gauge bar mounting caps from both sides of tractor.
3. Jack tractor high enough to remove gauge bar mounting pads (Illust.27).
4. Support tractor front and back leaving gauge bars free for removal.
5. Remove the track frames forward on the track (Illust.28).
6. Re-locate gauge bars forward on tractor frame. See Illust.57. The inner ends of the rear gauge bars are bolted to the tractor main frame. Holes are provided for this setting in all tractors. Adjust the front gauge bar as shown in Illustration 57.
7. Remove the final drive housings and spacer castings as a unit by removing the bolts that secure the spacers to the main frame. This will require removing the steering clutches. For details of this see the information under that heading.

   NOTE: Do not rotate the final drive housing on the spacer casting. This will close off an oil passage.
8. Rotate the final drive housing forward one bolt. Replace the bolts and torque to 120 - 135 ft. lbs.
9. Remove the final drive gauge bar stop shown in Illustration 58 and replace it with the correct one.
10. Re-assemble is the reverse of disassembly. Install the new gauge bar mounting pads in the same position as used for the regular track position.



Illust. 57. Track frames set "Forward".

To set Track Frames in "REAR POSITION":



Illust. 58. Install the correct final drive gauge bar stop.

1. Loosen the track chain tension and break the track.

2. Remove the gauge bar mounting caps from both sides of the tractor.

3. Jack the tractor high enough to remove the gauge bar mounting caps. (Illust. 27)

4. With the tractor firmly supported remove the track frames by pulling them forward on the track (Illust.28).

5. Remove the steering clutches (see details under that heading).

6. Remove the final drive housings and spacer castings as a unit by removing the bolts that secure the spacer to the main frame.

   NOTE: Do not rotate the housings on the spacers. This will close off an oil passage.

7. Rotate the housing and spacers one bolt rearward. Replace the bolts and torque to 120 - 135 ft. lbs.

8. Remove the final drive gauge bar stops (Illust.58) and replace with the correct ones.

9. Re-assembly is the reverse of disassembly. Install the new gauge bar mounting pads on the track frame in the set of holes provided forward of the holes previously used.

NOTE: In the event of making the above setting on a four roller track frame it will be necessary to loosen the front gauge bar and slide it in order to install the track frame. See the section in this book on Track Frame Removal (Illust.30).

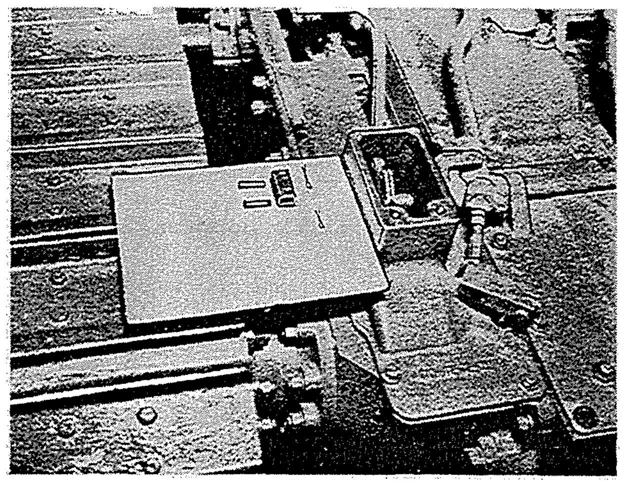
STEERING CLUTCH REMOVAL

NOTE: In the preceding pages, it has been indicated that altering the position of the track frame on the chassis of the tractor requires removing the steering clutches. All the tractors which are so set when assembled at the factory are done in the manner described. It is possible to re-locate the track frames without removing the steering clutches if desired. If this is the method chosen, proceed as before until coming to the removal of the housings and spacer castings as a unit. Instead, remove the housing leaving the spacer casting on the tractor frame. Using the gasket as a template drill one hole in each final drive housing to line up with the drain hole in the spacer casting when the housing is reinstalled in its new position. When drilling, pack a wiper cloth in the area where the drill will come through to prevent cuttings getting into the final drive gears. Keep in mind that the re-worked housings will not be inter-changeable with new housings, and will only work on one side of the tractor. If a new housing ever has to be installed on a tractor set by this method it will also require re-working.

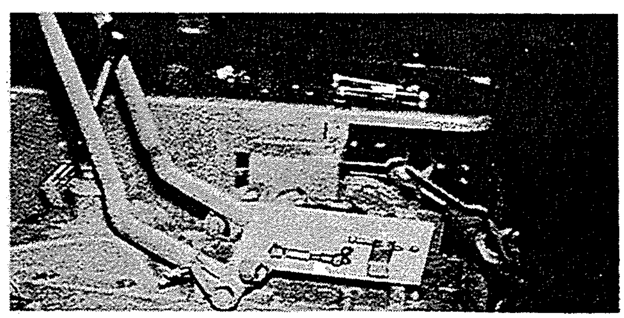
Keep in mind that removing the steering clutches is not a difficult operation. Weigh the facts before making your decision as to the method to use.

To remove the steering clutches, remove the tractor fenders or the seat. Which one to remove will depend on the equipment on the tractor. If the tractor has a hydraulic valve mounted on the right fender for example, removing the seat will eliminate the need for opening hydraulic lines.

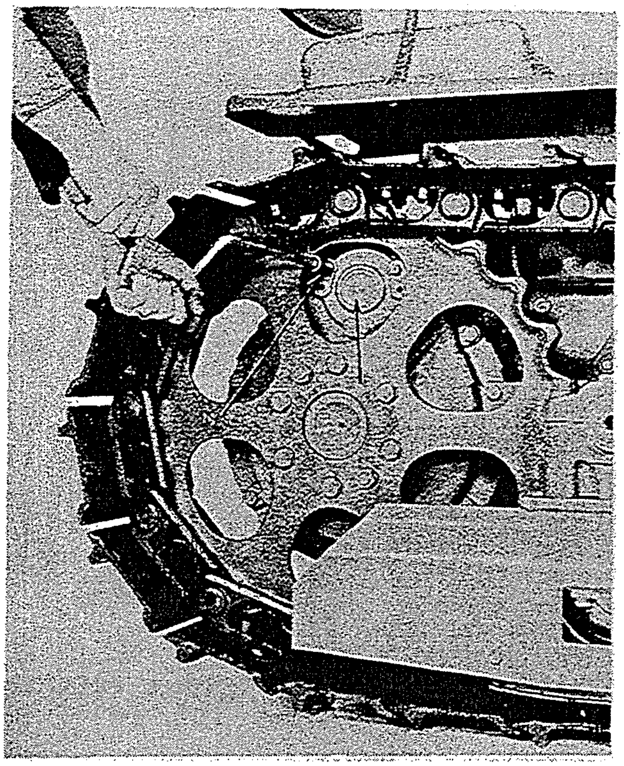
1. Remove the inspection cover from the steering clutch housing.
2. Disconnect and remove the brake lever link (Illust.59).
3. Remove the steering clutch link and the arm from the top end of the steering clutch release shaft.
4. Remove the steering clutch housing cover.
5. Remove the final drive pinion shaft cap from the final drive housing. (Illust.61). Use the caps screws for lifting the cap off (Illust.62).



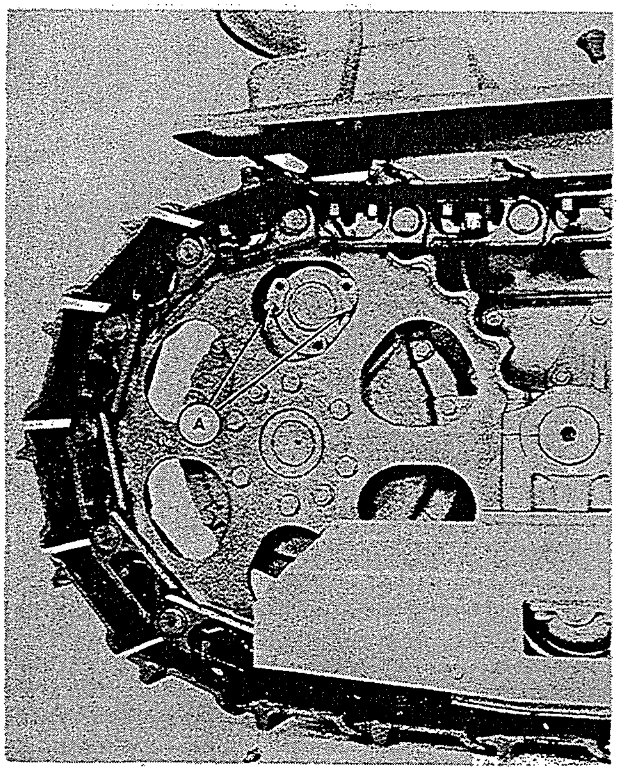
Illust. 59. Remove the steering clutch housing inspection cover.



Illust. 60. Remove the steering clutch linkage.



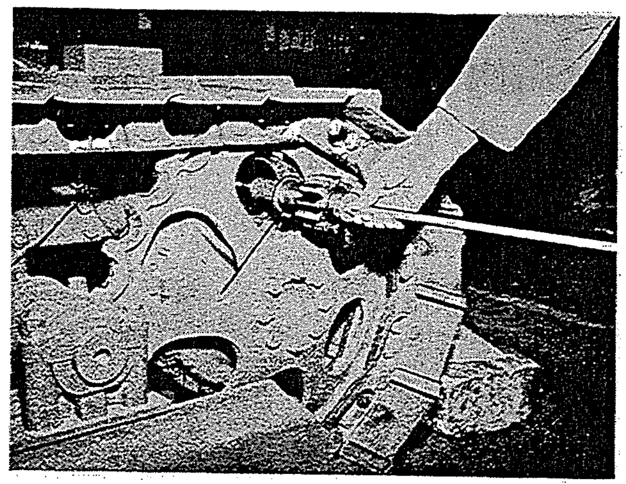
Illust. 61. Remove final drive pinion shaft cap.



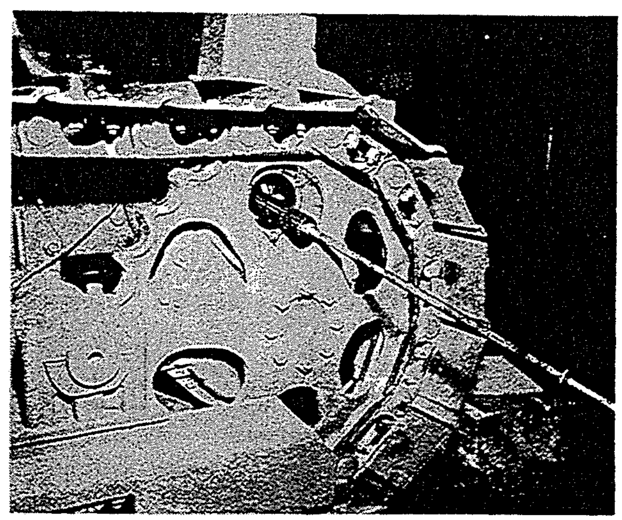
Illust. 62. Use screws in threaded holes for lifting cap off.

6. Remove final drive pinion shaft as shown in Illustration 63. The end of this shaft is drilled and tapped to take a 1/2" NC thread. Use a slide hammer to pull the shaft. NOTE: On the inside face of the pinion a steel thrust washer is located to take the end thrust of this shaft. TAKE CARE NOT TO DROP THIS WASHER into the final drive housing when removing the pinion shaft. If by chance the washer should drop it may be recovered by removing the final drive housing and inverting.

7. With the same fitting on the slide hammer, reach into the opening left by the pinion shaft and pull out the bevel gear shaft. See Illustrations 64 and 66. The steering clutch may now be lifted out through the top



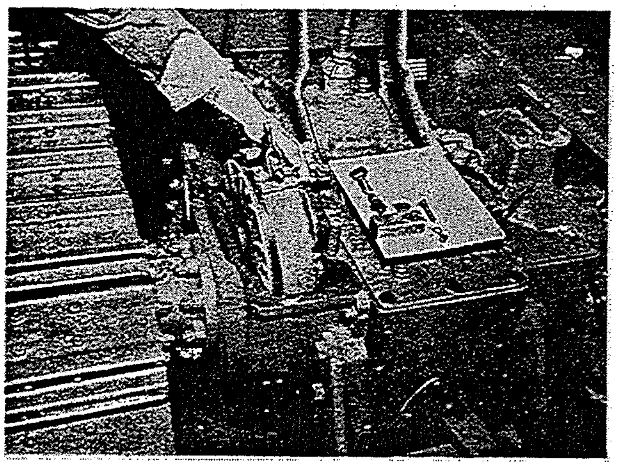
Illust. 63. Remove pinion shaft.



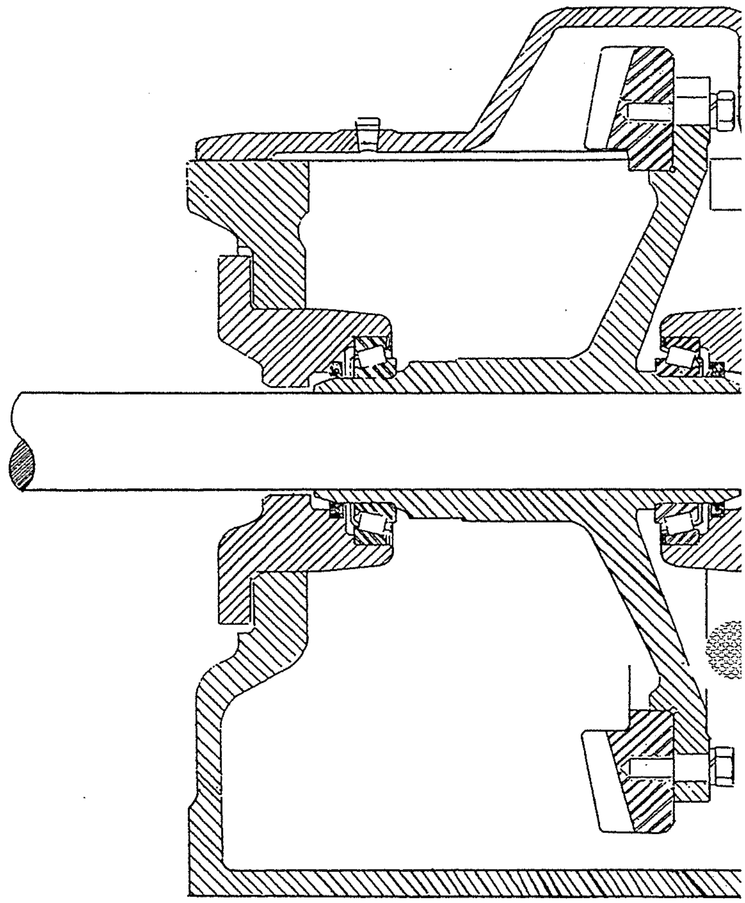
Illust. 64. Remove bevel gear shaft.

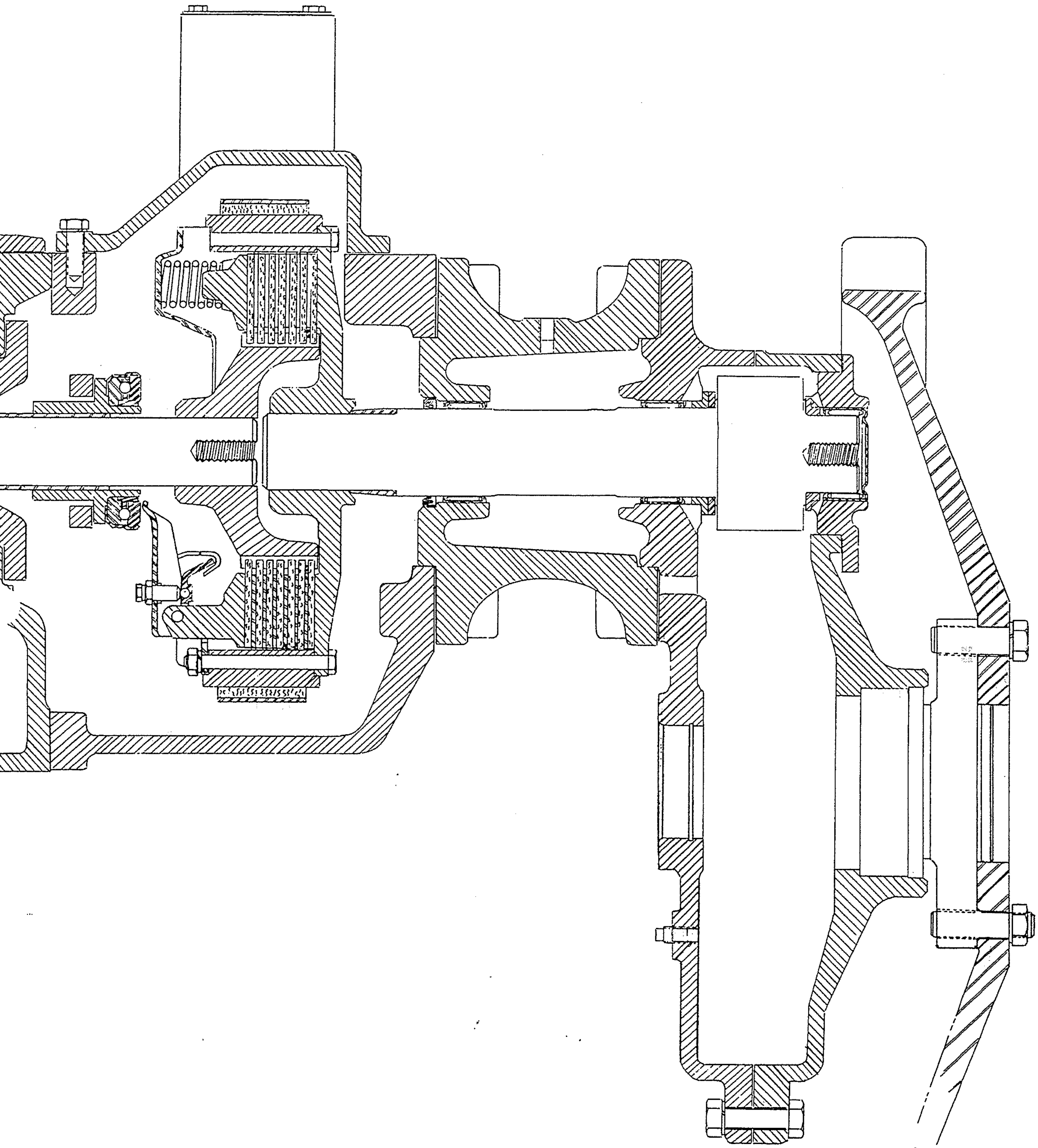
complete with the brake band. Illust.65.

Installation of the steering clutch is the reverse of removal. After completing the re-assembly, adjust the steering brakes and clutches.



Illust. 65. Removing steering clutch complete with brake band.





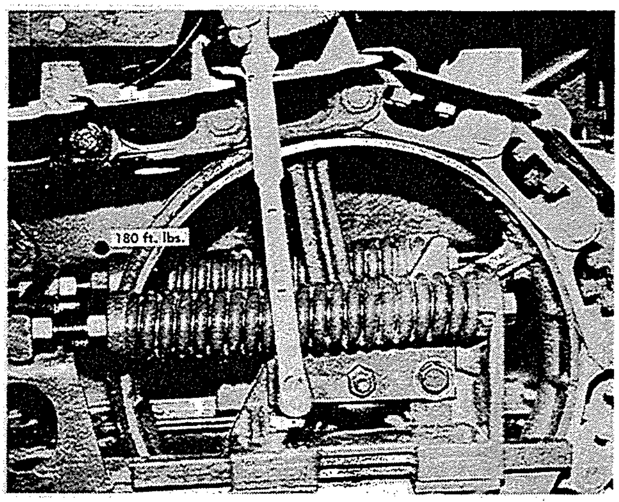
Illust. 66.

TORQUING OF BOLTS

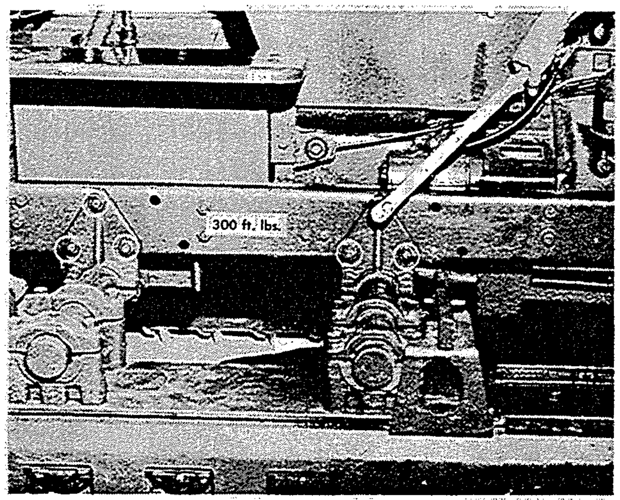
The correct torquing of bolts is important in any mechanical work. The bolts used in the track frames of this tractor differ in material and it follows that two 1/2 inch bolts, used in different places may have different torque specifications. For example, illustration 67 shows two cap screws and the end of the idler shaft which have the same thread but different torques. The cap screws in this case are torqued to 180 foot pounds and the shaft is torqued to 135 ft. pounds. This reduced figure is brought about in this case by the fact that the idler shaft is drilled for a grease fitting.

In the following illustrations, the correct torques are shown for one bolt but apply to all other such bolts serving the same purpose. For example, in Illustration 68 the torque figure applies to six bolts on each side of the tractor. Illustration 69 likewise applies to eight bolts on each side.

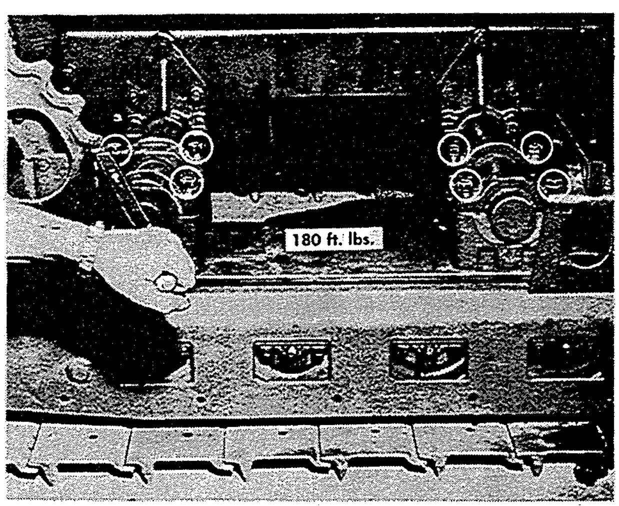
All torque readings are to be taken on undamaged threads, lubricated with engine oil and free of dirt or other foreign matter which may affect the friction between threads, or bolt heads and mating surfaces. When torquing a bolt and nut always measure the torque on the nut where possible. (Illust. 70 & 71).



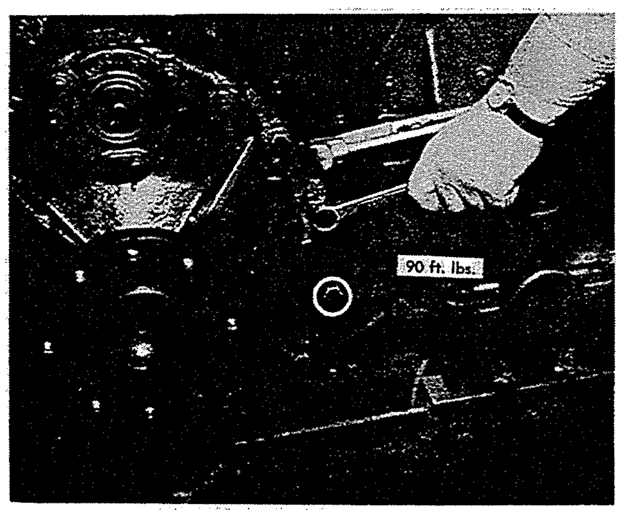
Illust. 67.



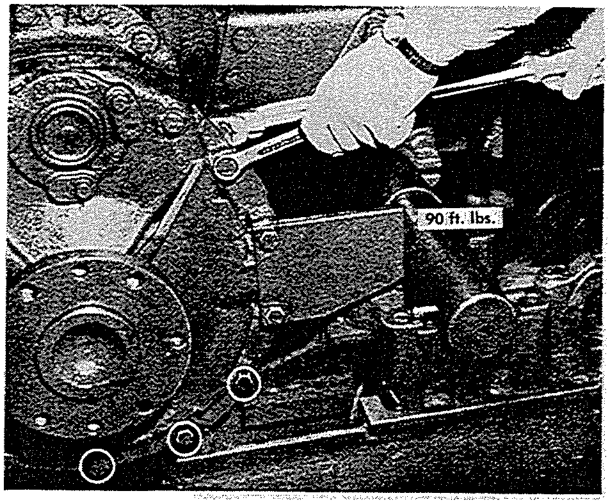
Illust. 68.



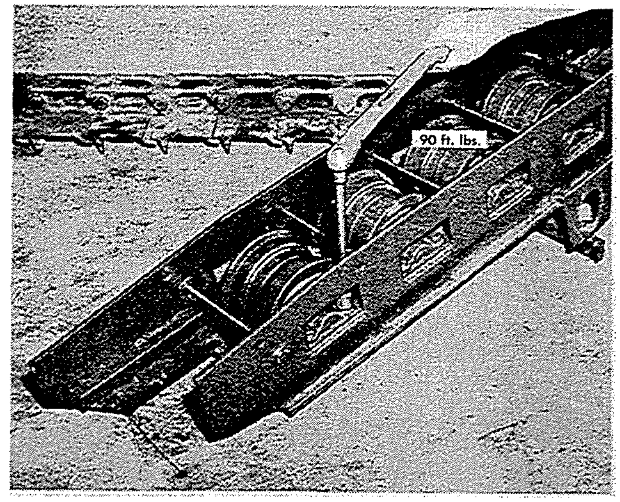
Illust. 69.



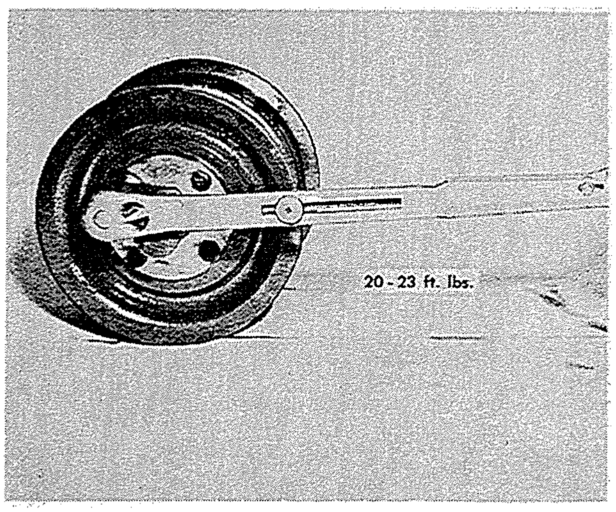
Illust. 70.



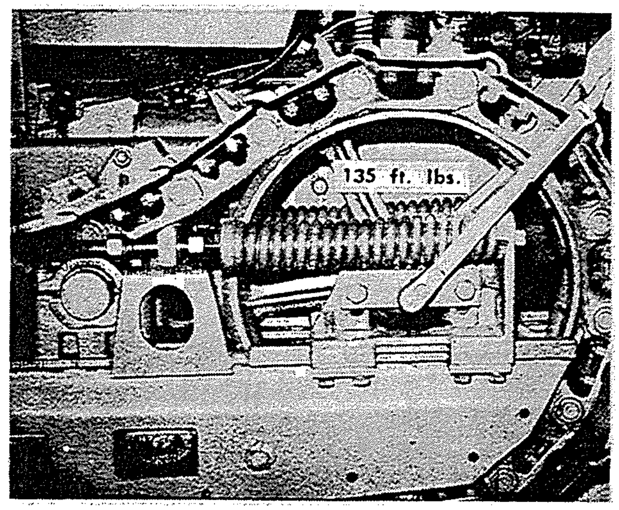
Illust. 71.



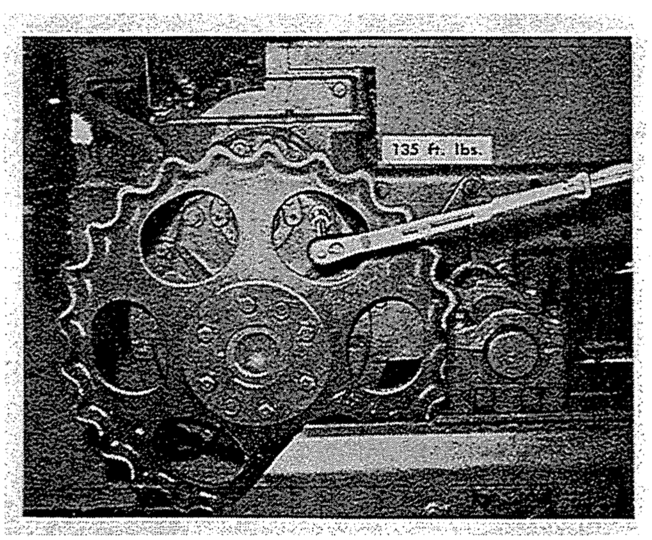
Illust. 72.



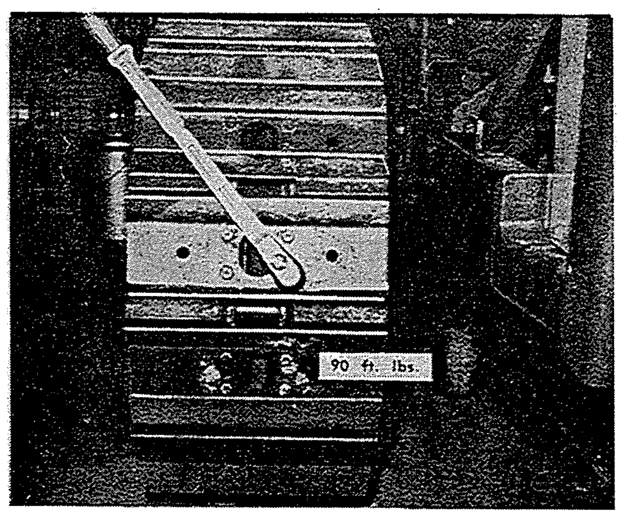
Illust. 73.



Illust. 74.



Illust. 75.



Illust. 76.

MODEL T4, T5, TD5
TC5 and TDC5

Transmissions & Final Drives

FORM
GSS-1255

CONTENTS

DESCRIPTION

The T4, T5, TD5, TC5 and TDC5 crawler tractors are all equipped with the same basic transmission. The standard tractor which has no Torque Amplifier or Reverser has a two shaft transmission, the top shaft being in two parts. The front portion is carried in a cage on two ball bearings. This shaft accommodates a roller type pilot bearing and supports the front of the rear member of the top shaft. The rear end of the top shaft with the bevel pinion is carried by two tapered roller bearings mounted in a cage. These bearings take end thrust as well as radial load. The lower shaft, or countershaft, is supported front and rear on ball bearings. The front bearing is located in the housing with a snap ring and cap. The rear bearing is a push fit in the housing and end movement is controlled by the countershaft. The countershaft is splined to accommodate the gears. These gears are held in place by a retainer washer and two 5/16" bolts, which compress gears, spacers and bearings into a solid unit. A constant mesh gear on the front section of the top shaft drives a matching gear on the countershaft. Changes in speeds are effected by sliding gears on the rear section of the top shaft, meshing with the stationary gears on the countershaft. The reverse idler is driven off the 2nd gear on the countershaft. The low gear on the top shaft when moved to the rear of the transmission housing meshes with the reverse idler thus providing a reverse gear of relatively low speed.

When a tractor is fitted with a Torque Amplifier or Reverser the solid transmission countershaft is replaced with a hollow shaft. The same gears are used with both countershafts. The gears in this case are secured with a nut on the front end of the countershaft. The front bearing is located in the housing and the rear bearing is located by the countershaft. Through this hollow countershaft runs the power take-off shaft when the tractor is so equipped. The power take-off is driven from a point forward of the Torque Amplifier or Reverser, thus PTO shaft speed and direction will not be affected by these attachments.

The Torque Amplifier is a planetary gear reduction unit located between the engine clutch and the transmission. It provides a dual range for the regular transmission. When the tractor is equipped with TA, the low gear is blanked out Therefore the TA unit provides 8 forward speeds and two reverse in place of the regular 5 forward and 1 reverse. This shift can be made without using the clutch pedal. It should be understood however, that clutching is required for shifting the transmission gears.

The Reverser attachment is accommodated in the same housing as is the Torque Amplifier. They cannot, however, be installed simultaneously. It provides a reverse in every transmission speed, thus giving as many reverser as forward speeds. The control lever moves a shifting collar which will provide forward, neutral, or by means of a planetary gear train, reverse. When a reverser is installed in a tractor the reverse idler is not provided in the transmission.

The Power Take-Off in the standard tractor (no torque amplifier or reverser) runs off the transmission countershaft. The PTO drive is effected through a sliding collar actuated by a shifter fork and hand control on the left side of the tractor main frame casting.

When the tractor is equipped with Torque Amplifier or Reverser there may be either of two types of power take-off used; transmission type PTO or constant running PTO. In the case of transmission type PTO the engine is fitted with the same clutch and flywheel as is used with the standard transmission. The drive to the transmission is through a solid shaft fitted with a gear which drives the PTO through a lower shaft which passes through the hollow transmission countershaft. It follows that any tractor equipped with Torque Amplifier or Reverser has a different countershaft than does a tractor with a standard transmission.

The Constant Running PTO which may be used with either Torque Amplifier or Reverser (not standard transmission) is made possible by a two stage clutch. This clutch is operated through one stage at a time by a single foot pedal which first disengages the transmission drive, then the PTO drive, by pressing the pedal all the way down. The drive from the first stage goes directly to the transmission top shaft through a solid clutch shaft. The PTO drive is taken off the second stage of the clutch (rear driven member) by a hollow shaft outside the solid clutch shaft, by a pair of gears, to the PTO drive below, through the hollow countershaft, to the PTO at the rear of the tractor. Tractors equipped with Torque Amplifier or Reversers at the factory, but less PTO, have the front drive parts installed.

At the rear of the transmission in a separate compartment but opened to the same lubricating oil, are the bevel gear and pinion. The pinion is integral with the top transmission shaft. The drive from the bevel gear to the driven members of the steering clutches consists of a splined shaft running through and carried by the bevel gear. The bevel gear is carried on tapered roller bearings.

The steering clutches are identical and interchangeable. They are a spring loaded multiple dry disc clutch with 7 fiber friction discs and 6 floating clutch plates. The outer circumference of the clutch housing serves as a brake drum. The clutch levers (steering levers) actuate the brakes on their particular side. The foot brake operates the two brakes simultaneously, and is equipped with a latch which can be used as a parking brake.

The driven member of the clutch is carried on a splined end of the final drive pinion shaft. The pinion shaft is carried on needle roller bearings.

The final drive gear which is driven by the pinion is carried on tapered roller bearings. Oil seals in the final drive spacer castings and bevel gear bearing retainers keep oil from entering the steering clutch housing. The drive sprockets are bolted directly to the shaft carrying the final drive gear.

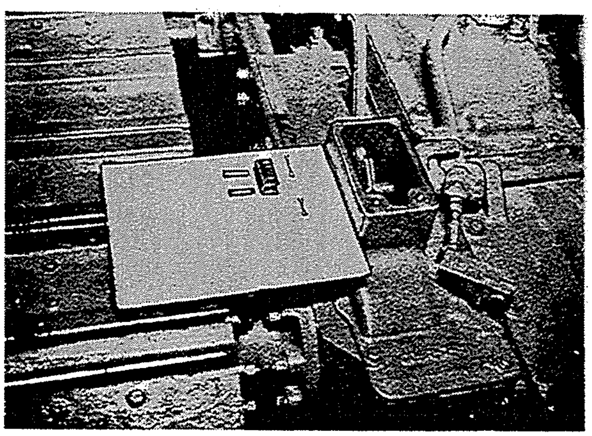
STEERING CLUTCHES & BRAKES

The steering mechanism and brakes are very closely related in crawler tractors, so they will be dealt with jointly. Removal of one requires removal of the other as well, so it is considered advisable to check both at the same time. The brakes in this tractor are relatively heavy, and for that reason will give long service when properly adjusted. The steering clutches likewise are designed for long periods of use without replacement, and when properly adjusted will operate for long trouble-free periods. The adjustments are simple and easily accessible.

A brake is provided for each track by a band around the clutch housing. The brake is operated by the same lever that disengages the steering clutch. By pulling the steering lever back part way the clutch is disengaged. Further movement of the lever applies the brake. It will be seen that it is important to have the clutch completely disengaged before the brake starts to apply. Failure to maintain proper adjustment here can contribute to wear of both the clutch and the brake. Proper adjustment will provide easier operation and better control for the operator.

Removal:

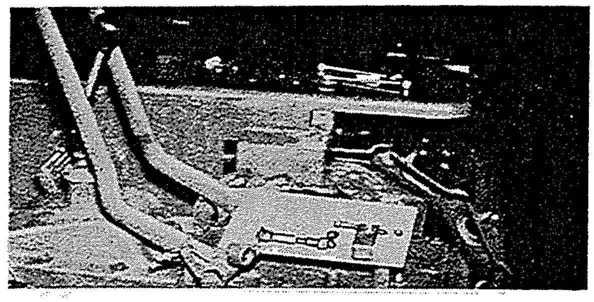
To remove the steering clutches and brakes, remove the tractor fenders or the seat. Which one to remove will depend on the equipment on the tractor. If the tractor has a hydraulic valve mounted on the right fender for example, removing the seat will eliminate the need for opening hydraulic lines.



Illust. 1

Remove the steering clutch housing inspection cover.

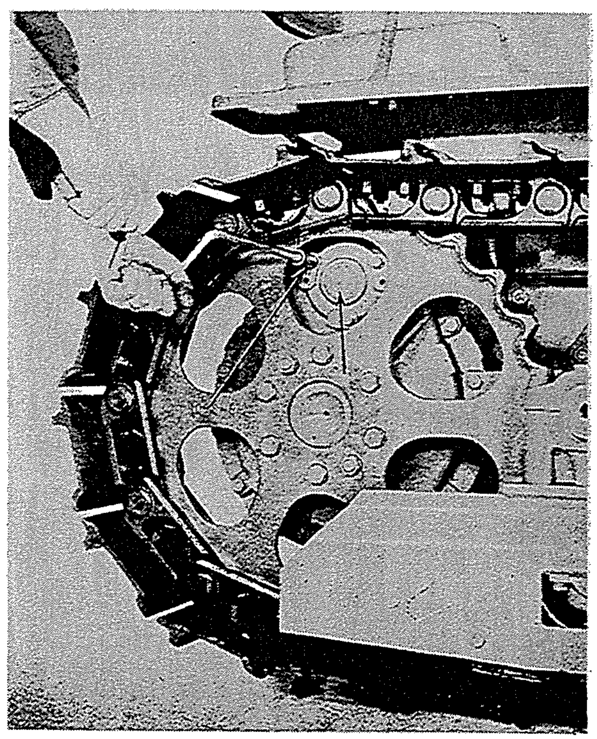
1. Remove the inspection cover from the steering clutch cover.
2. Remove the fender rear support bracket.
3. Disconnect and remove the brake lever link. (Illust. 1.)



Illust. 2

Remove steering clutch linkage.

4. Remove the steering clutch link and arm from the top end of the steering clutch release shaft.

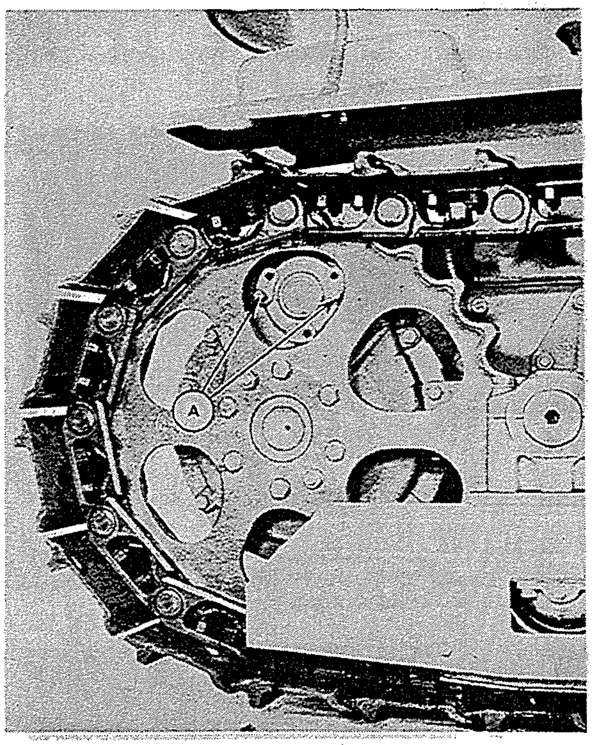


Illust. 3

Remove final drive pinion shaft cap.

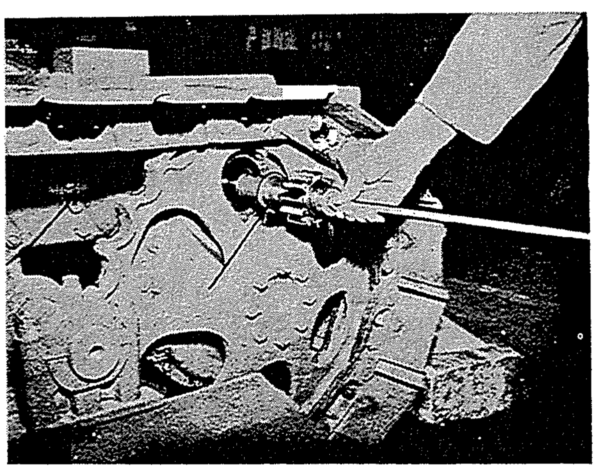
5. Remove the steering clutch housing cover.

6. Remove the final drive pinion shaft cap from the final drive housing, (Illust. 3). Use the cap screws for lifting the cap off, (Illust. 4).



Illust. 4

Use bolts in threaded holes for lifting off cap.

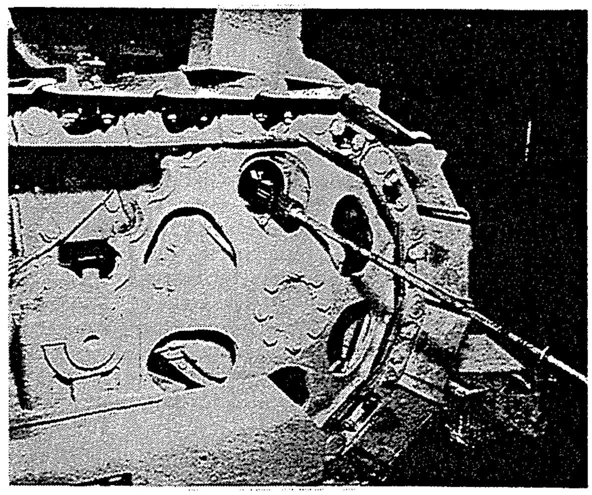


Illust. 5

Remove pinion shaft.

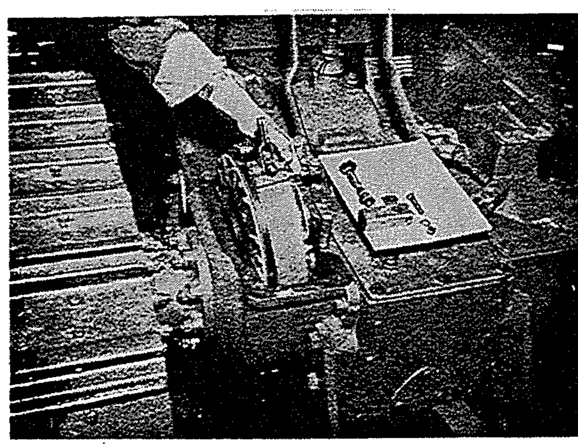
7. Remove the final drive pinion shaft as shown in Illust. 5. The end of the shaft is drilled and tapped to take a 1/2" NC thread. Use a slide hammer to pull the shaft.

8. With the same thread on the slide hammer, reach into the opening left by the pinion shaft and pull out the bevel gear shaft. (Illust.6) The steering clutch may now be lifted out through the top complete with the brake band. (Illust.7)



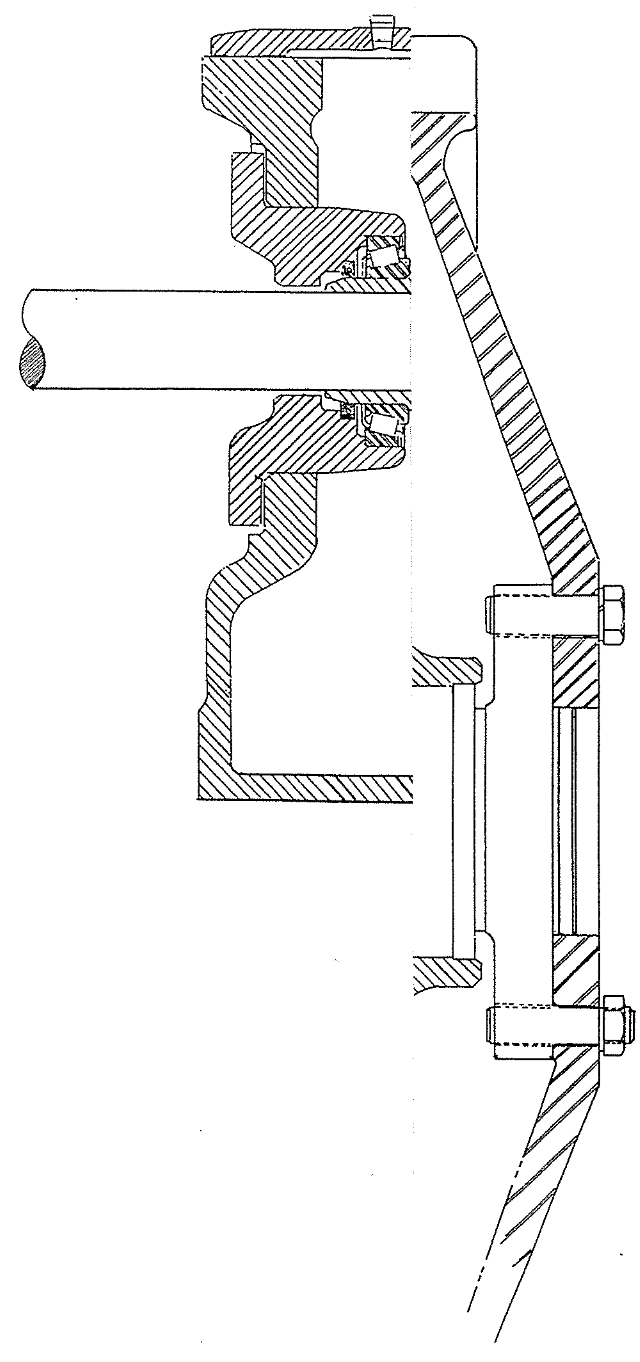
Illust. 6

Remove bevel gear shaft.



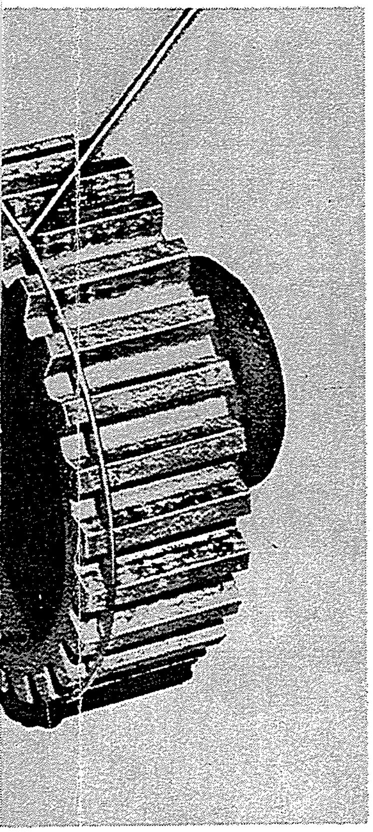
Illust. 7

Remove the steering clutch complete with brake band.



Illust. 8

ap ring on the hub
for proper seating in



ub with snap ring in

and evidence of wear on

ıgs on the clutch plates
:hes in the drum for

ırfaces of the discs and
ıding the inside faces
and base, for scoring

ıter circumference of the
(brake surface) for
ɔther damage.

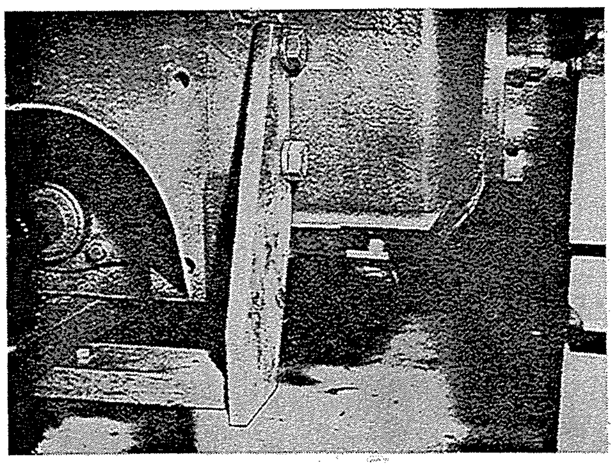
lutch release levers for
the clutch release bear-
ɔntact.

ɔndition of the clutch
ring at this time. The
ase bearing is pre-
and should not be washed.

Check the clutch lever springs.

Check the clutch release lever adjustment as shown in Illust.13.

Evidence of rust in the steering clutches is not uncommon, and some rust will not interfere with the operation or life of the clutch. If rust accumulation is excessive, check the drain holes in the bottom of the steering clutch housings. Some of the early tractors are not equipped with this drain. If it is considered necessary, holes may be drilled and fitted with plug 636 052 and cotter pin 108 635 (1/4" pipe plug and 1-1/8" X 1/8" cotter pin). If a tractor is working in water these holes should be plugged with a pipe plug. The housings can be drained if necessary by removing the lower bolt which secures the brake anchor pin. (Illust.12)



Illust. 12

Brake anchor pin.

Assembly and Adjustment:

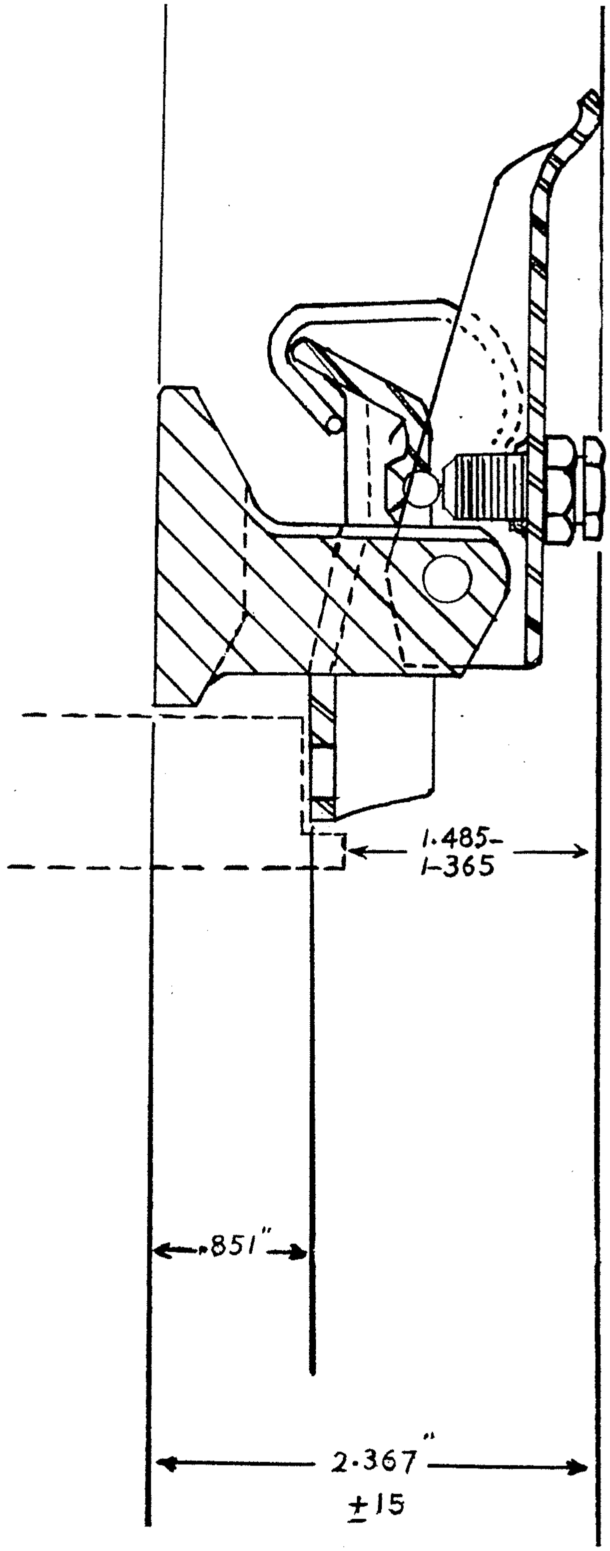
Assembly is in general the reverse of disassembly. Keep in mind when installing the clutch plates and discs, a plate is located directly over the snap ring on the drive hub (Illust's. 8 & 11). One disc fits between this plate and the face of the drum. Install the remainder of the discs and plates, a total of 7 discs and 6 plates. Install the six bolts with the same washers as were removed (if any). Install the pressure plate assembly and tighten the bolts to 15 foot pounds.

Check the height of the clutch release levers above the drum. This height should be 1.485 to 1.365 inches, (Illust.13) with the clutch release levers properly adjusted as shown in Illust.13. If the release levers are less than 1.365", remove a washer (6) from between the back plate and the drum. If new discs are installed, and the lever height is more than 1.485", install washers to bring the adjustment within limits.

Check the condition of the brake linings. Replace as necessary.

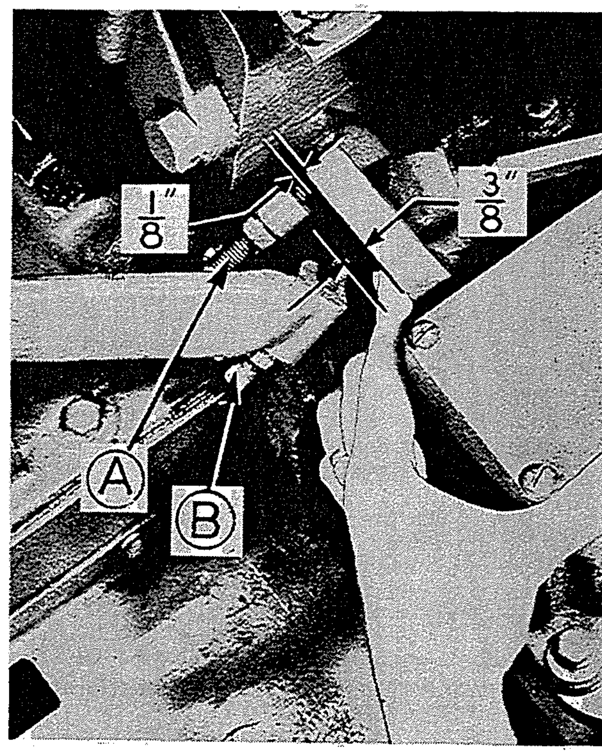
Installing the steering clutches is the reverse of removal. The steering clutch complete with the brake band may be installed. Work the brake band into place over the anchor pin.

Install the bevel gear shaft before replacing the covers on the steering clutch housings.



Illust. 13

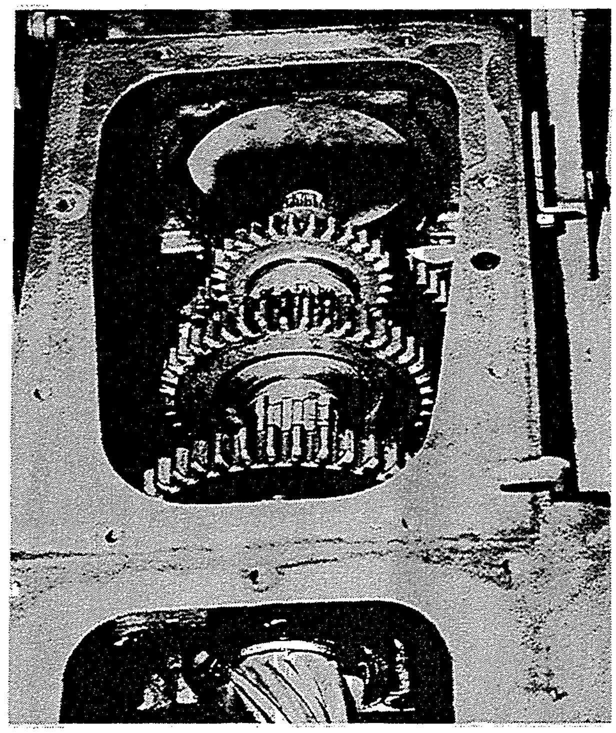
Check and adjust clutch release levers.



Illust. 14

Back off adjusting bolts.

To adjust the foot brake, be sure the pedal is all the way back. Back off bolt "A" and "B" Illust. 14 until only about 1/8" protrudes. Adjust each band as shown in Illust. 15. Hold the brake actuating lever back with finger pressure and adjust the nut "B" Illust. 15 until 1/8" clearance is obtained between the actuating lever and the protruding end



Illust. 18

Transmission input shaft removed.

The bearings may now be removed from the pinion shaft by first removing the two lock nuts and locking washer which hold the bearings in place. The pinion shaft may then be pressed out of the bearings. Keep the spacer and shim pack which are located between the bearings for reassembly.

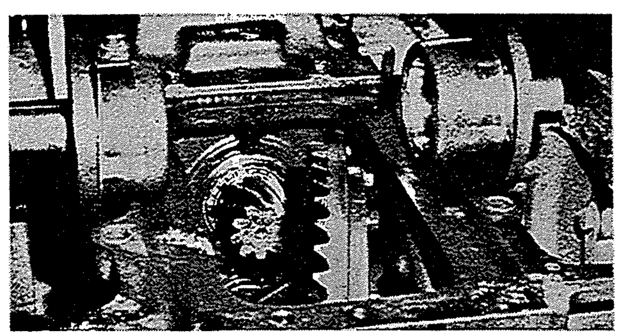
Inspection:

Check the condition of the oil seals in the retainer assemblies (Illust.21). If there is any doubt as to the condition, replace the seals. Look for signs of pits or scratches in the rollers, and the inner and outer races of the bearings. Check the condition of the bearings on the pinion shaft for signs of damage. Check the bevel gear and pinion for signs of damage, uneven tooth wear or galling on the contact surfaces of the teeth.

Careful examination of the bottom of the housing will often indicate conditions of wear which may be watched for. A small amount of cuttings is natural. Keep in mind that this same lubricant circulates through the transmission and in many applications serves as hydraulic fluid. Deposits in the

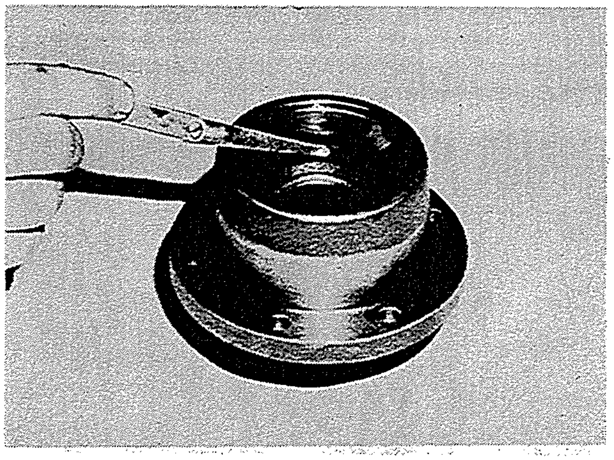
Illust. 19

Remove pinion shaft.



Illust. 20

Bevel gear retainers.



Illust. 21

Check the oil seals in the retainer assemblies.

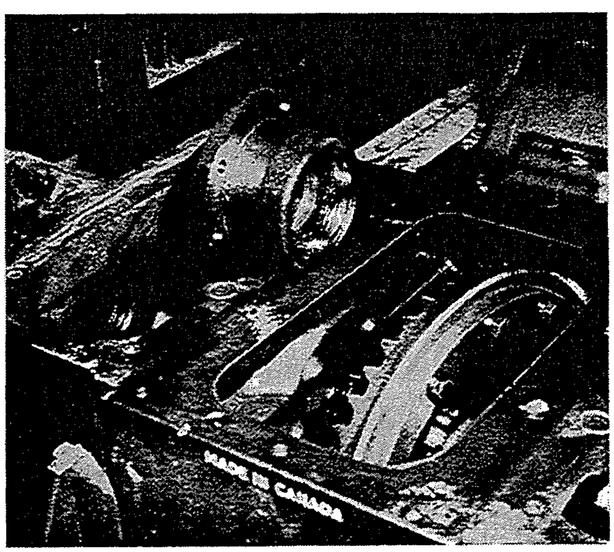
rear compartment therefore may be from either of these units also.

Check the torque of the bolts which secure the bevel gear to the hub for correct torque of 56 - 63 foot pounds.

Replace parts as necessary.

Installation:

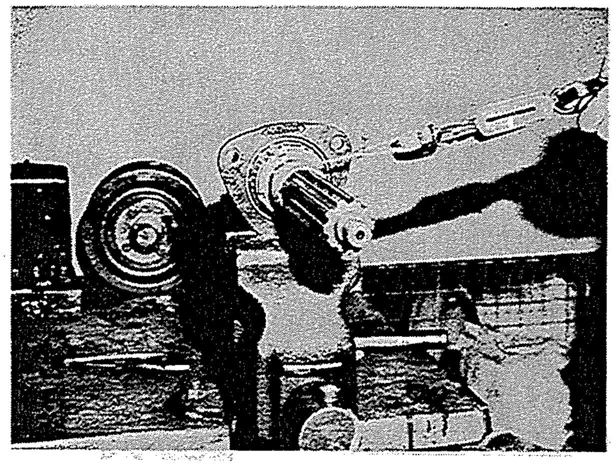
When assembling the bevel gear and pinion, install the bevel gear and hub in place with the retainers, but using no shims on the left side. It will be found easiest to bolt the left retainer into place after first setting the bevel gear in the housing (Illust.22). The



Illust. 22

Install the left retainer.

right retainer is then put in place, locating the bevel gear and hub. Tighten the bolts in the right retainer turning the bevel gear while doing so. Tighten the bolts evenly and only until a drag is felt on the bevel gear. This will locate the center line of the assembly for mounting the pinion in place.



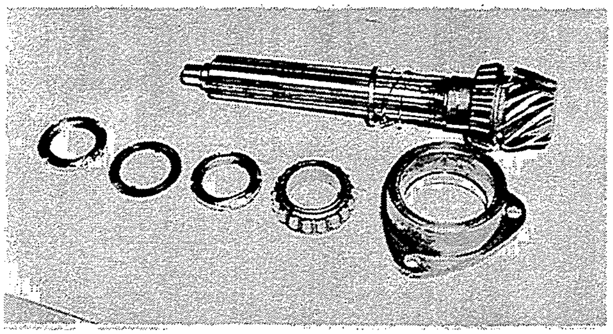
Illust. 23

Adjusting pinion bearing pre-load.

The bevel pinion bearings may be pressed into place using for a start the spacer and shim pack that were removed. Place the retainer in a vise as shown in Illust.23. Tighten the bearing lock nut until the inner races of the bearings are tight against the spacer and shim pack. Turn the shaft while tightening the lock nut. An application of light engine oil will aid in obtaining proper adjustment. With the bearings thus pressed together, a pre-load of 5 - 7 pounds, measured as shown in Illust.23 should be obtained. Adjust by adding or removing shims from the pack between the bearings. It will be noted that more than the specified pull will be required to put the shaft in motion. However, a steady pull of 5 - 7 pounds should keep the shaft rotating slowly.

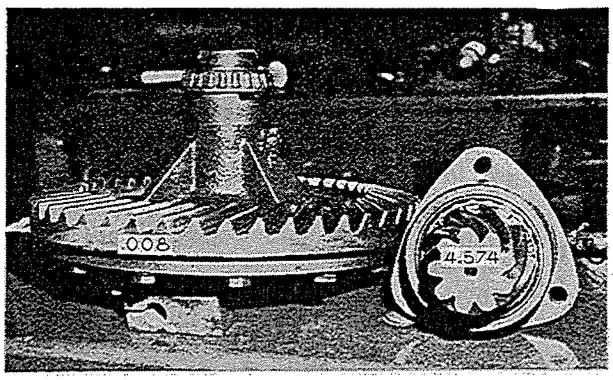
With the pre-load properly adjusted and the two lock nuts in place and locked, install the assembly in the transmission less the sliding gears. Use the shim pack removed for a starting point. Observe the number etched in the face of the pinion. Illust.25. In this case the reading is 4.574 which indicates the distance in inches, from the center line of the bevel gear assembly to the face of the pinion for correct mesh of the gears. This figure will vary with different gear sets.

The diameter of the machined portion of the hub (Illust.26) is 2.5".



Illust. 24

Bevel Pinion Assembly.



Illust. 25

Figure on bevel pinion indicates correct distance between bevel gear center line and pinion face.

Figure on bevel gear indicates correct backlash.

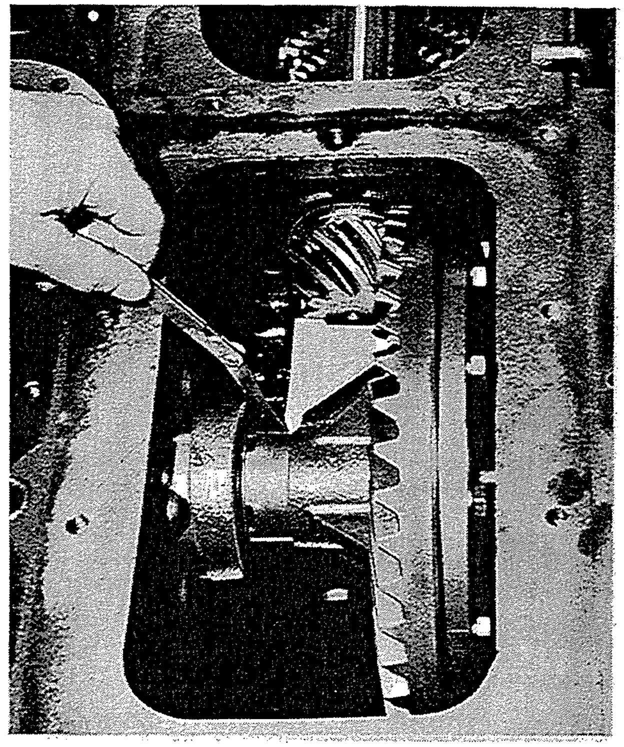
Therefore the correct distance <u>in this case</u>, from the face of the <u>pinion to the</u> machined surface of the hub (Illust. 26) will be

$$4.574 - \frac{2.5}{2}$$

OR

$$4.574 - 1.250 = 3.324''$$

Using the gauge block, (Illust.114) which is 3.300" a .024"feeler is used to make up the difference, thus giving the correct setting. Add or remove shims between the retainer and the housing, to arrive at the correct figure. Shims are available in .030, .018, .015, .006 and .0016 inch thicknesses. Using these shims, the measurement can be brought within limits of .0008 in. Careful adjustment is important for long, smooth quiet operation.

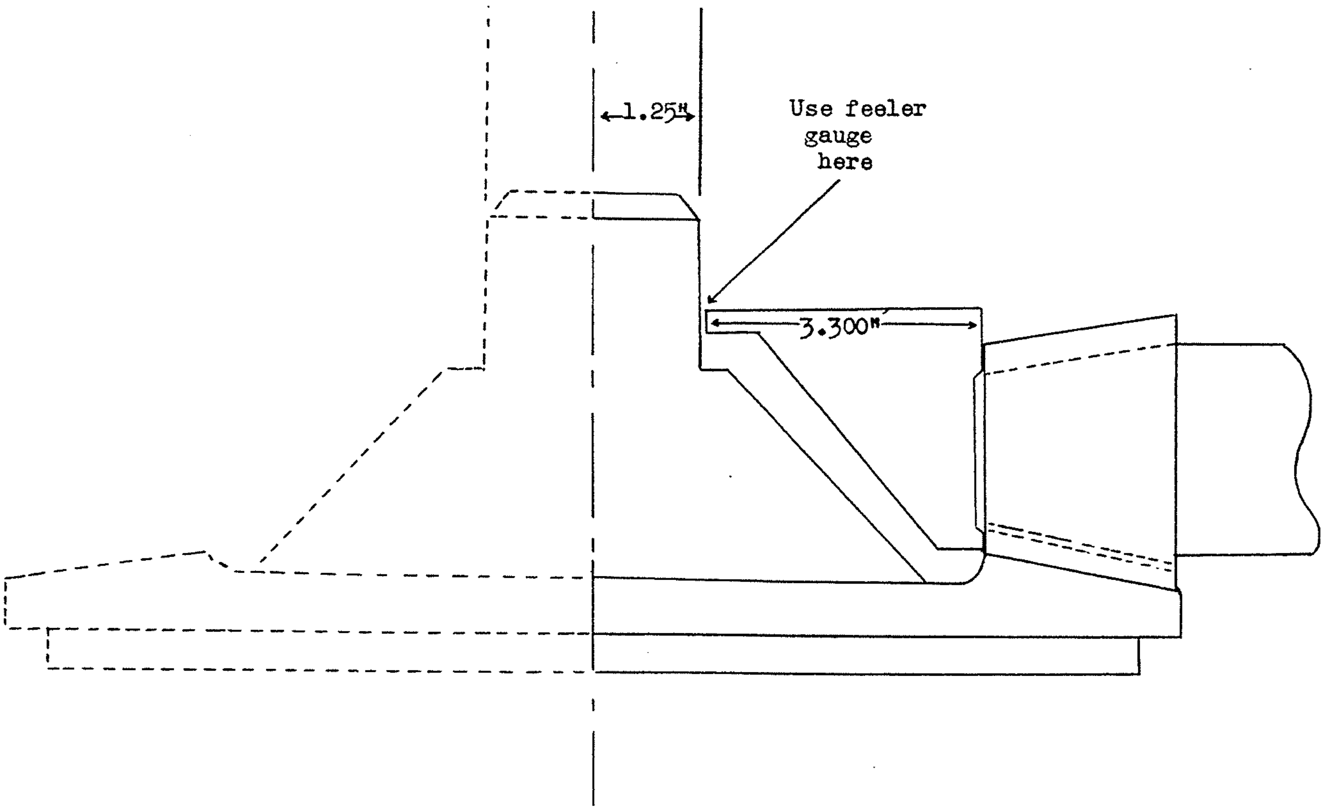


Illust. 26

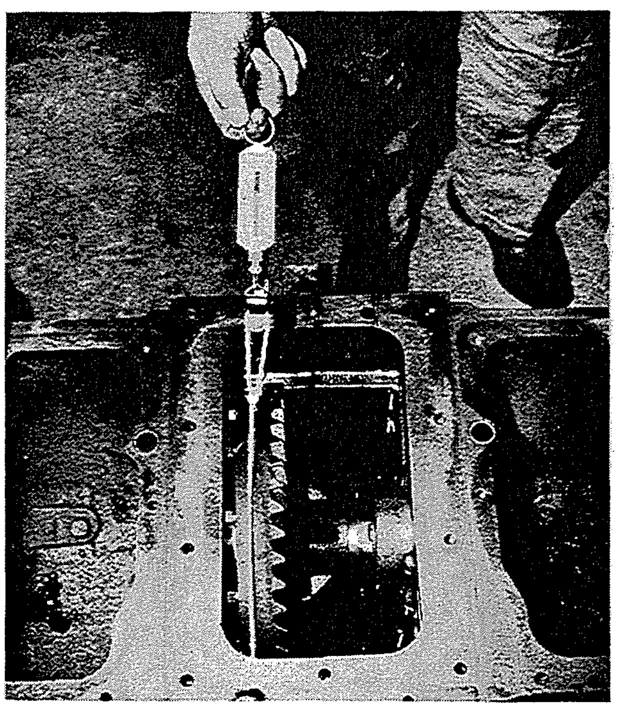
Checking pinion setting with gauge block and feeler gauge.

Remove the pinion shaft and the shim pack. Using shims as removed with the bevel gear hub retainers originally for a starting point, install the bevel gear. Adjust by adding or removing shims until a bearing pre-load of three (3) pounds is obtained, measured as shown in Illust.28. Always turn the bevel gear as the bolts holding the retainers are tightened. This allows the rollers of the bearings to run into place, and prevents the possibility of a false reading.

Now that the correct pre-load is arrived at for both the pinion and the bevel gear, also the correct distance from the pinion face to the center line, the only remaining adjustment is backlash between the gears. Install the pinion with the correct shim pack. This time the sliding gears should be installed on the shaft. Check with a dial test indicator as shown in Illust.29. With the anvil of the dial against a

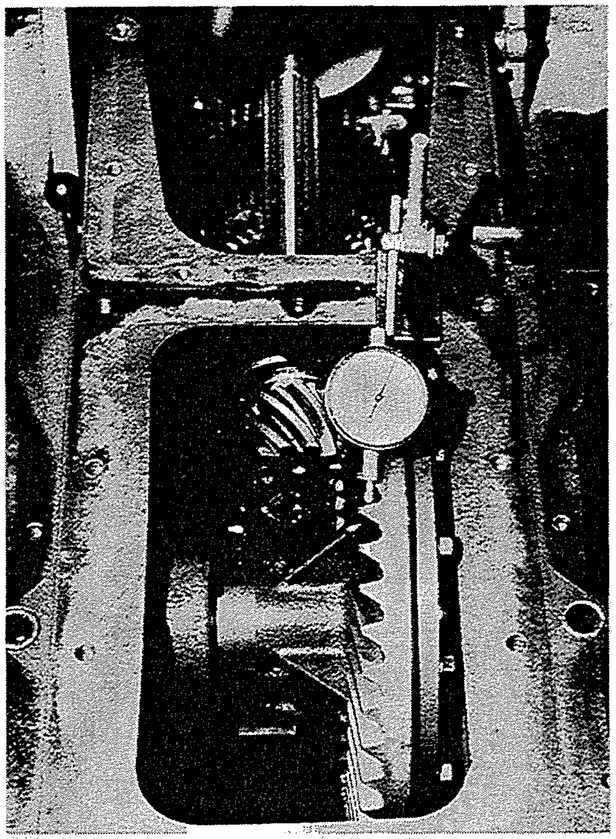


Illust. 27



Illust. 28 Check bevel gear pre-load.

tooth of the bevel gear at right angles to a line drawn from the point of contact to the center line of the bevel gear assembly, hold the pinion solid and move the bevel gear. The correct back-lash for each set of gears is etched on the bevel gear. (Illust.25) In this case it is .008". If the back-lash is more than this remove shims from under the right retainer and place under the left, thus maintaining the correct bearing pre-load, but moving the assembly over to the left an amount equal to the thickness of the shim(s). These shims are provided in thicknesses of .003", .005" and .010". Inversely, if the back-lash is too little, a shim is moved from the left to the right retainer.



Illust. 29

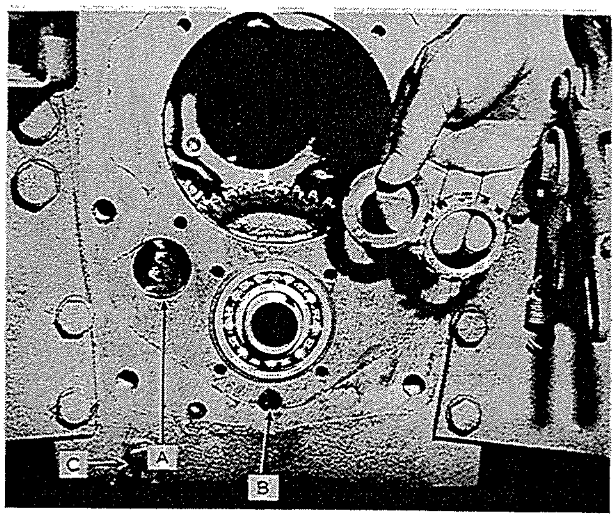
Check gear back-lash.

The operation outlined above takes some time to do correctly. Time spent getting all the settings correct will be time well spent. If new oil seals are being installed in the bevel gear retainers, it is recommended that the old ones be removed and all the adjusting be done without seals before installing the new. It is easy to damage a seal and not know about it until it starts leaking. Also, when checking bevel gear bearing pre-load with a scale (Illust.28) no allowance is made in the figure of 3 pounds for oil seal friction. If oil seals are in place during this check, allow one pound for friction.

TRANSMISSION

The transmission, and bevel gear and pinion assembly are housed in a single casting containing two compartments, front and rear. The rear compartment houses the bevel gear and pinion and the forward section contains the transmission proper, with the sliding gears which effect changes of speeds. The two compartments are interconnected so the same lubricant serves both units. The oil in this casting in many cases is used as hydraulic oil when the tractor is fitted with a hydraulic system. In these cases the transmission oil is being constantly circulated through the hydraulic oil filter which takes out a large portion of the foreign matter which collects in transmission oils.

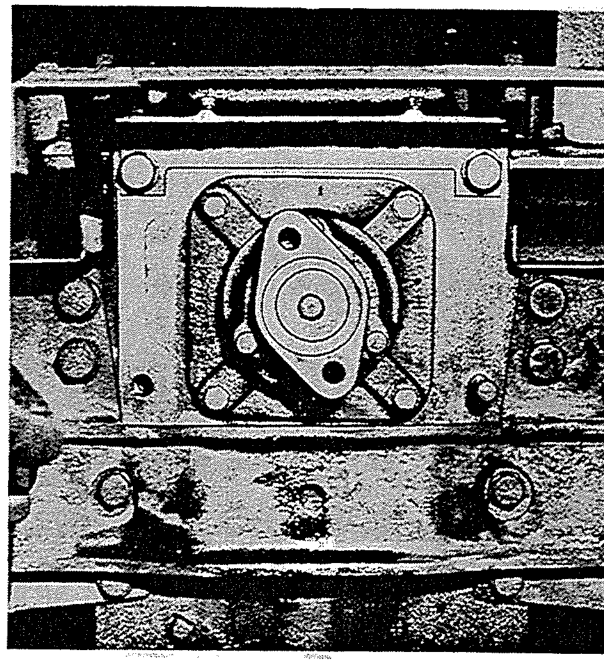
When the Torque Amplifier or Reverser units are installed, a separate casting is mounted forward of the transmission. This casting is also connected to the transmission housing so the transmission oil lubricates these units as well. Illust.30 shows a front view of a



Illust. 30

Front view of transmission with TA or Reverser housing removed.

transmission with the middle casting (torque amplifier or reverser) removed. "A" and "B" are passages through which oil passes. In the event of a standard transmission (no TA or reverser) these holes are plugged, "A" with an expansion plug and "B" with a 3/8" pipe plug. "C" is the transmission oil drain plug. Illust.31 shows the front of the same transmission with standard equipment.



Illust. 31

Front view of transmission with standard equipment.

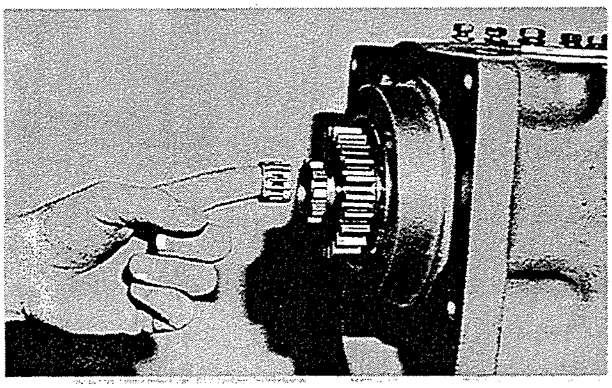
Removal:

If the tractor is equipped with Torque Amplifier or Reverser, it is necessary to remove the attachment to dismantle the transmission. The engine and middle casting may be removed as a unit. In cases where the middle casting is being serviced as well as the transmission it will be found better to remove the engine first, then the attachment.

In the case of standard transmission the engine may be left in its mounting and the transmission completely dismantled with only taking out the propellor shaft assembly. It will prove advantageous to remove the tool box also.

Drain the transmission oil through the drain plug. ("C" Illust.30). If the tractor is equipped with a hydraulic system using the transmission oil for fluid, the oil may be pumped into a can or barrel with the hydraulic pump. If this method is used, care should be taken to stop the engine as soon as air starts coming through the system, thus guarding against the possibility of running the pump dry. All the oil will not pump or drain out. A tray should be used to catch the remaining oil that will leak out when the castings are parted.

Remove the transmission in-put shaft: When a torque amplifier or reverser are installed, removing the attachment also removes the in-put shaft which is an integral part. With standard transmission, remove the bearing cage assembly complete. In either case watch for the pilot bearing. It is a roller bearing and can easily fall out. (Illust.32)

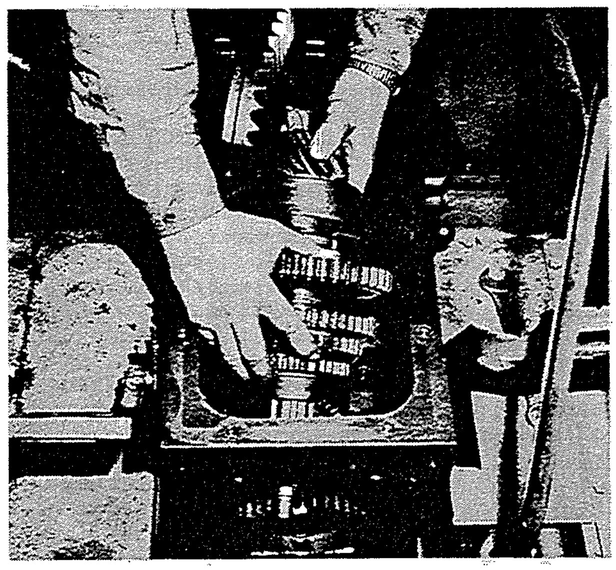


Illust. 32

Transmission pilot bearing.

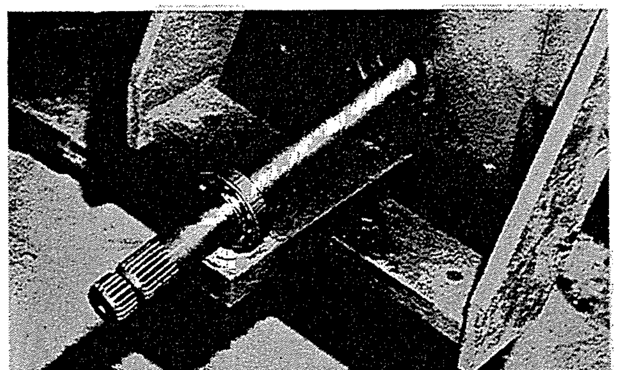
Remove the top shaft: Remove the bevel gear and transmission covers. Remove the three nuts from the bolts which hold the pinion bearing cage to the rear wall of the transmission. Two of these bolts may be removed, the third is behind the bevel gear and cannot be removed at this time. Move the shaft and bearing cage forward until the pinion can be lifted out of the housing. Hold the sliding gears from falling off as the shaft is lifted out. (Illust.33)

Remove the countershaft: Remove the power take-off shaft if the tractor is so equipped. The shifter spool may be lifted out from the rear.
Disconnect the shifter lever on the outside lower left of the transmission housing by taking the cotter pin out of the cross shaft and removing the arm.
Tip the PTO shifter back and down against the bottom of the housing.
If the tractor is equipped with a torque amplifier or reverser AND PTO, remove the power take-off driving shaft to the rear (Illust.37). Note the flat washer



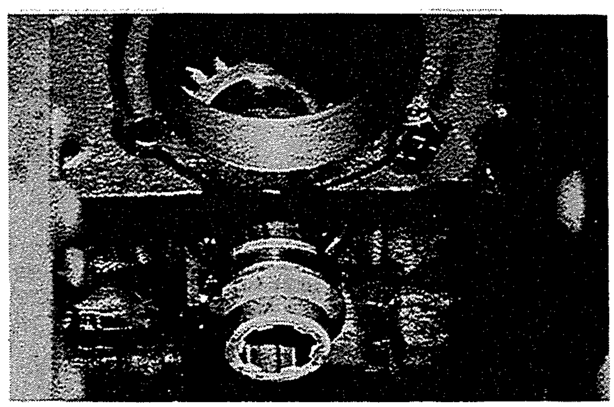
Illust. 33

Remove the spline shaft.



Illust. 34

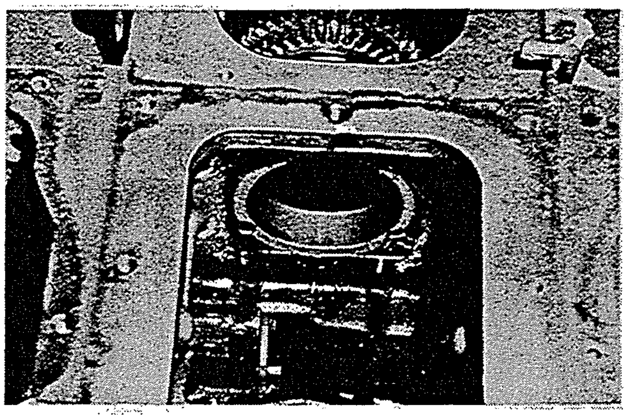
Remove PTO shaft.



Illust. 35

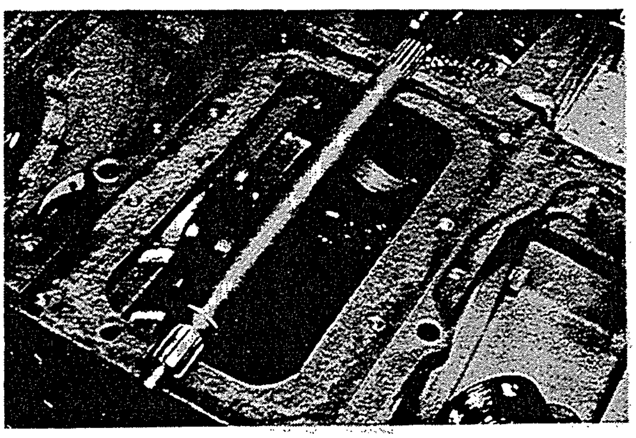
Shifter spool.

that comes with it. Tractors with torque amplifier or reverser and NOT equipped with PTO will not have this shaft. Tractors with standard transmission do



Illust. 36

Tip the shifter out of the way to remove the countershaft.

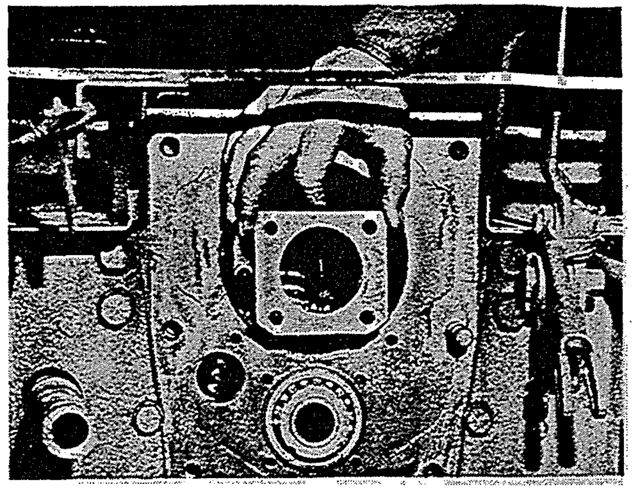


Illust. 37

Remove Power Take-off driving shaft.

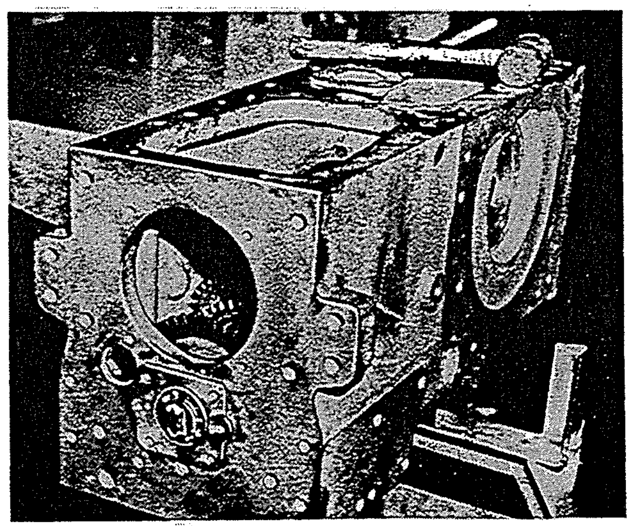
not use this shaft. Remove the plate, (Illust.38) and the nut and lock washer (Illust.30), or if standard transmission, the cap, bolts and lock plate. (Illust.39)
The shaft may now be driven out to the rear.

When driving the hollow shaft use the tool shown in Illust.111 and the driving mandrel, Illust.106. The solid countershaft may be driven out with a soft drift. It will be noted in the case of a solid shaft that the front bearing and cage may be removed with the aid of two bolts. This should be done after the countershaft is removed, thus reducing the possibility of the rear bearing "cocking" when the shaft is being driven out. The countershaft may be removed without removing the bevel gear. The reverse idler is removed by first removing the snap ring and flat washer from the rear of the shaft. The



Illust. 38

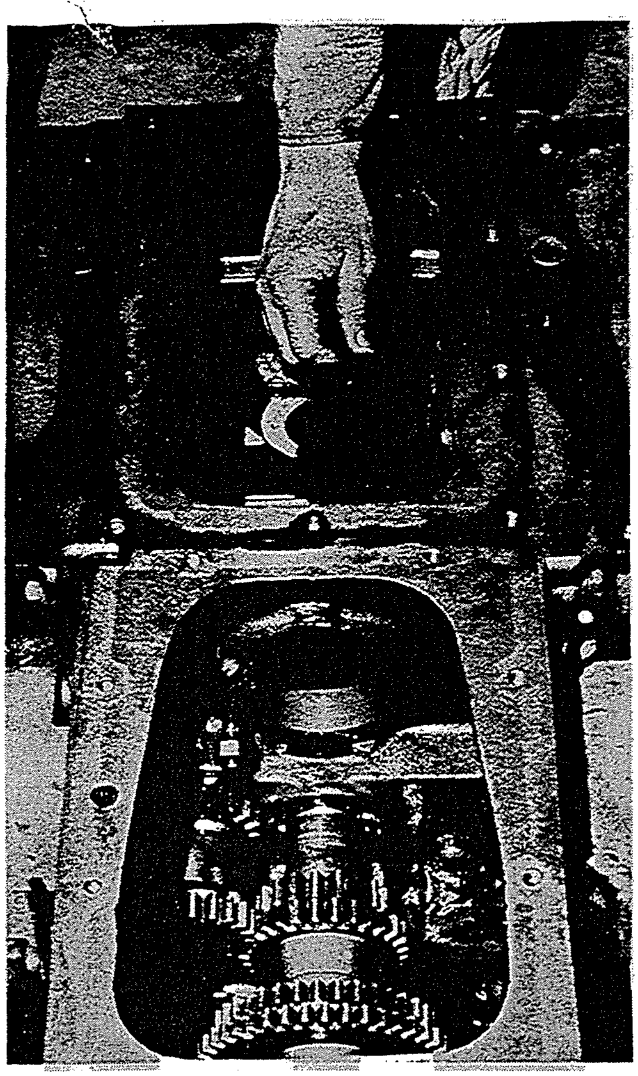
Countershaft front bearing plate.



Illust. 39

Remove cap, bolts and lock plate.

idler shaft and the front gear are integral. The rear gear fits on the serrated portion of the shaft (Illust.42) Tractors equipped with a reverser at the factory above serial number 1300 are not equipped with a reverse idler in the transmission. Trouble can develop from an operator using two reverse speeds to obtain a forward speed. The bronze bushings in the reverse idler will not stand up to continuous operation. It is recommended that these idlers be left out of tractors below ser.no. 1300 on overhaul, if the tractor is equipped with a reverser.

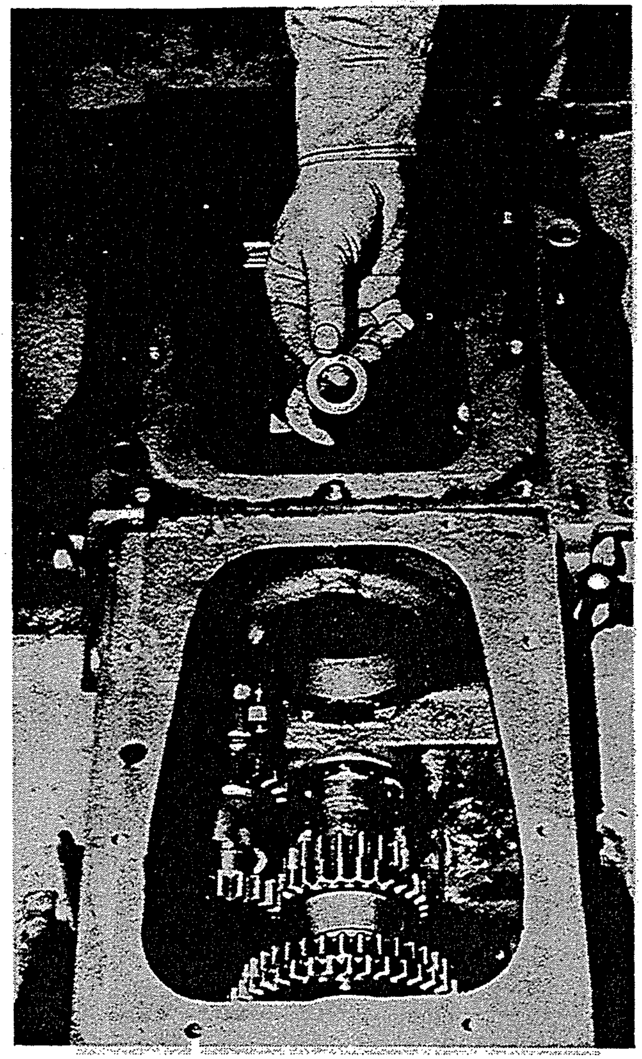


Illust. 40

Remove the snap ring from the reverse idler.

The in-put shaft may be removed from its bearings and cage by removing the propellor shaft joint coupling and pressing the shaft out. The bearings may then be removed from the cage. Details for removing and installing the pinion bearings are contained in this book under "Bevel Gears".

Details of servicing the Torque Amplifier and Reverser units are contained in this book under separate headings.

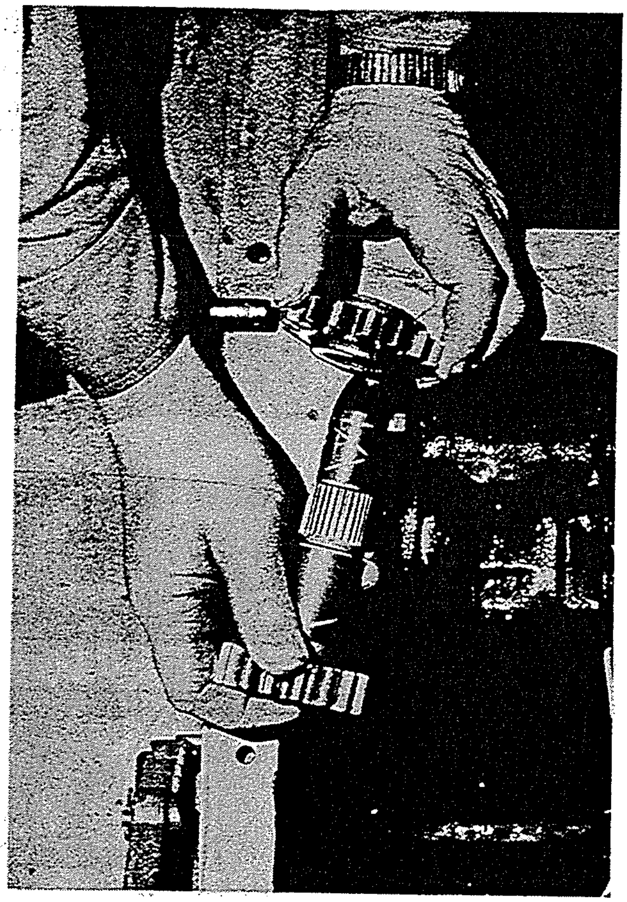


Illust. 41

Flat washer fitted behind snap ring.

Inspection:

Check the bearings for condition. When a ball bearing is removed it should be wrapped in paper and kept free of dust and foreign matter. When checking, do not force the bearing if it does not turn freely. Wash it out with clean solvent with a minimum of turning. After the bearing is clean apply light engine oil and turn it by hand. Never use air on a ball bearing. If the bearing will turn freely by hand with no roughness on the friction surfaces, and no excessive clearance exists, the bearing can be assumed to be serviceable. It is not unusual to find a bearing that will have a rough spot detected when checking it. This may be the result of damaged balls or ball races in which case the bearing should be replaced. Be sure however that this roughness is not the result of a particle of foreign matter. Wash the bearing again in clean solvent and recheck before discarding it. If there are visible scratches on the balls and ball races the bearing can be discarded without further checking. The construction of ball bearings makes it difficult to do such a check thoroughly, so in most cases the hand turning test will be the one used.



Illust. 42

Reverse idler assembly.

It is highly possible that ball bearings have been replaced in many cases where it was unnecessary. This of course is not a serious error on the part of the mechanic. If there is any doubt, keep in mind the fact that the cost of a new bearing is much less than the labor involved replacing it. Generally a defective bearing is not difficult to find. In many cases the defective bearing will come out of the bearing cage in pieces. Other factors to keep in mind when doing such checking is the residue found in the bottom of the transmission housing. If the oil is contaminated with foreign matter that could be injurious to bearing surfaces, this should be considered.

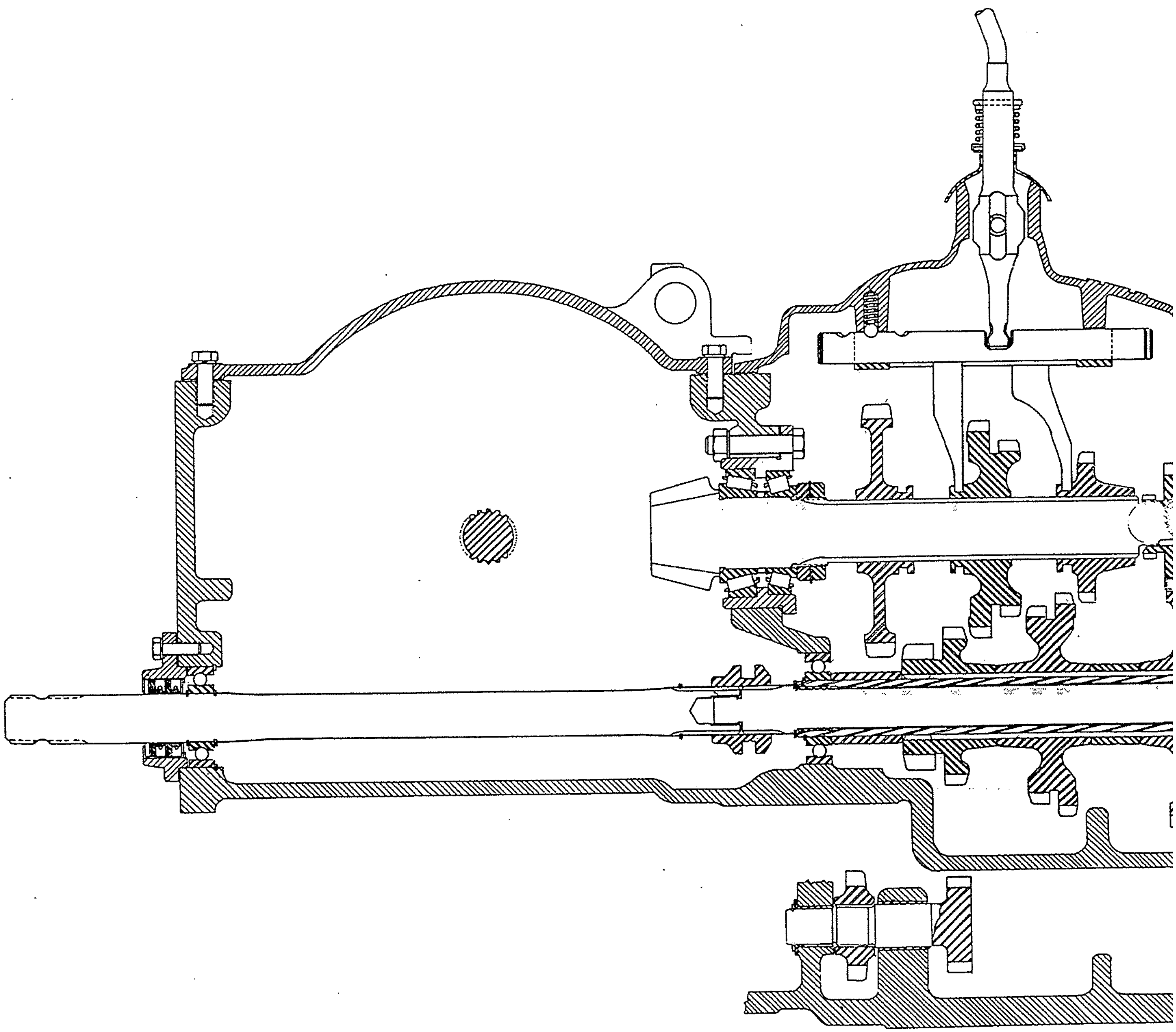
Check the condition of the pilot bearing in the top transmission shaft. Check the splines of the top shaft for wear. Irregular, worn splines can make gear shifting difficult. Check the shifter forks for possible bending, cracks, etc. Shift through all the gear positions and check the latching action of the poppets in each position. Check all the snap rings and their grooves. Grooves should be clean and possess square surfaces for the snap ring to bear against. The snap rings can become distorted when removing them. If there is any indication of distortion, replace with new. Check the condition of all the bronze bushings by slipping the mating shaft into place and checking for excessive clearance. Also check the bearing surfaces of shafts for signs of abnormal wear. Bronze bushings will be found in the reverse idler mounting, the hollow countershaft, and the front PTO shaft when the tractor is equipped with TA or Reverser.

Check gears for chipped or damaged teeth.

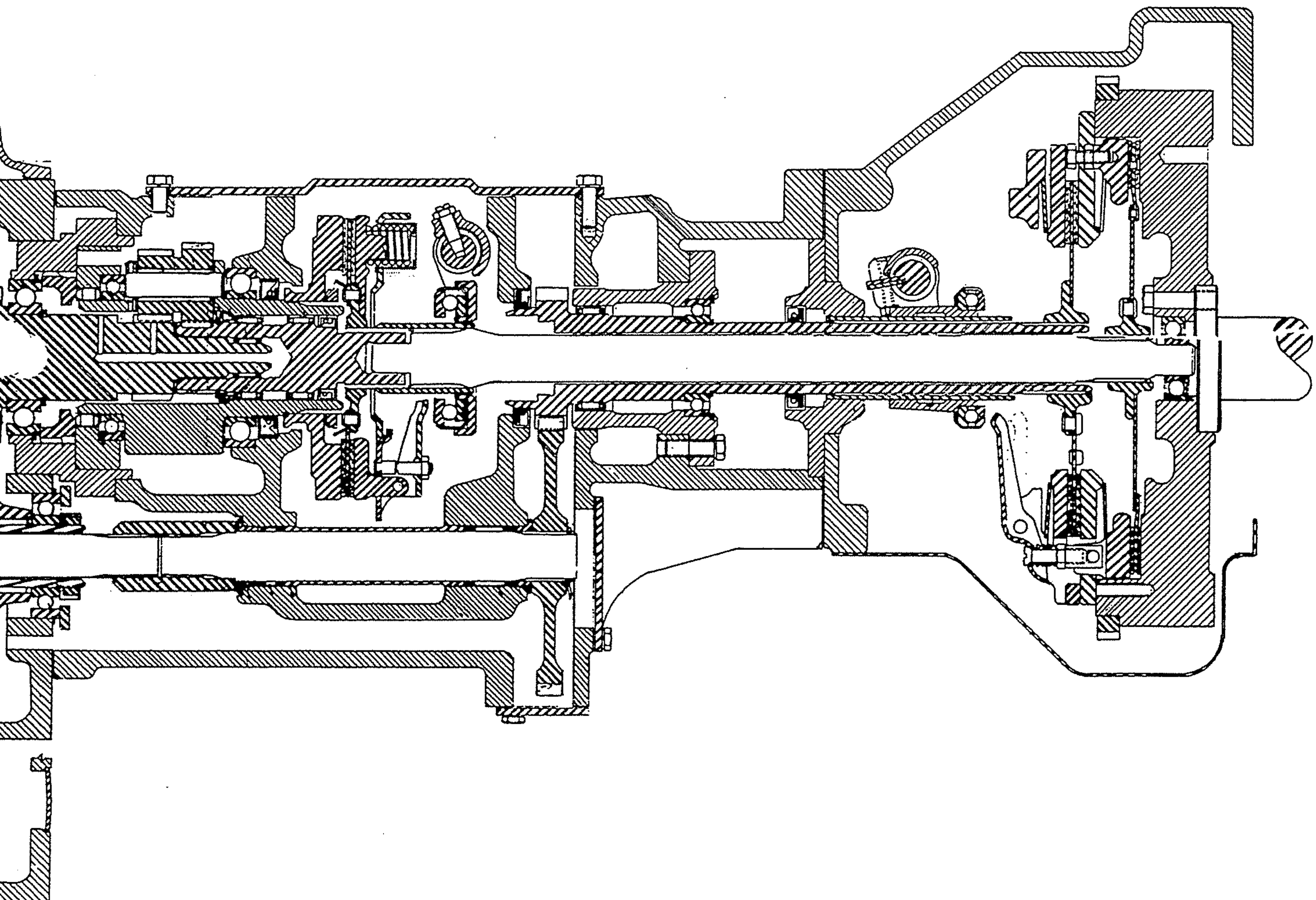
Replace parts as required.

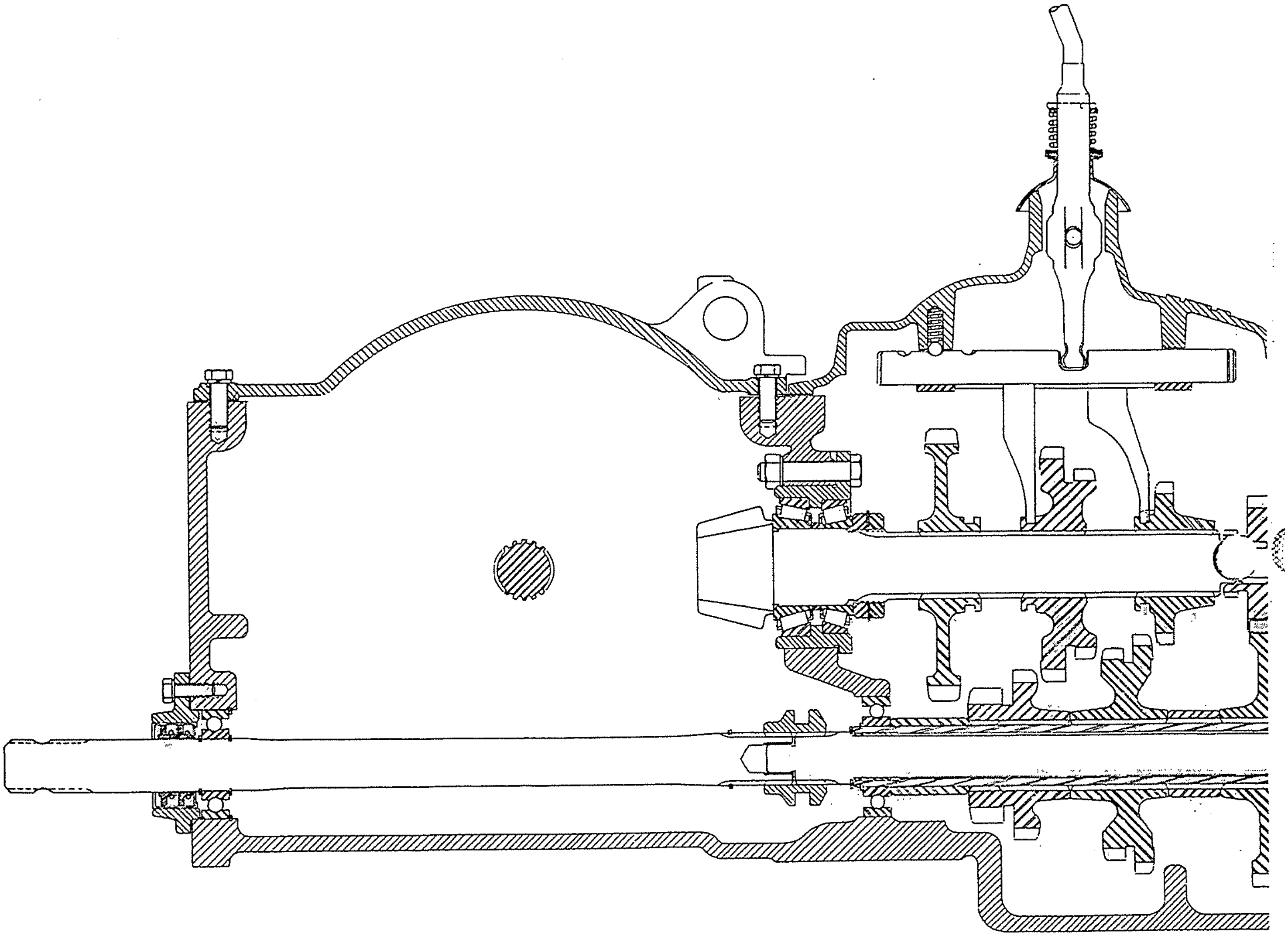
Assembly and Installation:

Assembling and installing the transmission is in general, the reverse of removal. The countershaft assembly is the first unit to install. Before installing the countershaft, put the spacer, rear bearing, and snap ring into place. (Illust.43 and 44) The shaft is entered into the transmission compartment from the rear and the gears put on with a spacer between the 3rd and 4th gear and the constant mesh gear. (See Illusts.43 and 44). With all the gears in place, install the front bearing and install and tighten the nut (Illust.30) or the lock plate, (Illust.39), ensuring that no movement of the gears on the countershaft exists. When installing the front bearing keep in mind that there is nothing to prevent the countershaft moving to the rear. Lock the nut with the lock washer, or bolts with the lock plate, and install

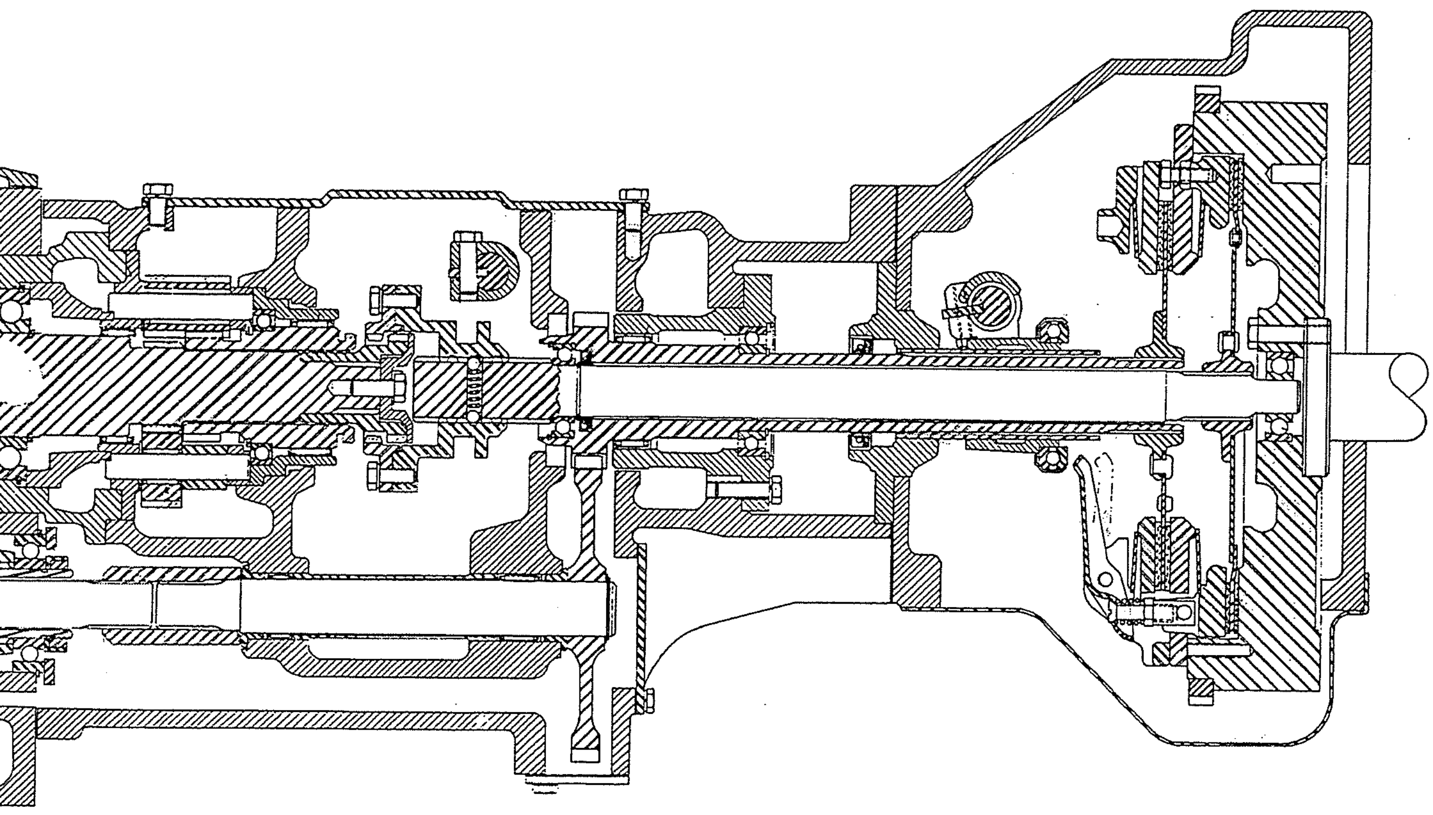


Illust. 43





Illust. 44



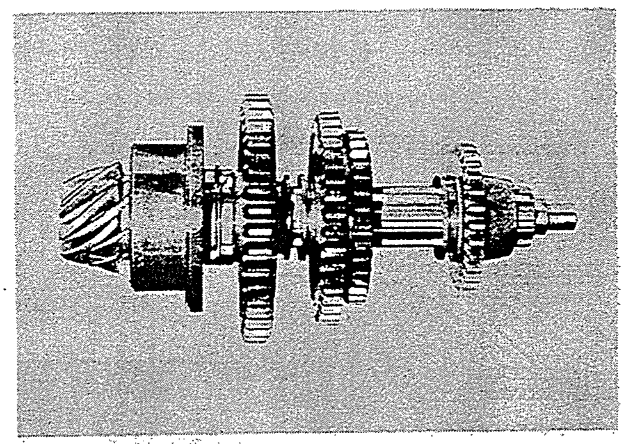
Assembly and Installation: Continued

the plate, or cap. The plate (Illust.38), in the case of the hollow countershaft locates the shaft by securing the front bearing. No lock ring is used on the rear bearing which is located by the countershaft. In the case of the solid shaft (Illust.39) a cap fits over the bearing cage locating the countershaft in the same manner.

If the bevel gear has been removed, proceed with adjusting as described in the section of this book pertaining to that subject. Assemble the gears on the spline shaft as shown in illustration 45 (details shown in illustrations 43 and 44). Using the correct shim pack install the spline shaft assembly lowering the front of the shaft into the housing first, then place the pinion bearing cage in place. Before going further check the location of the sliding gears with illustrations 43 or 44. When the gears are properly located, install the bolts and nuts to secure the cage.

The input shaft (Torque Amplifier or Reverser) is now ready to install. The pilot bearing is best installed on the shaft. Lubricating with chassis lubricant will assist in keeping the bearing in place. If a middle casting is to be installed, use aligning dowels (Illust.100) to assure proper alignment of all mating parts. Install these dowels in the lower corners of the transmission housing. When all the other bolts are installed and properly torqued, remove the dowels and install the two remaining bolts.

Install the transmission cover being sure the shifter forks all drop into their respective grooves in the sliding gears. Before installing the bevel gear cover it is usually convenient to fill the gear case with oil from this point. If however, a time will elapse before this is done, replace the cover temporarily if necessary, to prevent foreign matter getting into the gear case. Fill the housing to the marks indicated on the dip stick in the transmission cover. It will be noted that two oil levels are marked; one for tractors with hydraulics which use the transmission oil as fluid, and a lower mark which indicates a sufficient quantity where the tractor has either no hydraulic system, or one with a separate reservoir.



Illust. 45

Top transmission shaft assembly.

FINAL DRIVES

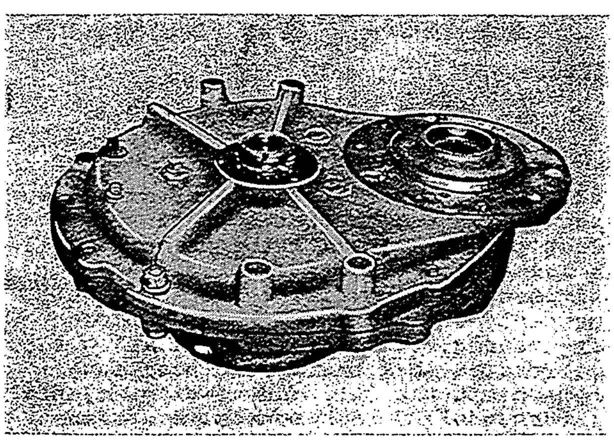
Removal:

Break the track chain. Remove the final drive pinion, (Illusts.3, 4 and 5) and drain the final drive lubricant. The housing can then be removed from the spacer casting by simply removing the bolts. It will be found easier to handle if the sprocket is removed from the bull gear shaft before removing the housing from the chassis.

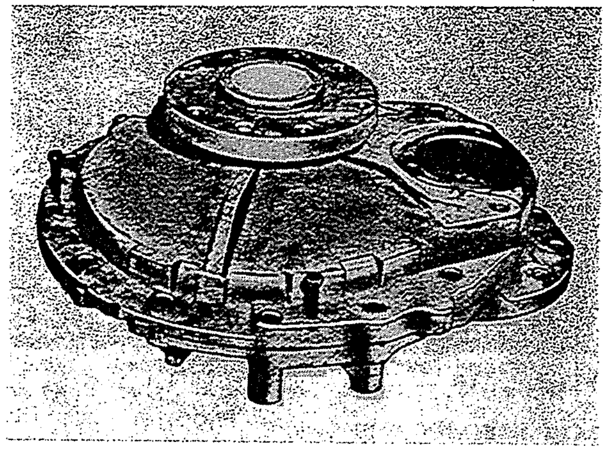
Disassembly:

Remove the bull gear shaft lock nut and lock washer (Illust.46). Remove the bolts holding the two sections of the housing together. The housing is then ready to split. Three threaded holes are provided, (Illust.47) in which bolts can be used to force the two sections apart. This takes sufficient force to pull the inner bearing off the bull gear shaft. With tension on the three bolts, drive the axle down (Illust.46), using a soft hammer.

When the housing is split the bull gear can then be removed from its shaft by first removing the snap ring (Illust. 48) and the steel washer(s). The shaft may then be driven out of the bearing. The oil seal should be removed if it has not already come out. Driving the shaft out will very likely damage the seal so it will require replacing. The gear may be lifted off without removing the shaft, and thus prevent damage to the seal, if there is no need for removing the larger bearing. See illustration 51.



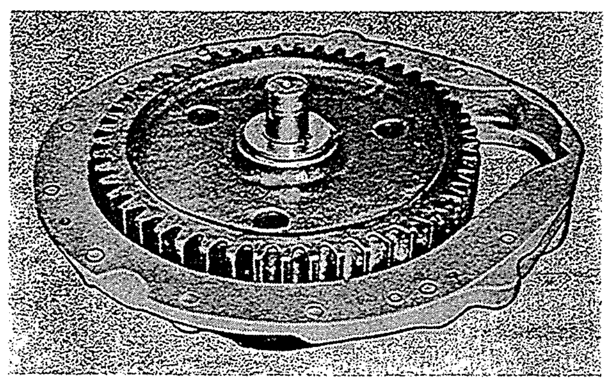
Illust. 46 Remove lock nut from shaft.



Illust. 47

Use three bolts to separate castings.

The bronze pinion thrust bearing may be lifted out if necessary. The needle roller bearing can easily be driven out with the driver shown in illustration 110. The bearings may be removed from the outer retainer in the same manner.



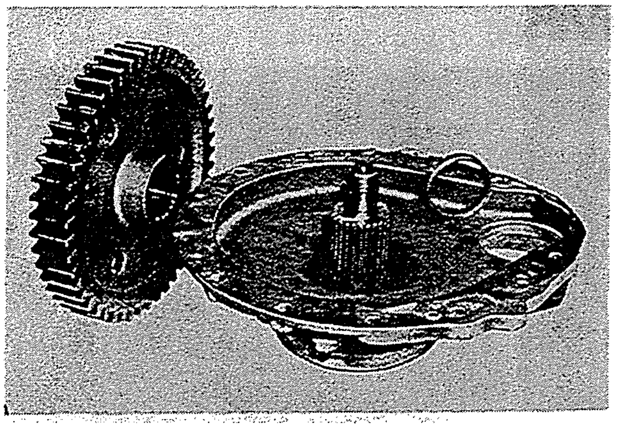
Illust. 48

Remove the snap ring.

Inspection:

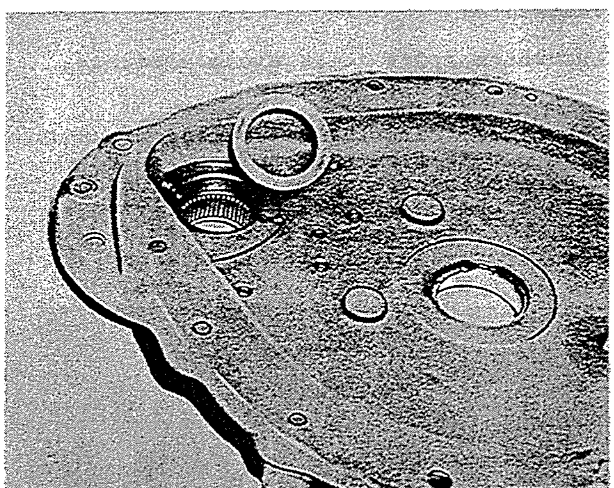
Check the gear and pinion for indications of wear on the teeth. Check the condition of the bearings. Check the condition of the needle roller bearings in the final drive housing, also in the spacer casting.

Replace parts as required.



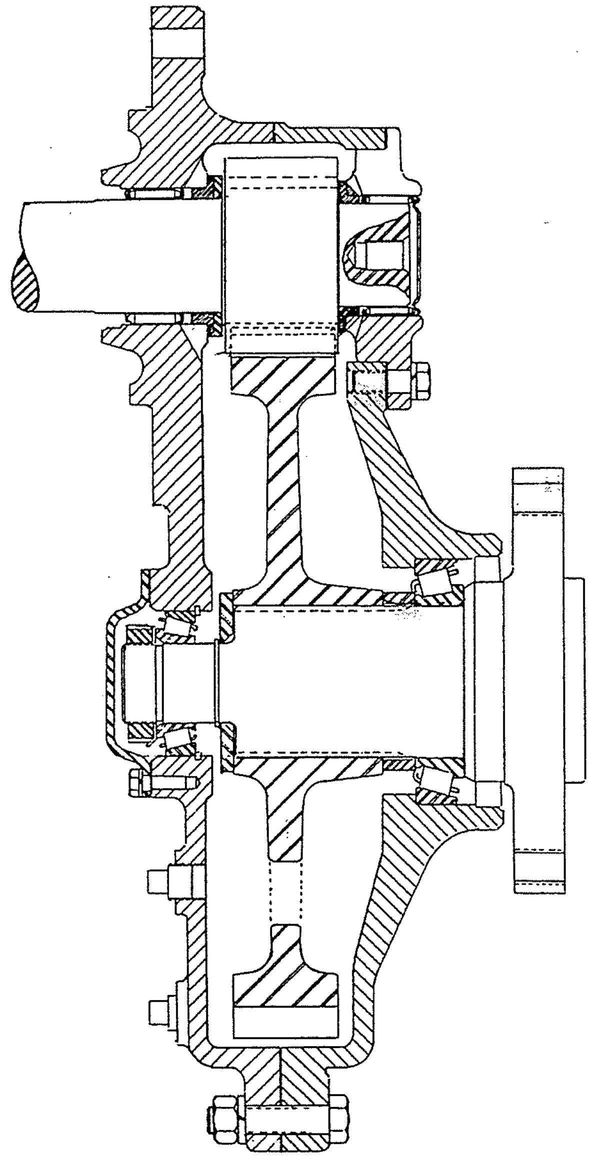
Illust. 49

Lift off the bull gear.



Illust. 50

Bronze pinion thrust bearing removed.



Illust. 51

Assembly:

Assembly is in general the reverse of disassembly. Note the location of the spacer shown in illustration 49. The hub protrudes further on one side of the bull gear than the other. The longer side of the hub goes next to the large bearing with the spacer between the bearing and the gear. See illustration 51. Lubricate the bearings with light engine oil.

Replace the flat steel washer using the thin washers as shims to reduce the end movement of the gear on the shaft to an absolute minimum. Do this with the unit resting on the shaft as shown in illustration 49. Also, be certain the outer (larger) bearing is bottomed in the housing and on the shaft. Replace the inner member of the housing with a new gasket and tighten the bolts to 90 foot pounds. Install the inner (small) bearing on the shaft (Illust.46) and tighten the nut until the bearing is properly seated in the housing. When tightening, turn the shaft to allow the rollers to seek their home positions. Loosen off the nut, and re-tighten until a torque of 20 inch pounds is obtained on the bull gear shaft. This can be determined by the method shown for the bevel gear in illustration 28. With a string wound over the outer circumference of the bull gear shaft, a pull of 6 to 8 pounds is correct. Bend over a tab on the lock washer to hold the nut in this position.

If it is necessary to replace the pinion shaft needle roller bearings use the tool shown in illustration 110. Always drive the end of the bearing with the lettering on it. The bearing is pressed into place in the outer cap.

Installation of the final drive housing on the chassis is the reverse of removal. Be sure all the bearings are lubricated with light engine oil during assembly. This will ensure lubrication during the initial running period until oil will reach these surfaces through the regular means. Also, when checking bearing pre-load, lubrication is necessary to give a true reading.

Fill the housing to the oil level plug with SAE 80 or 90 transmission oil. When filling the housing, put approximately one half pint of oil into the spacer casting through the hole provided at the top. This oil will ensure lubrication for the inner needle roller bearing until oil from the bottom of the housing reaches this point.

NOTE: In the event of a tractor being equipped with 68 inch tread, the inner spacer bearing is lubricated by external means. In this case, oil from the final drive housing does not enter the spacer.

ENGINE CLUTCH

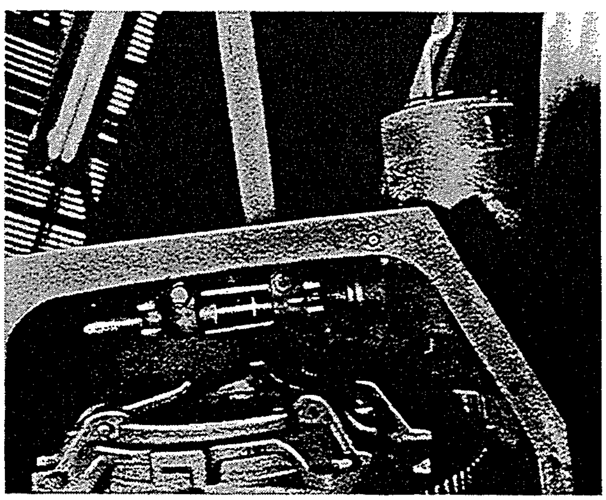
Description:

Engines used in these tractors may be fitted with either a single stage, or dual clutch. The single stage, single disc clutch is of conventional design. The two stage clutch used in tractors equipped with Constant Running Power Take-off is also of simple design and not difficult to service.

The clutch release bearing in early tractors is a pre-lubricated type. Where tractors are used in operations requiring frequent clutching, this bearing can be replaced with the newer, lubricated type. (Illust.54)

Removal:

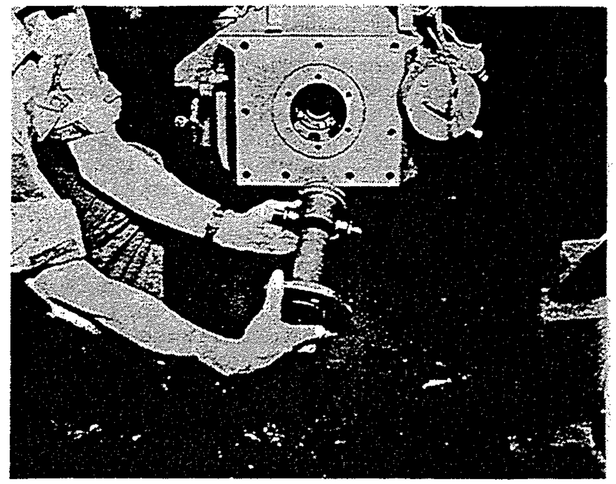
If the tractor has a standard transmission (no TA or reverser), it will be equipped with a single stage clutch. This clutch can be removed from the bottom by taking out the propellor shaft and removing the bottom clutch housing cover. The clutch release bearing and guide must be removed. (Illust.53). The clutch can now be removed (Illust.52) without removing the engine.



Illust. 52

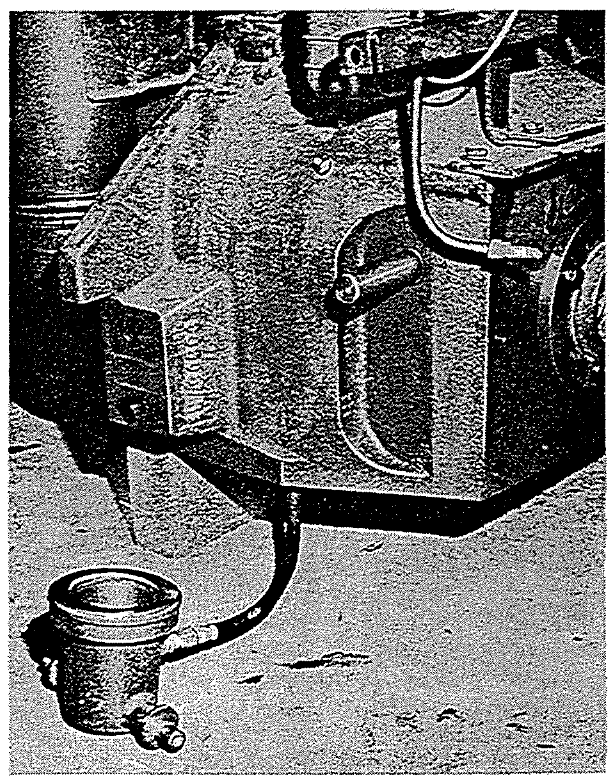
Single stage clutch can be removed from the bottom.

If the clutch is the lubricated type (Illust.54) it will be necessary to disconnect the lubrication hose.



Illust. 53

Remove clutch release bearing and guide.



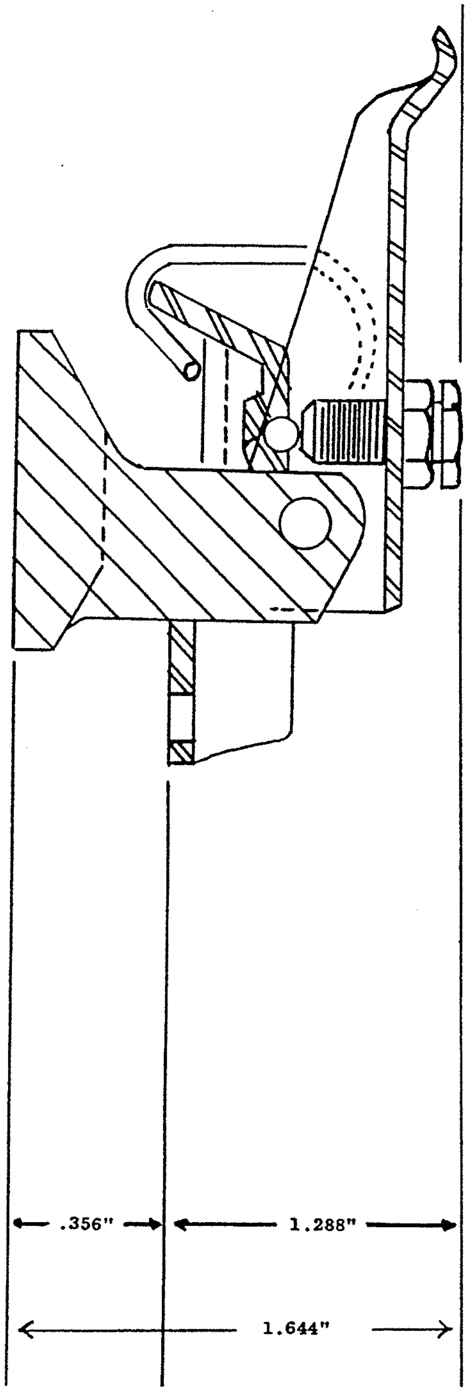
Illust. 54

Lubricated clutch release bearing.

Disassembly and Inspection:
(single stage clutch)

Check the clutch facings for wear. Check the pressure plate and flywheel for signs of cracks or warping. Check the clutch release bearing for condition. Check the clutch release levers for wear at the point of contact with the clutch release bearing. Check the bearing in the retainer, illustration 57. In the case of a single stage clutch this retainer is fitted with a pre-lubricated bearing, but no oil seal.

Replace parts as necessary. Adjust the clutch release lever height as shown in illustration 55.



Illust. 55

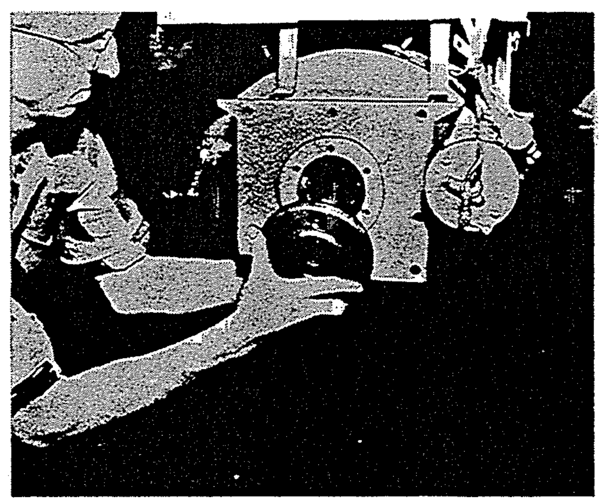
Single stage clutch adjustment.

Installation:

Installing the single stage clutch is the reverse of removal. The clutch shaft can be used for centering the clutch driven member before tightening the clutch back plate to the flywheel.

Removal of the Two Stage Clutch:

Removing the two stage clutch (with TA or Reverser) requires moving the engine forward. See details of engine removal under that heading in this book. Remove the clutch housing cover. Remove the clutch release bearing and guide (Illust.56). The clutch assembly can now be removed from the bottom (Illust.52).



Illust. 56

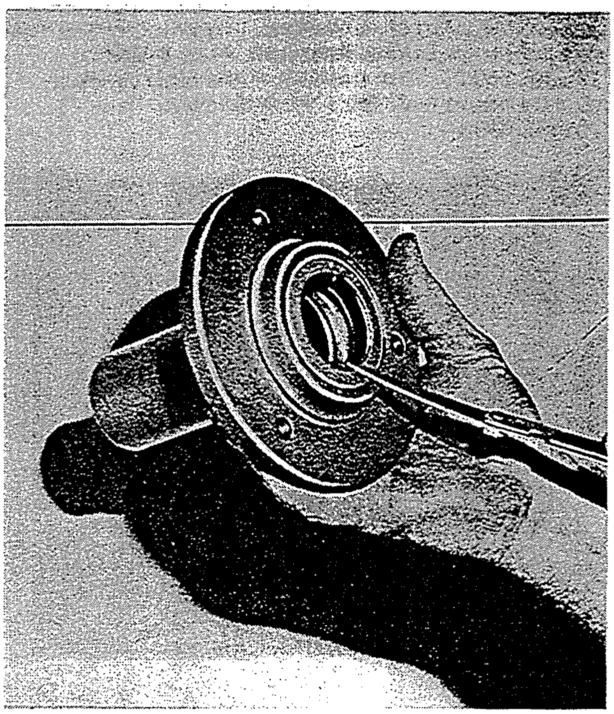
Remove clutch release bearing and guide.

Disassembly and Inspection:

The release bearing sleeve retainer in this case has no bearing in it, but does have an oil seal. (Illust.57) Check the condition of the oil seal.

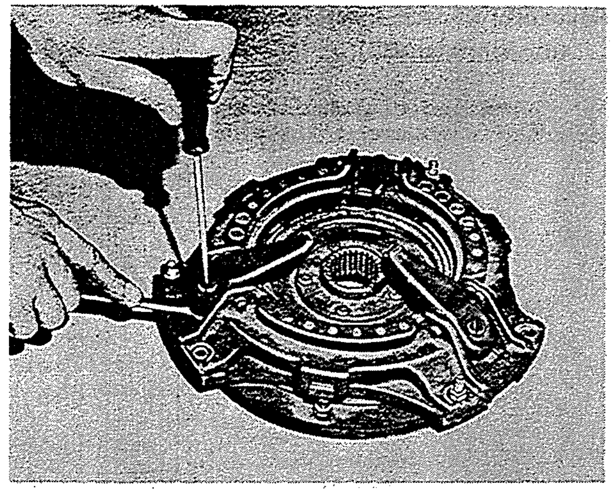
Punch mark the clutch back plate and the three pressure plates so they can be reassembled in the same position. Install three bolts as shown in illustration 58 and tighten them sufficiently to close the space between the clutch back plate and the pressure plate. Loosen the three lock nuts and remove the screws (Illust.58). The clutch back plate and the 11 inch pressure plate can now be lifted off. (Illust.60). The Bellville washer, or clutch spring, can now be lifted off. Tag this washer so it can be installed in the same location. Remove the three bolts previously installed, and the PTO clutch driven member, pressure plate and Bellville washer can be removed. These two Bellville washers are identical in appearance, but have different spring pressures. Therefore IT IS IMPORTANT that they are installed in the position from which they are removed.

Check the condition of both driven members. Check the condition of the pressure plate and flywheel for signs of cracks or warping.



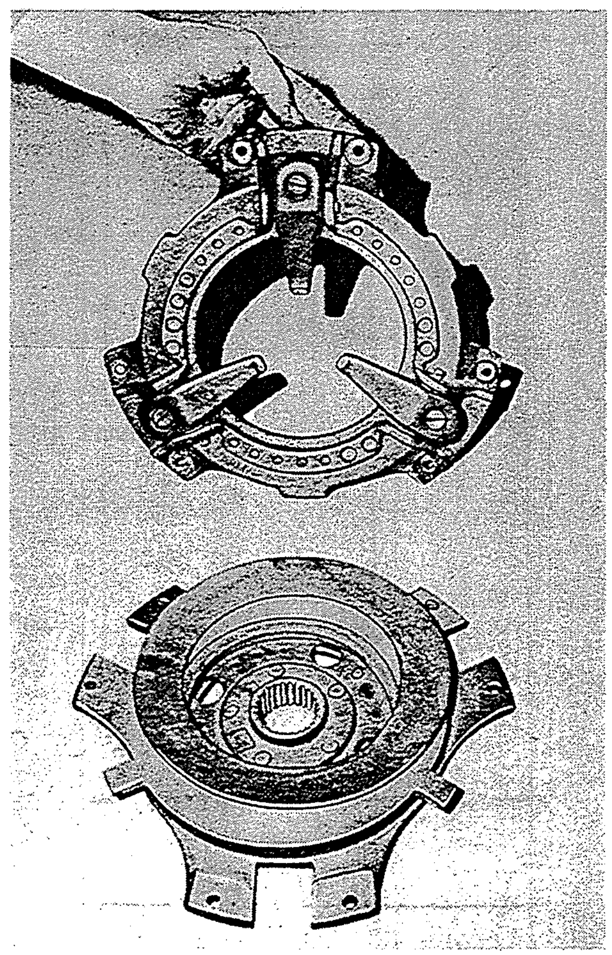
Illust. 57

Check oil seal <u>or</u> bearing.



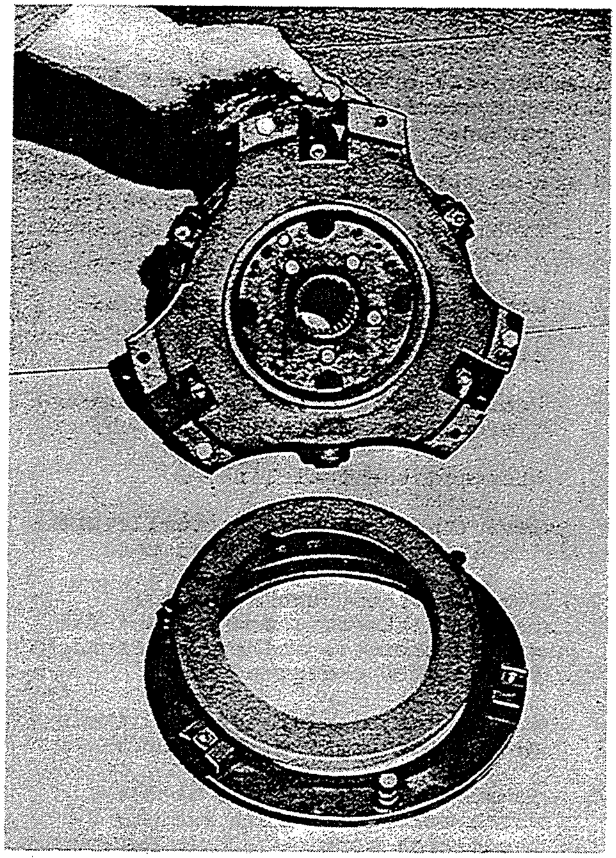
Illust. 58

Disassembly of the clutch.



Illust. 59

Back plate removed, showing PTO Bellville washer.



Illust. 60

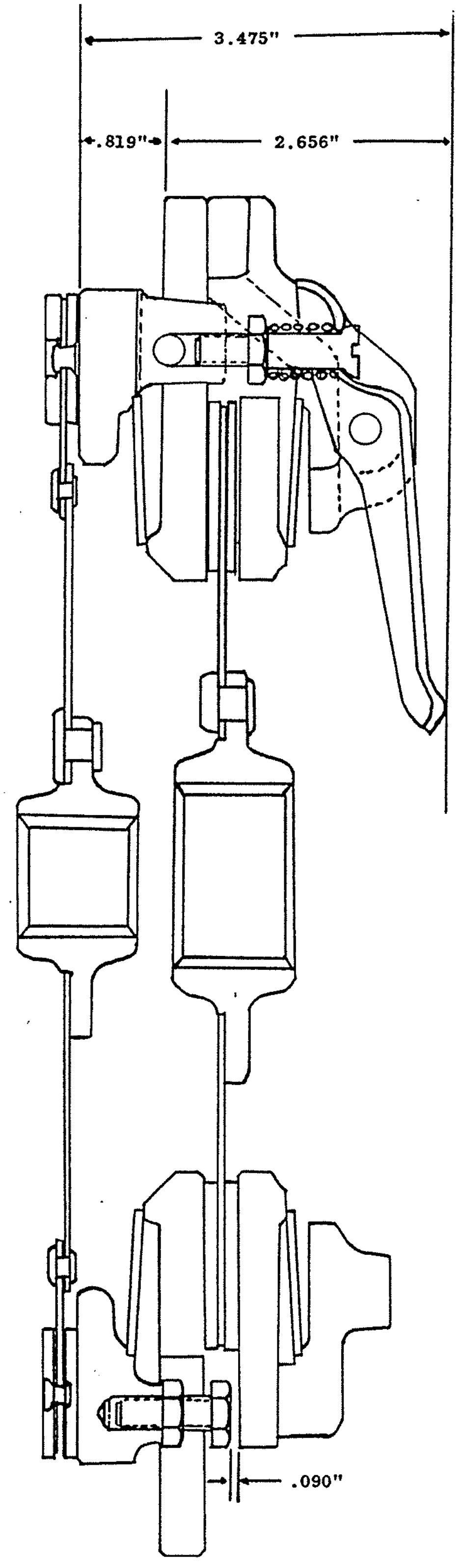
PTO clutch unit removed showing main clutch pressure plate Bellville washer.

Assembly and Adjustment:

Reassemble the clutch replacing parts as required. If new pressure plates or back plate are marked with paint, align these as best possible. If there are no marks, balance of these parts is such that they will work satisfactorily in any position. Align the parts removed that are being reinstalled, by the punch mark put on previously. Install the Bellville washers in the same position as before. See illustration 61 for details of assembly. Using the three bolts the same as in disassembly, tighten the two faces together. Adjust the clutch finger height and the set screws under the PTO pressure plate as shown in illustration 61.

Installation:

Installation is the reverse of removal. Use the tool in illustration 117 for aligning the driven members. Install the release bearing and guide. Adjust the clutch pedal.

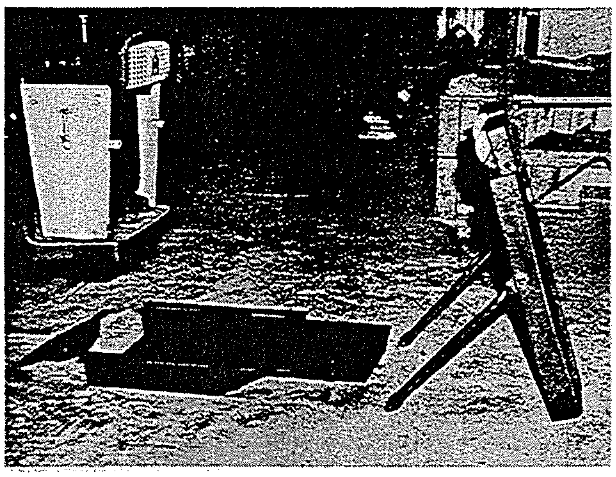


Illust. 61

REMOVAL OF ENGINE

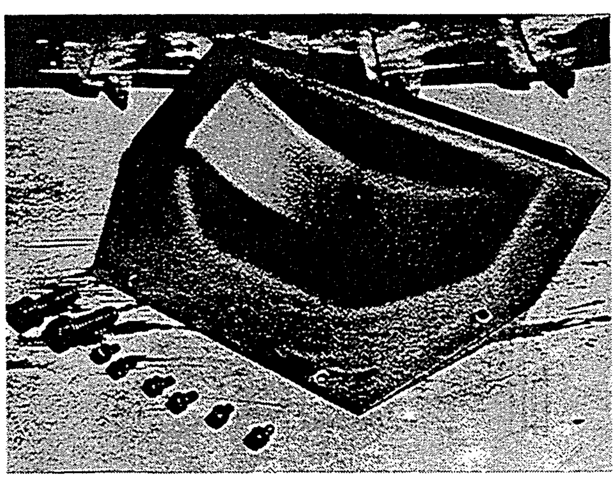
The engine is mounted in the frame of the tractor in such a manner that it is easy to remove. Occasions where it will be necessary to remove the engine other than for reasons related to the engine itself, would be for the removal of the Torque Amplifier, Reverser, or the clutch from a tractor equipped with either of these attachments. The engine complete with clutch housing, radiator and front member may be lifted out and reinstalled as a unit.

Removal:



Illust. 62

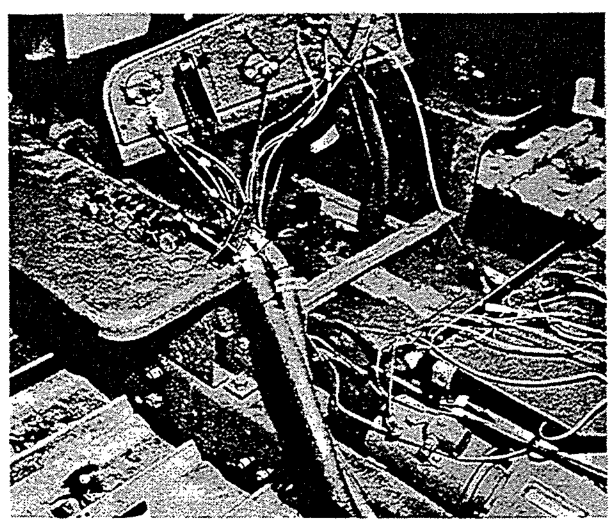
Radiator and crankcase guard removed.



Illust. 63

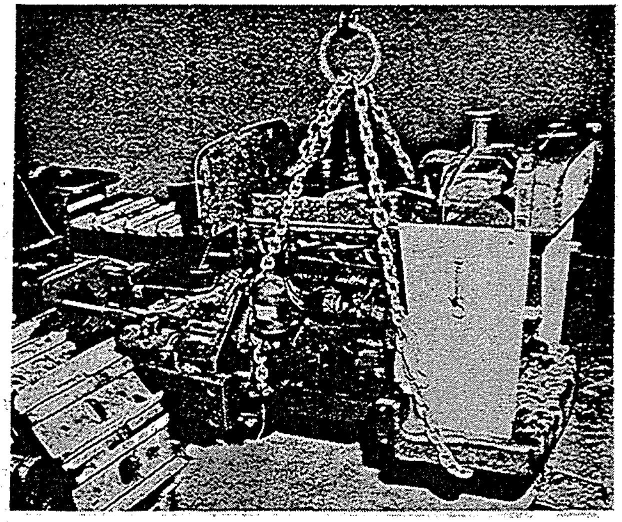
Remove clutch housing cover and two 5/8" bolts (TA or reverser)

1. Remove the crankcase guard and radiator guard if the tractor is so equipped.
2. Remove the clutch housing cover and the two 5/8" bolts which secure the clutch housing to the middle casting. (TA or reverser)
3. Drain approximately one gallon of water (anti-freeze) out of the cooling system.
4. Drain the oil from the transmission (TA or Reverser only).
5. Disconnect the fuel line.
6. Remove the instrument panel (Illust. 64) and lift off the fuel tank.
7. Disconnect the choke control, throttle linkage, temperature indicator bulb etc. and the electrical wiring at the engine ends.
8. Disconnect hydraulic lines at the pump if tractor is so equipped.
9. Remove the remaining 5/8" bolts which secure the middle casting to the clutch housing (TA or Reverser).
10. Support the weight of the engine with a hoist, remove the four bolts from the channel frame on each side, and slide the engine assembly forward and out of the frame.



Illust. 64

Remove instrument panel and fuel tank.



Illust. 65

Support engine with a hoist and remove by sliding forward.

Installation:

The installation of the engine is in general the reverse of removal. The use of dowel pins (Illust.100) will assist in aligning the engine with the TA or Reverser unit, by installing them in the upper corners of the clutch housing. If the clutch is removed, see details under the "Clutch" section of this book for reinstalling.

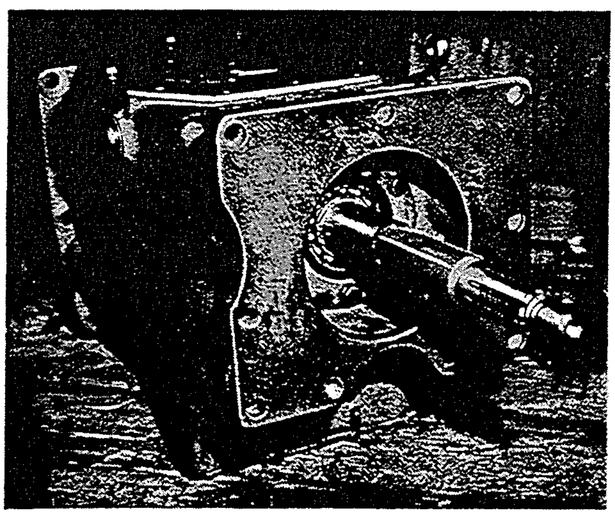
TORQUE AMPLIFIER

Removal:

To remove the Torque Amplifier assembly it is first necessary to remove the engine (see details under that heading). Drain the transmission oil. All the oil will not drain out, but loosening the PTO drive gear cover will allow oil trapped in that section to drain. Remove the TA housing complete. Using dowels shown in illustration 100 in the two lower corners of the main frame casting will assist in removing the TA housing. When separating these castings watch for the transmission pilot bearing which can drop out, and if it drops into the transmission housing it may be difficult to retrieve. Removing the transmission cover before separating the castings will prove helpful in this respect.

Disassembly:

Unlike the reverser which can be installed in the same housing, the TA must be dismantled from the front in order to remove the planet carrier. Whether the tractor is equipped with Standard or Constant Running PTO (Illusts.66 and 67) the procedure is the same.

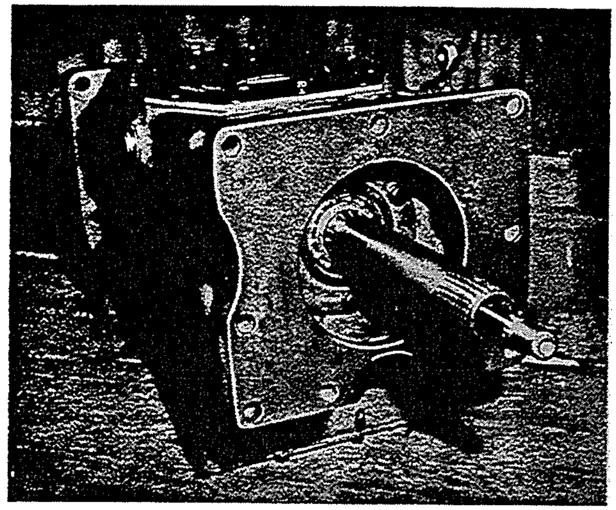


Illust. 66

Standard PTO. Single shaft.

Remove the three bolts which hold the front bearing retainer and remove complete with shaft. Remove the top cover from the TA housing. Working through this opening remove the TA clutch.

Clamp the TA clutch with three 5/16"x 7/16"bolts and plain washers to keep the assembly under compression. (Illust.68). Unlock the TA clutch carrier nut and remove the nut (Illust.69). See



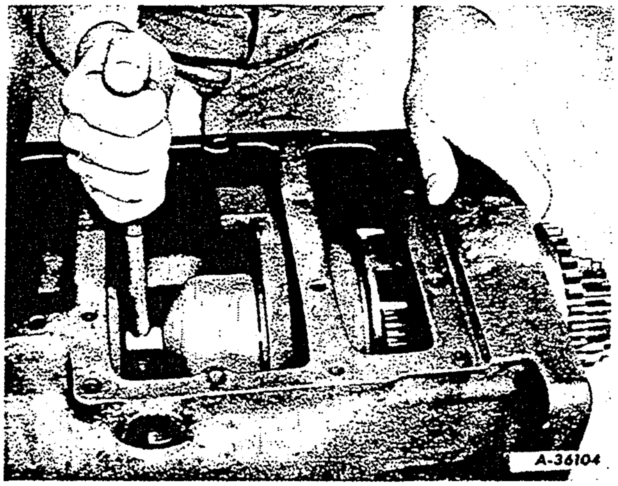
Illust. 67

Constant Running PTO. Dual shafts.

Illust. 68

Clamping the TA clutch.

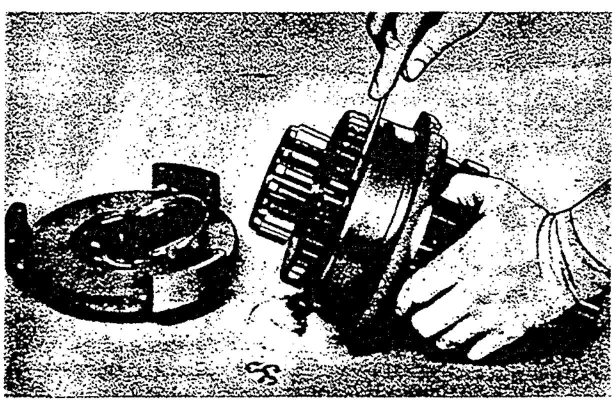
illustration 104 for the correct tool. Remove the four bolts from the transmission drive shaft bearing cage. The TA unit can now be removed.



Illust. 69

Remove the TA clutch carrier nut.

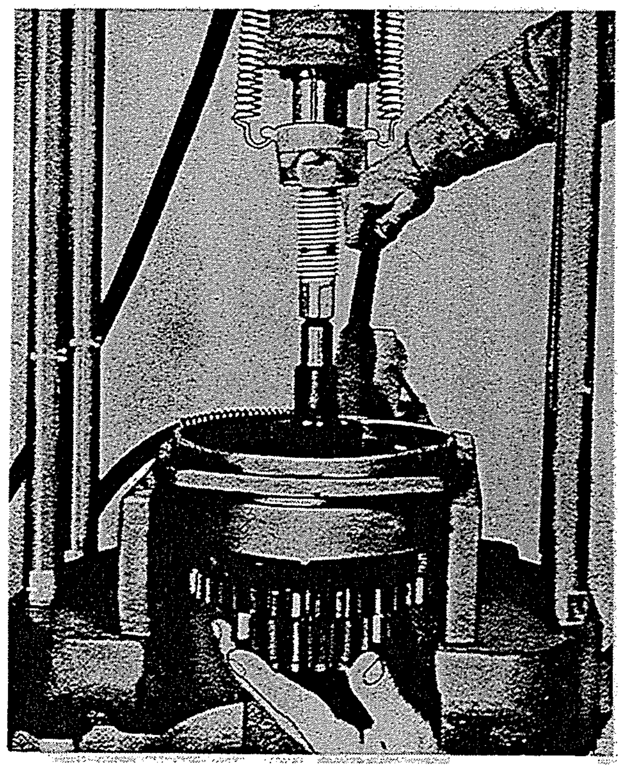
NOTE: Use the tool shown in illustration 102 to protect the oil seal when removing the planet carrier in the event that a new seal is not available for replacement. Remove the bearing carrier screw retaining rings (Illust.70). Remove the screws using a 3/8 inch 12 point socket. The over running clutch and planet carrier can now be removed from the bearing cage.



Illust. 70

Remove the retaining rings from the over running clutch bolts.

It is possible for the planet carrier to come out of the overrunning clutch as friction of the rollers is all that holds them together. Keep this in mind when handling the unit as it may fall apart accidentally. To remove the snap ring in front of the bearing on the transmission drive shaft, spread with snap ring pliers and lift from the groove with an offset screwdriver. Press the transmission drive shaft out of the bearing (Illust.71).



Illust. 71

Press the transmission drive shaft from the bearing.

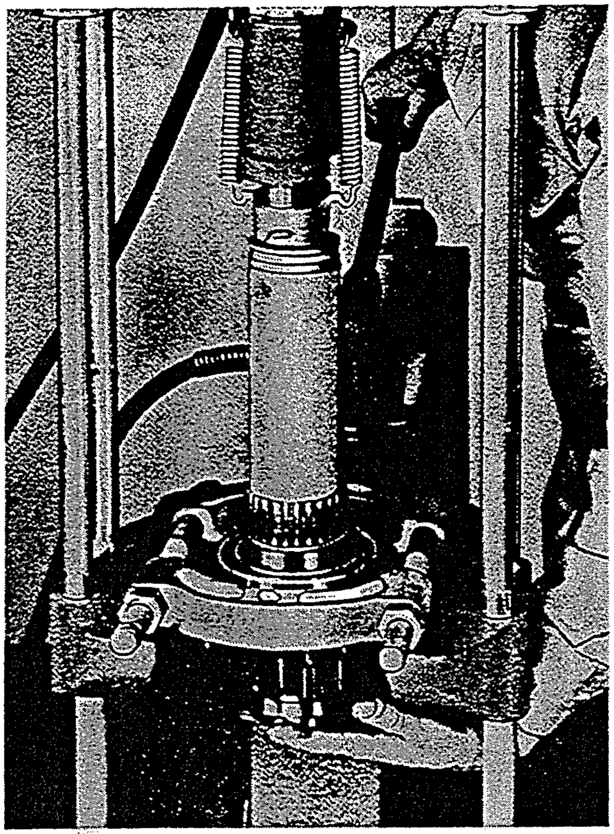
Lift out the overrunning clutch rollers with needle nose pliers. Tap the overrunning clutch ramp off the planet carrier and rear bearing.
Press the front and rear bearings from the planet carrier (Illust.72)
Drive the roll pins out of the planet carrier (Illust.73). Using a dummy shaft(Illust. 101) lift out the gear with the rollers in place.

Important: Use care not to damage or lose the spacers and thrust plates (Illust.73). The front sun gear and shaft may be removed from the planet carrier.

Inspection:

Primary Sun Gear:

1. Check the splines at the forward end for roughness and wear.



Illust. 72

Remove the planet carrier front bearing using a pipe to press against the carrier.

2. Inspect the oil seal surface for roughness and wear.

3. Check the bearing area of the shaft for wear.

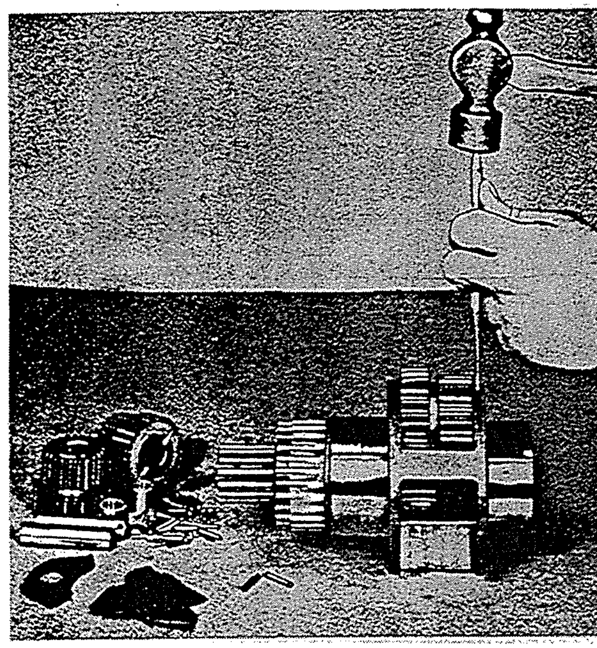
4. Examine the sun gear teeth for wear.

5. Inspect the secondary sun gear pilot bearing for roughness and wear.

Except for replacement of the pilot bearing, if any of the above items are found to be unsatisfactory, the primary sun gear and shaft should be replaced with a new part complete with pilot bearing.

Planet Carrier:

1. Check the sun gear shaft bearings in the planet carrier for wear and roughness.



Illust. 73

Driving out the roll pins and removing the planet gears.

2. Check the oil seal for damage and wear. If either the seal or the bearings are to be replaced, use a brass drift to remove these parts so as to prevent damage to the planet carrier.

3. Inspect the planet carrier for rough oil seal surfaces, and worn or damaged overrunning clutch roller surfaces.

4. Check the planet gears for worn or damaged teeth.

5. Check the bearing spacers, thrust plates and shafts for wear.

NOTE: When the planet gears are replaced always discard the planet gear shafts and bearing rollers. Use new ones in reassembly.

Important: The Torque Amplifier planet gears are manufactured in matched sets of three so that each gear will have equal backlash when installed, thereby eliminating the possibility of one gear carrying more than its share of the load. Under no circumstances should planet gears be replaced except in matched sets of three. For the same reason, all planet gear shafts and bearings must be replaced at the same time.

6. Clean and inspect the planet carrier front and rear bearings. If the bearings are not to be discarded, oil and wrap them in oil proof paper to keep them clean.

7. Inspect the planet carrier oil seal (located in the TA housing) for wear or damage and evidence of leakage.

Overrunning Clutch:

1. Inspect the rollers for damage and wear. All the rollers showing wear should be replaced. Complete set to distribute load.

2. Pull the rubber plugs and remove the springs and pins from the ramp. Check the pin for damage or wear. Check the springs for free length by comparing with new springs from stock.

3. Check the ramp for wear at the points of contact with the rollers.

Secondary Sun Gear and Transmission Drive Shaft:

1. Clean and inspect the ball bearing.

2. Inspect the pilot bearing surface for wear.

3. Check the gear teeth for wear.

4. Check the sun gear thrust washer for wear and scuffing.

5. Inspect the pilot bearing bore in the transmission driving gear for wear and roughness.

TA Clutch and Release Bearing:

1. Check the clutch carrier for checked or scored surfaces.

2. Examine the friction plate for loose or worn linings and worn splines.

3. Disassemble the clutch pressure plate assembly. Check for worn release levers, spring free length of 2 inches and tension of 161 pounds at 1-1/4". Inspect the pressure plate for scoring and cracks.

4. Assemble and adjust the TA clutch pressure plate assembly. The following equipment is required for proper adjustment:

   Surface plate or flat surface such as the top surface of the TA housing.

   TA clutch carrier 359 895 R3 (out of parts stock).

   TA clutch driven member 367 910 R91 (out of parts stock.)

   Gauge rod 1/2 X 3.490 inches. (See Illust.74)

   Dial indicator set.

Proceed as follows: To make adjustment of the TA pressure plate assembly:

a. Assemble a new driven member and the pressure plate assembly to the clutch carrier. Have the pressure plate assembly properly clamped before installing the bolts securing the pressure plate to the carrier.

b. After tightening pressure plate to carrier bolts, center the driven member and remove the clamping bolts.

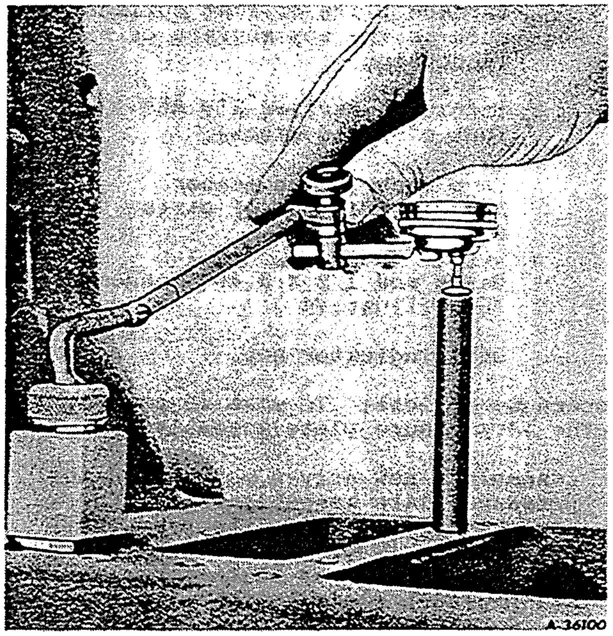
c. Secure the dial indicator to the surface plate (or flat machined surface). Set the dial gauge contact point in a vertical position.

d. Place the 3.490 inch gauge rod (Illust. 74) under the dial gauge. Bring the dial gauge contact point down against the gauge rod with enough pressure to give approximately 1/2 revolution to the indicator hand. Secure the dial gauge in this position and turn the dial to bring the zero under the hand.

e. Slide the clutch and carrier assembly under the dial gauge (release levers up). As the highest point on the end of each release lever is placed under the dial gauge point, the gauge hand should turn to zero. If not, adjust release levers to obtain this reading. (Illust.75)

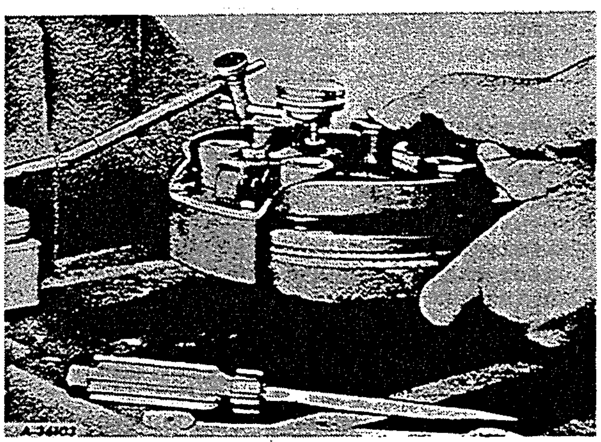
5. Check the release bearing for roughness and wear. Examine the release fork and shaft for wear.

All parts which are unsatisfactory for further service should be discarded and replaced with new.



Illust. 74

Setting dial indicator gauge.



Illust. 75

Checking adjustment of TA clutch levers.

Assembly and Installation:

1. To install the primary sun gear roller bearings in the planet carrier, press the front and rear bearings into place using the tool shown in illustration 107. This tool is designed for both installing and locating the needle roller bearings.

2. Press the primary sun gear oil seal into the planet carrier with the lip to the rear. Have the front of the oil seal flush with the edge of the carrier.

3. Install the secondary sun gear pilot bearing using the driver shown in illustration 105.

4. With the snap ring on the primary sun gear and the thrust washer immediately ahead of the snap ring, use the oil seal protector, illustration 103 to install the primary sun gear and shaft in the planet carrier. (Illust.76)

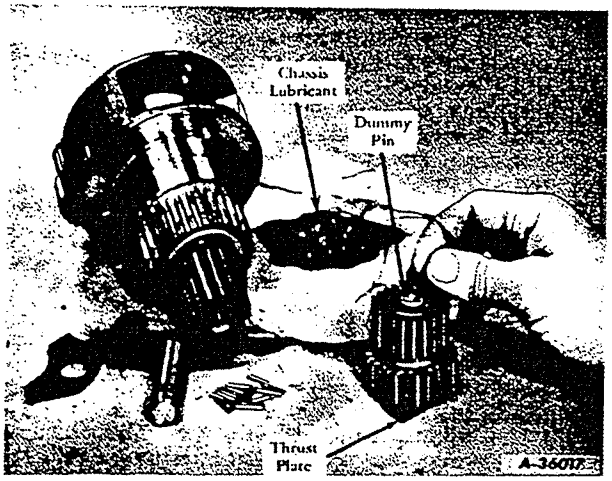
5. Use the dummy shaft shown in illustration 101 to assemble the needle roller bearings, 23 in each end of the gear (total of 46 in each gear). Use chassis lubricant to hold the needle rollers in place during assembly (Illust.77).

NOTE: Be sure the needles are assembled with the spacer between the two rows of rollers.

Illust. 76

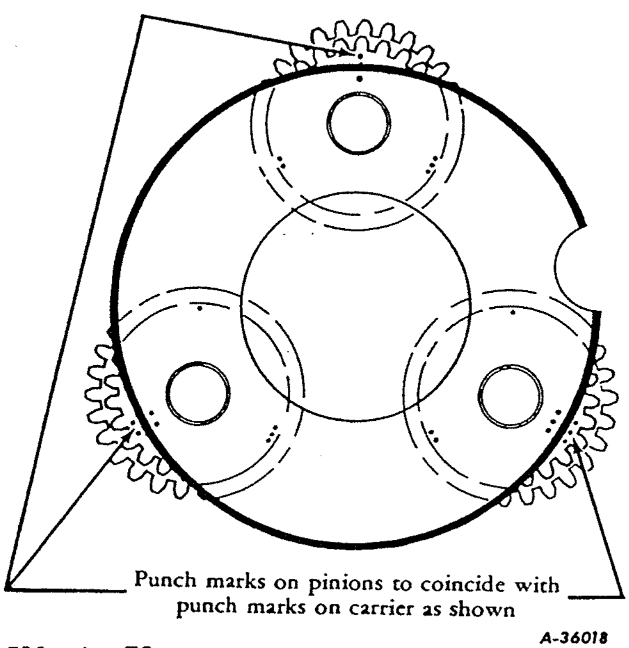
Installing the primary sun gear and shaft into the planetary carrier from the rear, using the oil seal protector sleeve.

Important: Timing the planet gears in assembly: The planet carrier has timing marks on the rear surface of each planet gear location. These are marked consecutively counterclockwise from 1 to 3. The planet gears are marked at three points, 120° apart on the back side of the gear. These gears are also marked consecutively clockwise from 1 to 3. Therefore, the planet gears are interchangeable within a matched set of three. In assembly, the timing marks on the planet gears must index and coincide with the marks on the carrier. (Illust.78)



Illust. 77

Assemble the planet gear needle bearings, using the dummy shaft.



Illust. 78

Planet carrier and planet gears with timing marks properly indexed, as viewed from the rear.

With the thrust plates in place, using the dummy shaft, place the planet gear in the carrier. Then insert the shaft in the carrier, which will push out the dummy shaft keeping the rollers in place. Secure the planet gear shaft with the roll pin. Proceed to assemble and install the two remaining planet gears.

6. Press the front and rear planet carrier bearings into place. Caution: When installing the rear carrier bearing, do not press against the primary sun gear and shaft. When installing the rear bearing, it is important to install it with the lettered side of the race next to the planet carrier.

7. Assemble the pins, springs and rubber plugs in the overrunning clutch ramp and install the ramp assembly on the planet carrier rear bearing.

8. Using a small screwdriver, push the pins back in the overrunning clutch ramp and drop the rollers in place.

9. Install the bearing with snap ring in the transmission drive shaft bearing cage. Press the bearing with the cage on the transmission drive and secondary sun gear shaft, and lock with the snap ring.

10. Position the planet carrier on the bench with the rear end up and place the thrust washer on the primary sun gear. Place the overrunning clutch thrust washer on the ramp so that the smaller polished surface of the washer will contact the ends of the rollers.

11. Insert the transmission drive and secondary sun gear shaft assembly in the planet carrier. Using a 3/8 inch 12 point socket, torque the bolts to 40 foot pounds. Install the retaining rings.

12. Using the oil seal protector (Illust. 102) over the splines on the planet carrier, install the TA unit in the housing from the rear. Install and tighten the 4 bolts in the transmission drive bearing cage. Torque to 40 foot pounds.

13. Place the TA clutch carrier on the planet carrier. Install the lock and nut with the tapered side of the nut to the rear. Tighten the nut

using the tool shown in illustration 104. Lock the clutch carrier retaining nut.

TA Clutch, Engine Clutch Shaft and PTO Driving Shaft:

1. Inspect the constant running PTO shaft (when installed) rear oil seal which is located in the TA housing, for signs of wear or evidence of leakage. Replace with a new part if necessary.

2. Place the TA clutch plate on the TA primary sun gear shaft. Install the TA clutch assembly on the clutch carrier and remove the three clamping bolts.

NOTE: At the time of manufacture, both the TA clutch carrier and the TA clutch are checked for balance. If any out-of-balance is detected, the part is marked with an arrow over a spot of white paint. When both the clutch carrier and the clutch have this mark, they should be assembled with the balance marks aligned as near as possible. If no balance marks are present or if only one part is marked, clutch balance can be disregarded.

3. Install the clutch release shaft fork and bearing assembly.

4. Clean and inspect the Constant Running PTO shaft bearings.

5. Install the input shaft bearing cage and torque the bolts to 40 foot pounds.

6. Install the housing top cover.

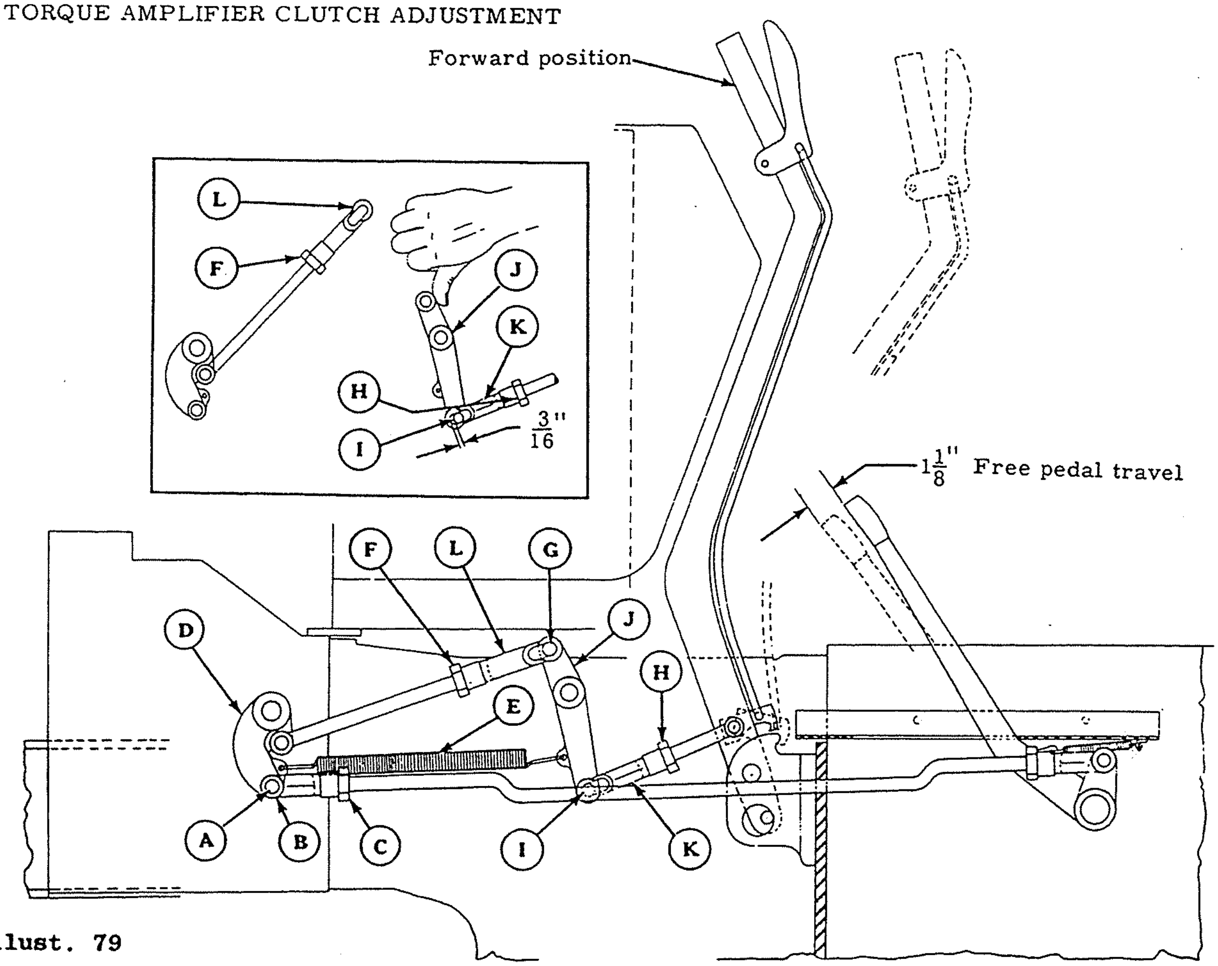
7. Install the TA housing on the main frame. It may prove easier to install the pilot bearing by mounting it on the shaft. Lubricate the bearing with chassis lubricant which will assist in holding it in place. Use the two dowels (Illust. 100) in the lower corners of the main frame housing to assure proper alignment of the TA with the transmission unit. Install and tighten the bolts before removing the dowels.

8. Replace the transmission lubricant. The engine may now be installed.

Adjustment:

The adjustment of the TA clutch basically consists of adjusting the main clutch and the TA clutch linkage so the two will disengage simultaneously. The first step is to properly adjust the clutch pedal so it has 1 to 1-1/8 inch free movement.

TORQUE AMPLIFIER CLUTCH ADJUSTMENT



Illust. 79

Remove the spring "E" and loosen lock nut "F" and remove clevis pin "G". With the torque amplifier lever in the forward position (see Illust.79) follow these instructions.

1. Loosen lock nut "H" and remove pin "I". Move torque amplifier clutch release shaft lever "J" counter-clockwise to remove the free travel.

2. In this position, the torque amplifier clutch release bearing just contacts the torque amplifier clutch release levers.

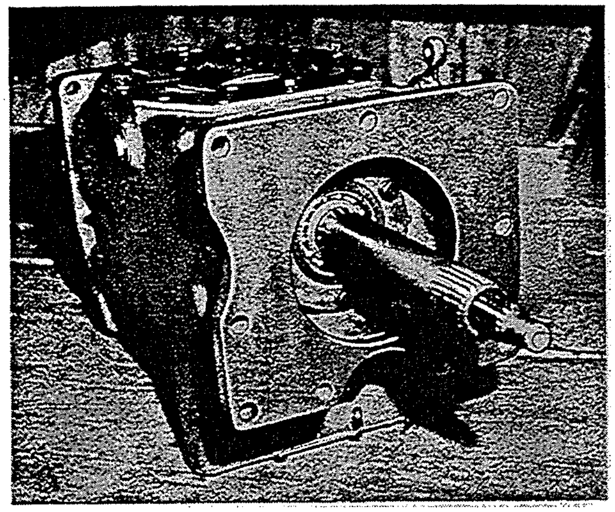
3. Adjust clevis "K" to provide a 3/16 inch space between the body of inserted pin "I" in lever "J" and the forward end of the slot in clevis "K", reinstall pin "I", tighten lock nut "H" and reinstall spring "E".

4. Adjust clevis "L" and assemble pin "G" to the shortest free length without altering the position of torque amplifier clutch release lever "J" previously established. Tighten lock nut "F".

REVERSER

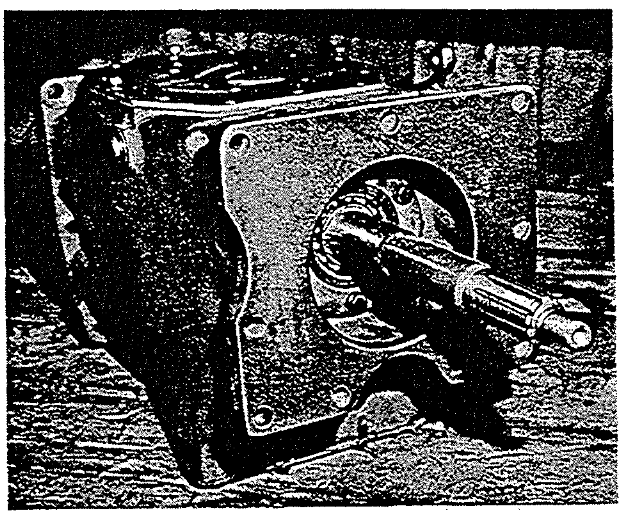
Removal:

To remove the Reverser assembly from the tractor it is necessary to first remove the engine. However, if the front shaft only (Illust.84) is to be removed, this may be done with the engine removed, but without removing the middle casting from the main frame. If the rear section of the reverser containing the planetary gears (Illust.86) only is to be removed, the reverser housing and engine may be removed as a unit. The rear section then may be removed without disturbing the front shaft. These cases will be the exception. It will be found advantageous in most cases to remove the entire unit when going this far, inspecting and replacing all parts as might be necessary. In either case it will be necessary to drain the oil from the transmission. Loosen the six bolts which hold the bottom cover of the PTO drive gear compartment to drain the oil from that section.



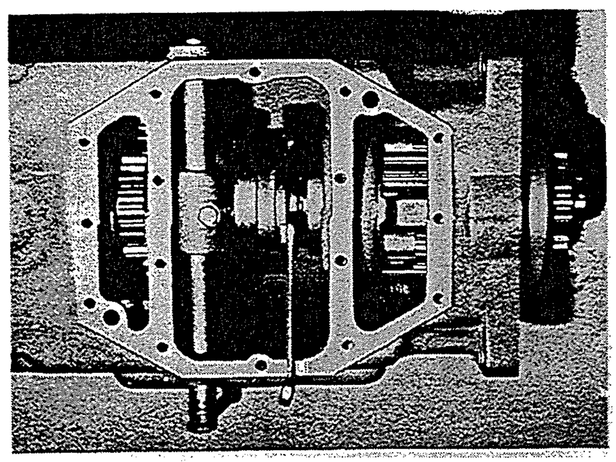
Illust. 81

Reverser with Constant Running PTO.



Illust. 80

Reverser with Standard PTO.



Illust. 82

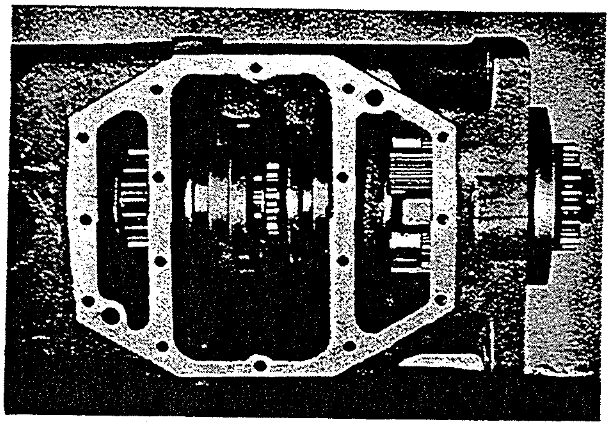
Remove the bolts from the shifter collar.

Disassembly:

Remove the inspection cover from the top and take out the cross shaft and shifter fork. Both the standard PTO, illustration 80 and the constant running PTO, illustration 81 are dismantled in the same manner. Remove the four bolts holding the spline shifter collar to the coupling. (Illust.82). The coupling is held in position with two spring loaded balls. Do not lose these when removing the front shaft. The front shaft is carried in a retainer. This retainer and shaft can be pulled forward after removing the three retaining bolts.

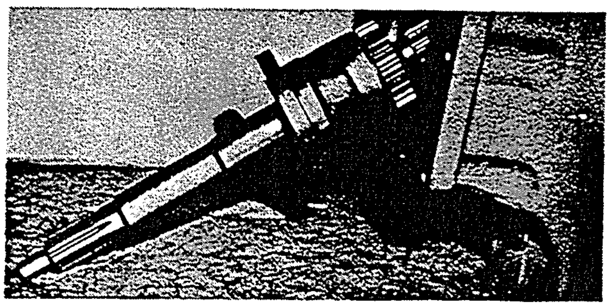
The front portion of the shifter coupling can now be removed from the housing.

The planet carrier assembly may be removed to the rear after removing the drive spline coupling, and the four bolts which hold the cage assembly in place.



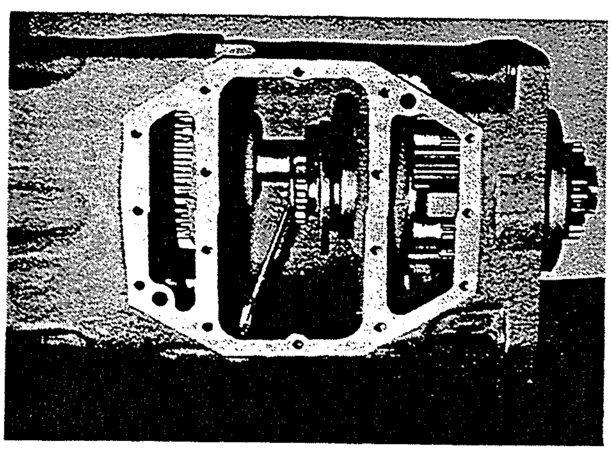
Illust. 83

Coupling separated for removal of either front or rear unit.



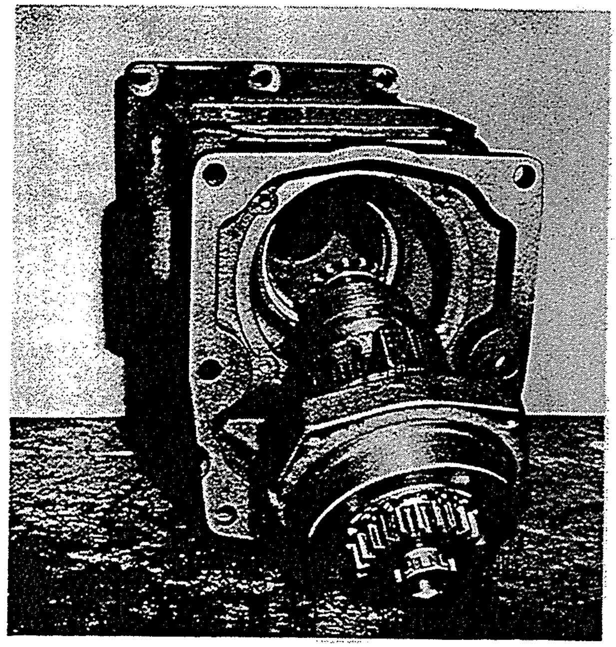
Illust. 84

Front shaft removed.



Illust. 85

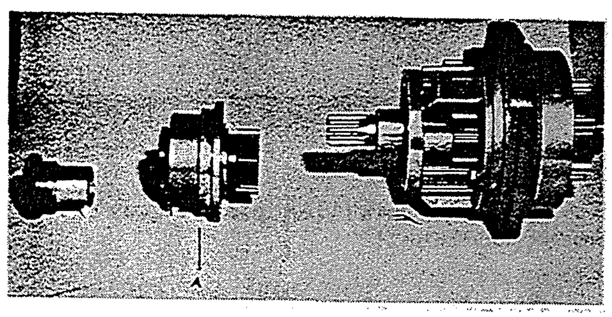
Remove the drive spline coupling.



Illust. 86

Remove the planet carrier assembly.

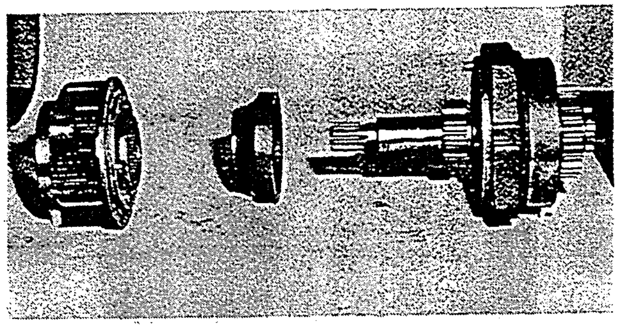
When removing the planet carrier assembly, the reverser drive sun gear, "A"(Illust.87)may come with it or may remain in the housing. If it remains in the housing, it may be removed to the rear at this time.



Illust. 87

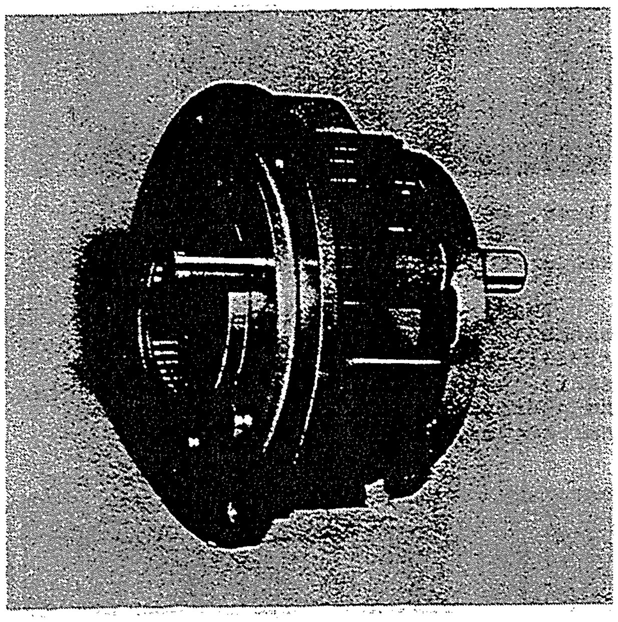
Planet carrier unit.

The planet carrier unit can be lifted out of the drive shaft bearing cage by first removing three bolts. The spacer can be easily removed from the planet carrier with a soft hammer. While working on this unit, take care to keep the planet gear shafts from slipping out of place, thus allowing the bearings to fall out of the gears. The planet gears may be removed without disturbing the needle roller bearings by using the tool described in illustra-



Illust. 88

Planet carrier, spacer and drive shaft bearing cage assembly.

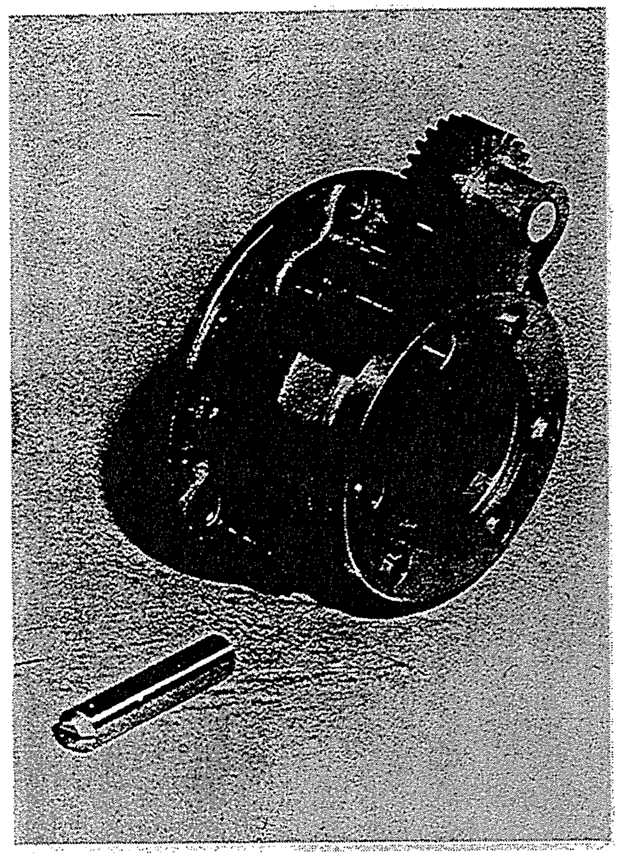


Illust. 89

Removing and installing planet gear using dummy shaft.

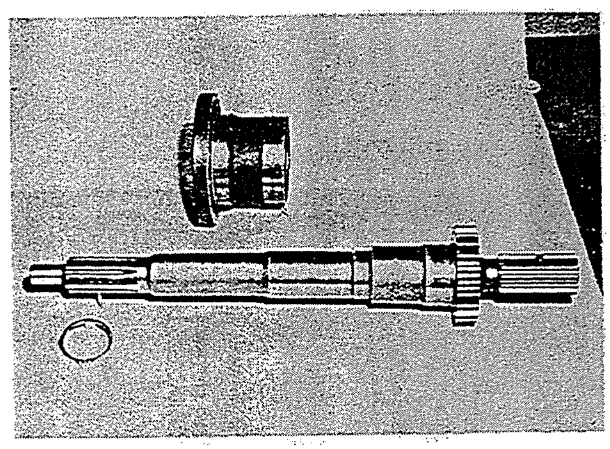
tion 101. This dummy shaft is required for assembling the bearings in the gears and installing the gears in the planet carrier. Illustration 90 shows the dummy shaft in place, with the gear ready for removal.

The input shaft and the transmission drive shaft, illustrations 91 and 92 may be removed from the bearing cages, and the bearings removed after first removing the snap rings.



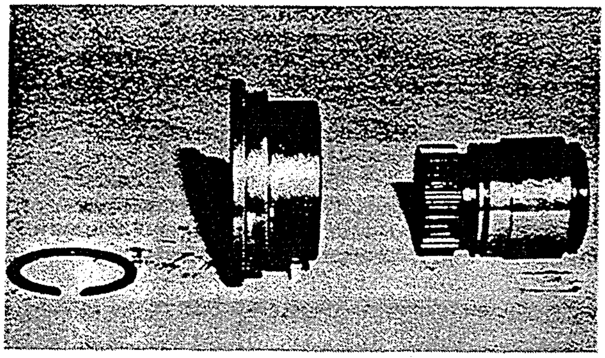
Illust. 90

Planet gears showing thrust plate.



Illust. 91

Input shaft removed from bearing cage assembly.



Illust. 92

Transmission drive shaft removed from bearing cage assembly.

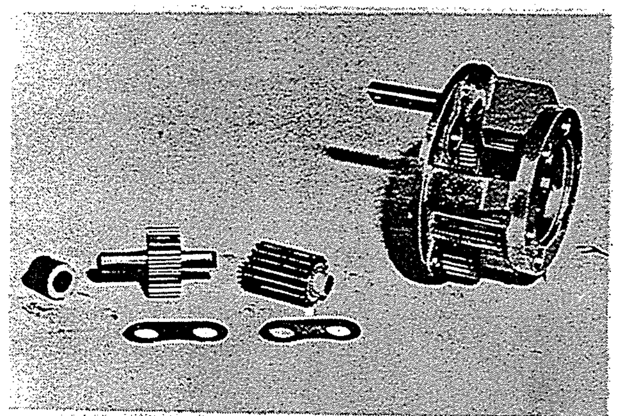
Inspection:

1. Check all the bearings and bearing surfaces.
2. Check the condition of the splines on the input shaft, the reverse drive sun gear and the drive spline coupling.
3. Check the condition of the springs and poppet balls (Illust.95).
4. Check the PTO drive gears for wear.
5. Check the shifter fork and the groove in the shifter coupling for excessive wear.
6. Check the condition of the thrust plates in the planetary unit.
7. Check the condition of the needle rollers in the planet gears.

If it becomes necessary to replace planet gears for any reason, they should be replaced as a set rather than individually. The needle roller bearings should be installed with a driver as shown in illustration 113. When installing needle roller bearings, always place the driver against the end of the bearing with the lettering on it. The construction of the bearing is such that the other end is unsuitable for driving against, and damage to the bearing may result. Drivers for all needle roller bearings used in this unit are illustrated in the pages covering "Tools".

Assembly:

Assembly is in general the reverse of disassembly. The planet gears are easily installed with the needle bearings in place by using the dummy shaft. Twenty three (23) needles are used in each bearing. When installing the short gear, install it against the rear, or larger end of the planet carrier. See illustration 94. The planet gear shafts may be inserted from either end. The slotted end must be at the front of the carrier. (Illust.94). The spacer casting is then tapped into place, holding the planet carrier in such a way that the shafts cannot slip out. Place the unit on a bench as shown in illustration 94, and with a screwdriver, turn and press the shafts until they drop into place, with the end of the shafts below the surface of the planet carrier. Install the reverse drive sun gear assembly. There is no timing of gears here such as in the case of the Torque Amplifier. Install the planet carrier on the transmission drive shaft assembly.



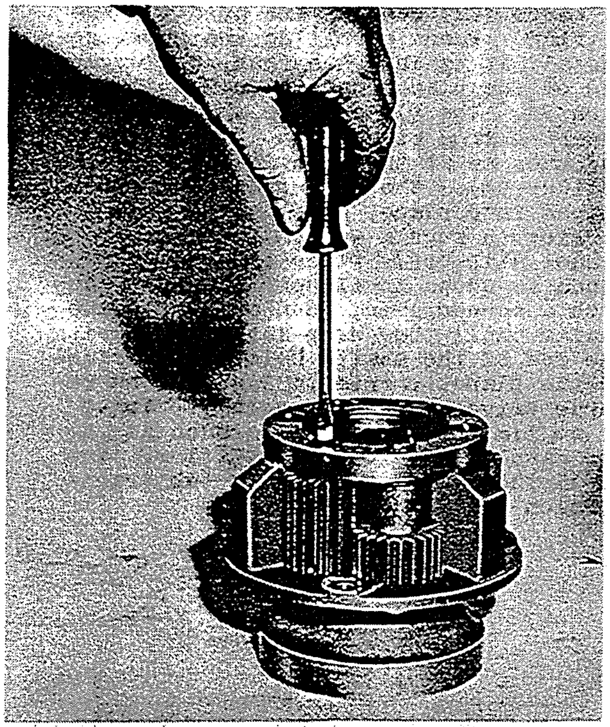
Illust. 93

Planet carrier assembly.

The use of chassis lubricant on the needle bearings and shafts will assist in installing the needles, and aid in preventing their falling apart accidentally. Also, it will provide lubrication for the interval between the units starting in initial operation after overhaul, and the time lubricant will get to all the moving parts through regular means.

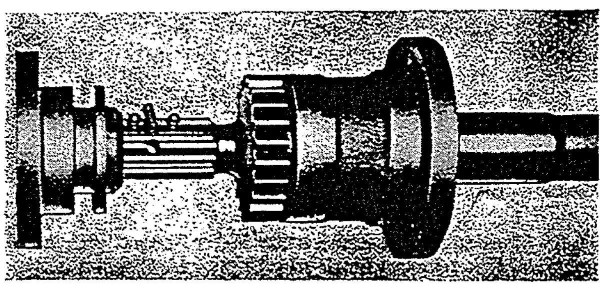
Installing the input shaft with the balls and spring in place may be easily accomplished with the use of two pieces of round stock such as cut from a 4 inch spike. The balls and spring are put in position and the round stock wired into place holding the poppets compressed. When the coupling is slipped into place, remove the wire and the two pieces of round stock from the housing.

The PTO drive gear and shaft (Illust.97) are installed in every re-



Illust. 94

Turn and press the shafts into place.



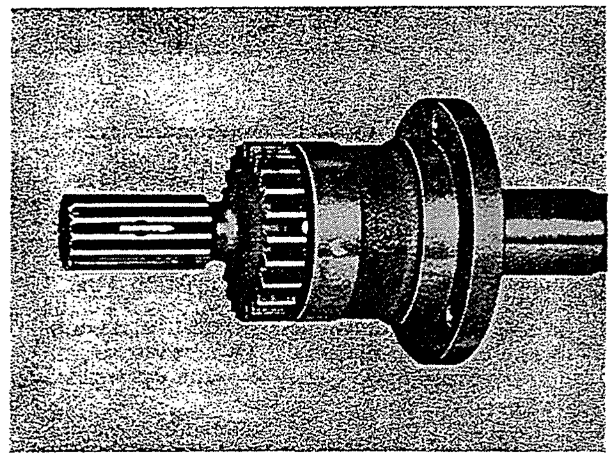
Illust. 95

Input shaft with poppet balls and spring.

verser at the factory, regardless of whether or not a PTO attachment is installed. This is for two reasons; first, it simplifies installation of a PTO attachment in the field, and second and most important, these gears carry lubricant up to the bearings on the input shaft. ALWAYS REINSTALL THIS SHAFT AND GEAR WHEN SERVICING THE REVERSER.

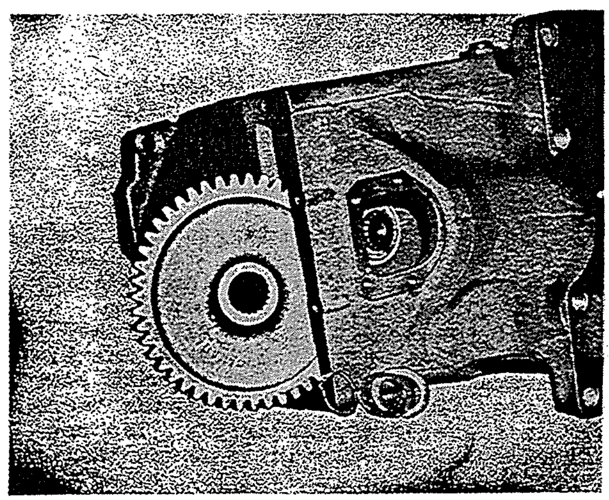
This shaft is carried on needle roller bearings with bronze bushings fitted in the outer ends of the bores to accommodate end thrust. Drivers for the needle bearings will be found in the "Tool" section of this book. (Illust. 112)

The gear is located on the shaft with a snap ring. Flat steel washers are added behind the snap ring to reduce the shaft end movement to a minimum.



Illust. 96

Poppets held in place for installing shaft.



Illust. 97

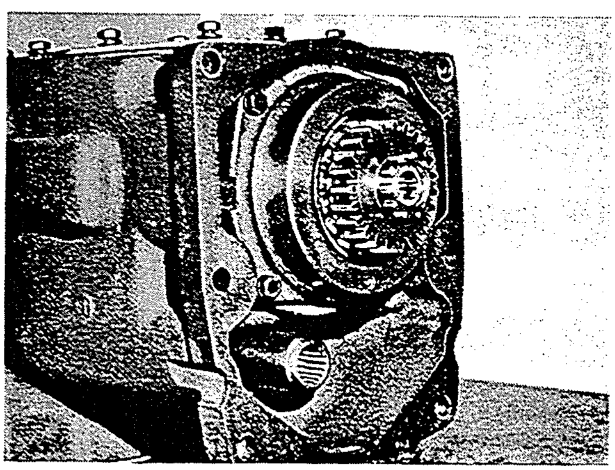
PTO drive gear and shaft.

POWER TAKE-OFF

Description:

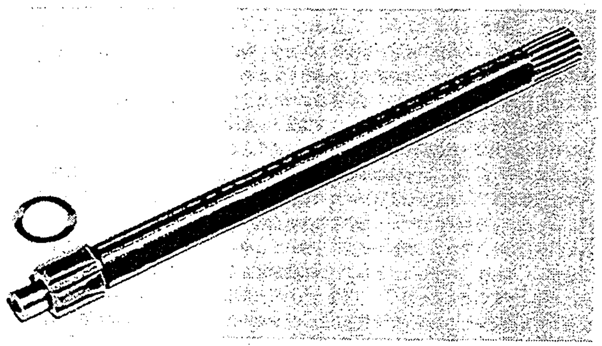
The power take-off in these tractors may be either Standard Transmission PTO or, if the tractor is equipped with either a Torque Amplifier or Reverser, a Constant Running PTO is available. The Constant Running PTO cannot be installed in a tractor without the middle casting (TA or Reverser). Tractors are equipped at the factory with all the necessary parts for installing a PTO attachment. The two attachments listed are identical in every respect and interchangeable except that, when the tractor is equipped with a TA or Reverser a shaft is required to extend through the hollow countershaft to meet the PTO shaft in the rear of the middle casting. (Illust.98) A flat washer (Illust.99) is also required to prevent this shaft sliding too far forward. When the tractor has no middle casting, the attachment does not require this shaft as the PTO is driven off the rear of the solid countershaft. It follows therefore that two attachments are listed, but the addition or deletion of this shaft and washer will make them the same. The attaching parts are the same for Standard PTO and Constant Running PTO when the middle casting is mounted.

The clutch and clutch shaft assemblies differ in cases of standard PTO and CRPTO (TA or Reverser). With CRPTO a two stage clutch is used which enables the operator to stop the forward (or reverse) motion of the tractor and shift gears without stopping the PTO shaft. It is necessary however to stop the motion of the tractor to engage or disengage the PTO.



Illust. 98

Middle casting showing PTO drive shaft.



Illust. 99

PTO driving shaft and washer.

Removal:

If the PTO shaft is to be removed for any reason, it may be done without opening up the top of the bevel gear housing. Drain the oil. The shaft complete with the bearing cage can be removed to the rear. If the shaft is to be reinstalled, engaging the PTO will prevent the shifter spool dropping off. If the spool should happen to drop, it may be retrieved and reinstalled with a light bar slightly longer than the PTO shaft itself. When installing it this way, ensure the shifter shaft is properly engaged in the groove of the spool. The front PTO shaft can likewise be installed or removed through this opening.

If the PTO attachment is removed from the tractor be sure to also remove the shifter spool, and if the tractor is equipped with TA or Reverser, the front drive shaft and washer as well.

Removal or replacement of the PTO front drive parts requires removing the engine from the tractor. These items should be serviced when overhauling the TA or Reverser units. Do not leave the PTO drive gear out even if there is no PTO attachment in the tractor. These gears are necessary for lubrication within the middle casting itself.

Replacement:

Reassembly of the PTO is the reverse of removal. Locate the shifter spool as shown in illustrations 43 and 44.

TOOLS

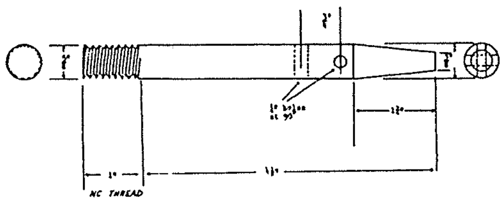
This tractor is so designed that standard tools such as found in any shop will perform all the adjustment normally required for servicing, and to a large degree, the work required for complete overhaul. The following pages deal with a few tools which will make some of the overhaul operations easier, faster, and reduce to a minimum the danger of damage to parts. Tools shown in illustrations 100 to 107 are contained in the OTC tool set ED-3269, which is the Torque Amplifier tool set for International Harvester wheel tractors. Illustrations 108 and 109 show tools which are also listed as available in the OTC catalog. In each case, the OTC number is shown for ease in ordering. Tools shown in illustrations 110 to 116 inclusive are tools that can be made on a lathe. Dimensions are given for each tool, and many shops are equipped to manufacture them should the need arise for immediate use.

It will be noted that the tools in illustrations 105 and 106 are very similar. Keep in mind that the tool in illustration 105 is for driving needle roller bearings into place, and burring or roughness on the shoulder which may result from using it in other applications could render it unsuitable for this purpose. For this reason, two separate tools are recommended.

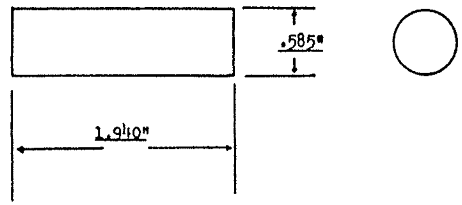
The sockets shown in illustrations 115 and 116 can be made in your shop by using two of the nuts from parts stock, removing the threads with a file, and welding them together with the notches in proper alignment. Material for the prongs may be obtained from a 3/4" lock washer, heated and straightened, and welded into place in the notches. A plate and nut of suitable size can be welded on the back. OTC 885, adjustable spanner will serve for these sockets.

Figures in the following illustrations that are underlined are critical measurements. Other figures will permit tolerances, best judged by studying the application of the tool.

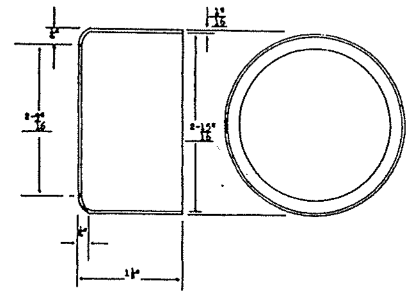
Illustration number and tool uses:



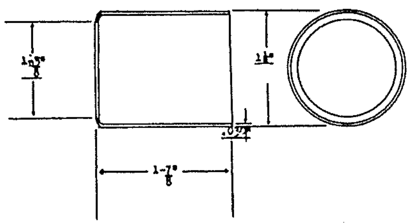
100 Aligning dowels (2 required) use to install engine, TA or Reverser units. (OTC ED-3271)



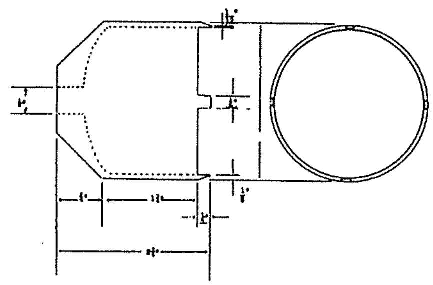
101 Dummy shaft, for installing needle roller bearings in planet gears. (OTC ED-3259)



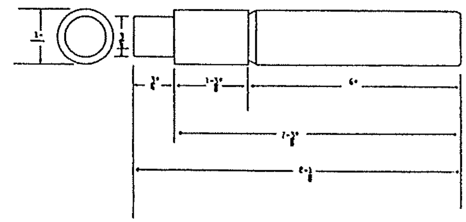
102 Seal jumper for installing TA units.(OTC ED-3253)



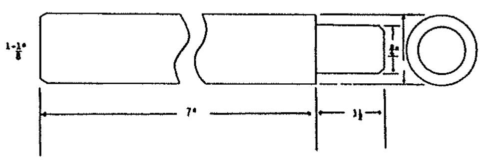
103 Seal jumper. TA overhaul. (OTC ED-3254)



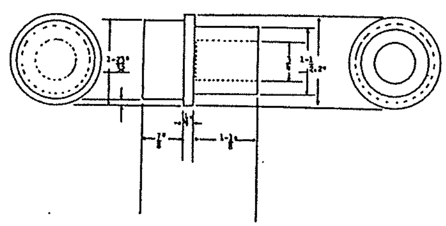
104 Peg socket. TA clutch retainer nut removal. (OTC ED-3251)



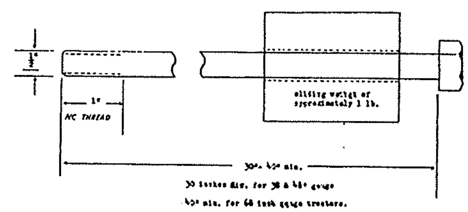
105 Needle roller bearing driver, TA overhaul. (OTC ED-3251)



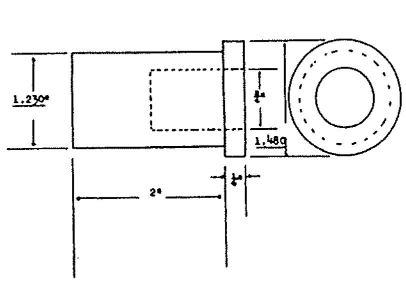
106 Mandrel, use with bearing drivers shown in illustrations 107,109,110,111, 112 and 113. (OTC 815)



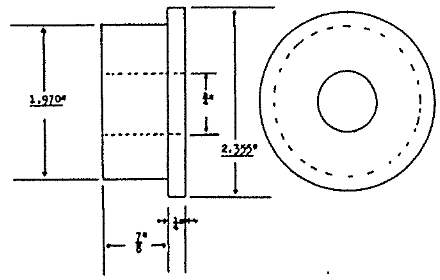
107 Bearing driver.(OTC ED-3250)



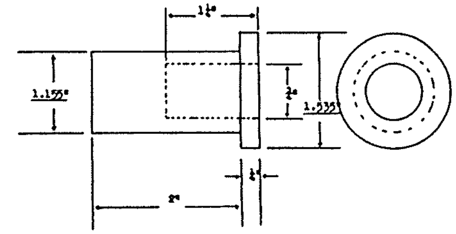
108 Slide hammer, drive pinion and bevel gear shaft removal.(OTC 943 slide hammer and adapter 17-M)



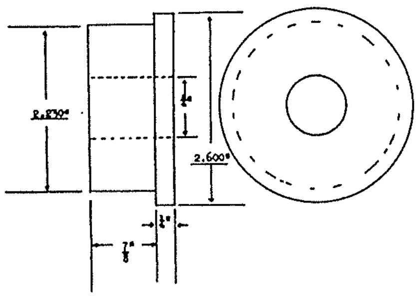
109 Bearing driver. (OTC 807)



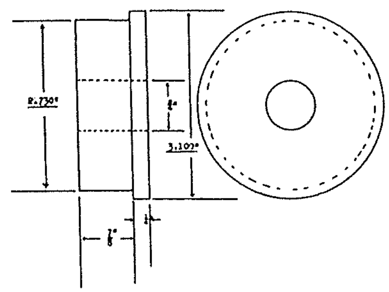
110 Bearing driver.



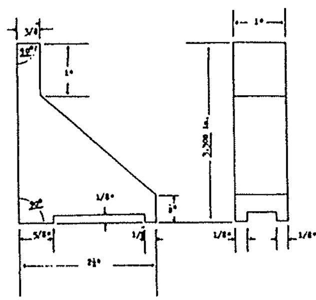
111 Bearing driver.



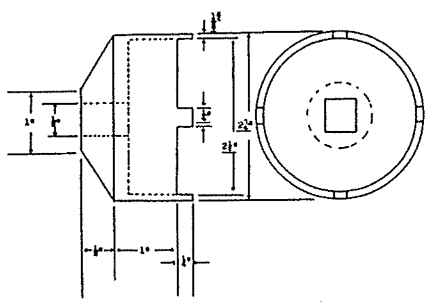
112 Bearing driver.



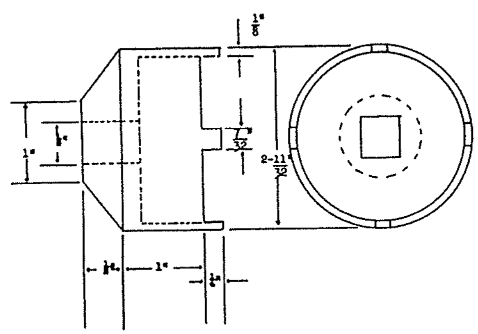
113 Bearing driver.



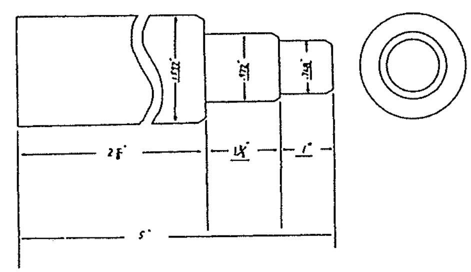
114 Bevel gear and Pinion adjusting gauge.



115 Peg spanner, bull shaft nut, final drive.



116 Peg socket. Hollow countershaft, transmission front.



117 Clutch aligning tool. Two stage clutch.