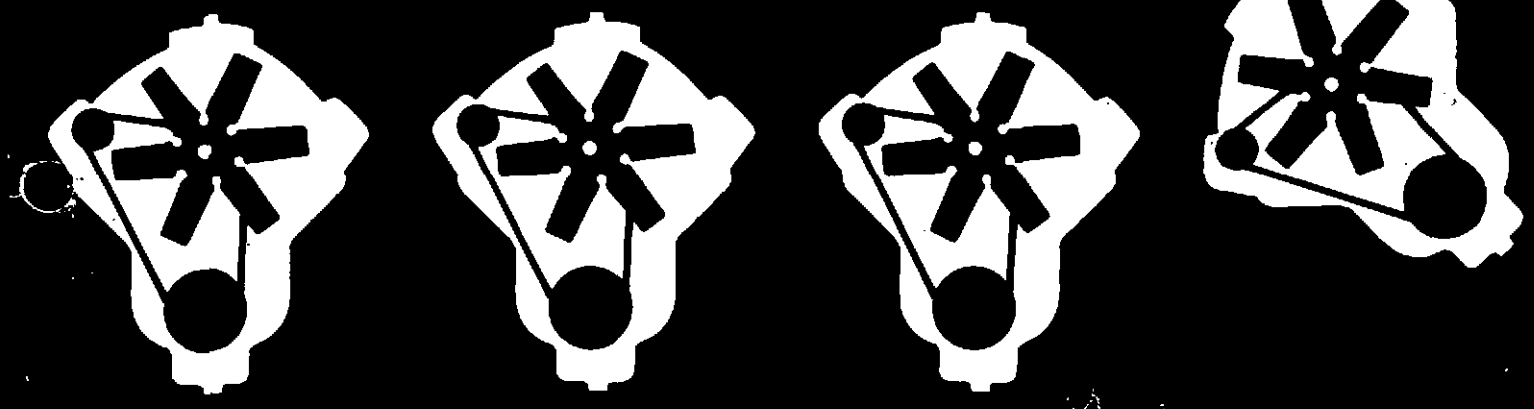
INTERNATIONAL HARVESTER

ENGINE

OPERATOR'S MANUAL

ENGINE MODELS

C-152	C-392
C-196	C-446
C-304	C-537
C-345	C-549



An Operator's Manual and a Parts Catalog are packed and shipped with this engine for customer use. Additional technical publications are available for this engine.

These additional publications are strongly recommended for the customer who performs his own maintenance and service on this engine.

It is the policy of International Harvester Company to improve its products whenever it is possible and practical to do so. We reserve the right to make changes or add improvements at any time without incurring any obligation to make such changes on products sold previously.

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

Periodic revisions may be made to this publication and mailed automatically to distributors. It is recommended that customers contact their distributor or dealer for information on the latest revision.

ENGINE MODELS

C-152	C-392
C-196	C-446
C-304	C-537
C-345	C-549

FORM 1 008 700 R2
JUNE 1977
(REV. NO. 1)

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SERVICE MANUAL INFORMATION

Your authorized International Engine Distributor and his factory trained servicemen are best qualified to service your equipment. Up-to-date instructions and adequate special tools are also a part of your Distributor's service facilities.

This Operator's Manual was prepared to instruct you in proper operation and maintenance of your engine. If you desire additional information you may purchase Service Manuals.

Cut out this order blank and forward, together with your check or money order in the appropriate amount (U. S. Funds), to:

International Harvester Company
Printing & Distribution Services
807 Blackhawk Drive
Westmont, Illinois 60559

ATTENTION: Cashier

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All Manuals . . . $3.00 per copy

Please send me (check items in box)

C-152 - Engine Manual CTS-2175 ☐

C-196 - Engine Manual CTS-2682 ☐

C-304
C-345 - Engine Manual CTS-2130 ☐
C-392

C-446 - Engine Manual CTS-2664 ☐

C-549 - Engine Manual CTS-2033 ☐

C-537 - Engine Manual CTS-2683 ☐

Carburetor Model	CTS No.	
1940	2609	☐
2210	2612	☐
2300G	2142	☐
4150G	2454	☐

_____ TOTAL

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C O N T E N T S

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CONTENTS (Continued)

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INTRODUCTION

Instructions on operation, lubrication and maintenance for the basic engine and attachments are covered in this manual. Disregard any instructions on attachments that are not applicable to your engine.

Throughout this manual, the use of the terms "left," "front" and "rear" must be understood to avoid confusion when following instructions. Some illustrations and text in this manual are of general application on machines of this model and may not show your equipment accurately in all details.

SERIAL NUMBERS

When in need of parts, always specify the AU-##### and engine serial numbers. The engine serial number is stamped on the engine as follows:

C-152 and C-196 engines, left side upper front.

C-304, C-345 and C-392 engines, on crankcase, right bank upper front.

C-446 *engines, in front of distributor.*

C-549 engines, top of crankcase, left bank front corner.

C-537 engine, on top of crankcase, right bank, front corner.

The AU number assigned is stamped on a name plate attached to the left side of the flywheel housing (Fig. 1).

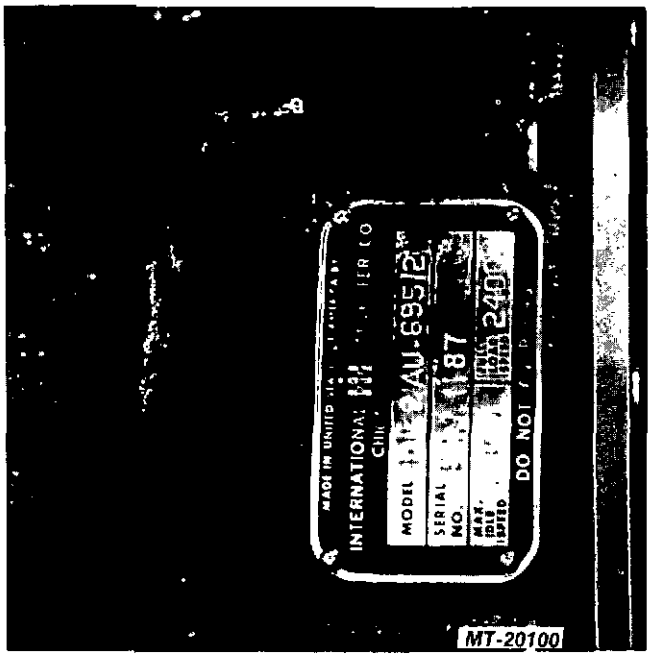

Fig. 1 AU Number Location

VENTILATION FOR ENGINES INSTALLED INSIDE OF BUILDINGS

Engines installed inside buildings, sheds or cabs should be the open type; that is, with the engine hood and back panel removed to permit free circulation of fresh air around the engine, radiator, etc. Steps must be taken to carry the waste heat to the outside, or to change the air in the engine room rapidly.

The exhaust pipe should be arranged to provide the shortest possible length within the engine room. The part of the exhaust pipe inside the building should be surrounded with a light steel tube, sufficiently large to permit a two-inch to four-inch air space all around. This space should be ventilated to the outside. Another method of insulation is to cover the exhaust pipe completely with at least two inches of air-cell asbestos.

Ventilate the engine room thoroughly and install engine so that air can flow freely through the radiator. An opening to the outside, in front of the radiator, is extremely desirable. Ducts should be provided between the radiator and the wall openings. On some installations, it may be necessary to provide a reverse flow fan to blow the heated air out of the buildings.

Where the door or window area is restricted, galvanized ducts extending from the ceiling above the engine to the top of the building are recommended to carry off the hot air. Not less than two ducts, 24 x 24 inches in cross section, should be installed. At the same time, as many openings in the sides of the engine room as possible should be provided to let in cool outside air. Openings to the north or to a shaded side of the building are preferred.

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4-Cylinder Engine Crankcase Refill Capacities

Engine Oil	4.75 Liters (5 Quarts)

Timing

To assure efficient engine operation, ignition timing should be checked at regular intervals. Attach timing light to No. 1 spark plug.

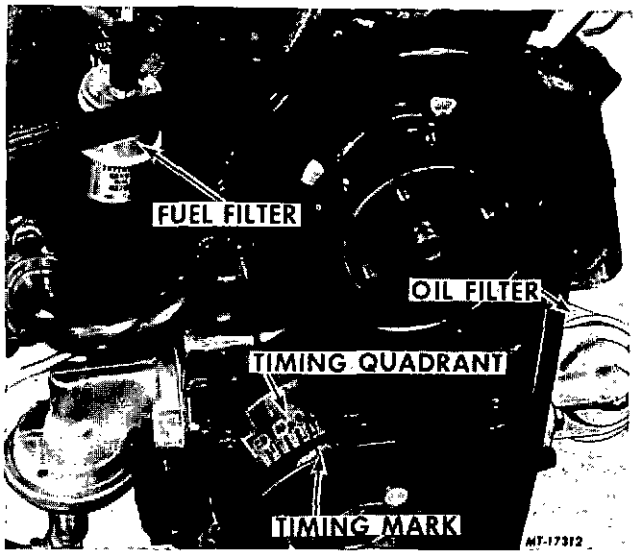

Fig. 2 4-Cylinder Engine

Oil Filter Replacement (Spin-On Type)

1. Remove oil filter assembly by turning counter-clockwise with the hands or a suitable tool. Clean filter mounting pad.
2. Coat the gasket on the new filter with a film of grease.
3. Place the new filter in position on the center tube. Hand tighten 1/2 to 3/4 of a turn after gasket first contacts base of mounting pad.
4. Start engine and run for at least five minutes to warm oil and check for leaks. Also check engine oil level.

Fuel Pump and Filter

The fuel pump on 4-cylinder engines is located on the right front side of the engine.

The in-line fuel filter should be replaced every 12 months.

C-304, C-345, C-392 Engine Crankcase Refill Capacities

Engine Oil	4.75 Liters (5 Quarts)

Ignition Timing

To assure satisfactory emission levels together with most efficient engine operation, ignition timing should be checked at regular intervals. Attach timing light to No. 8 spark plug on 8-cylinder engines.

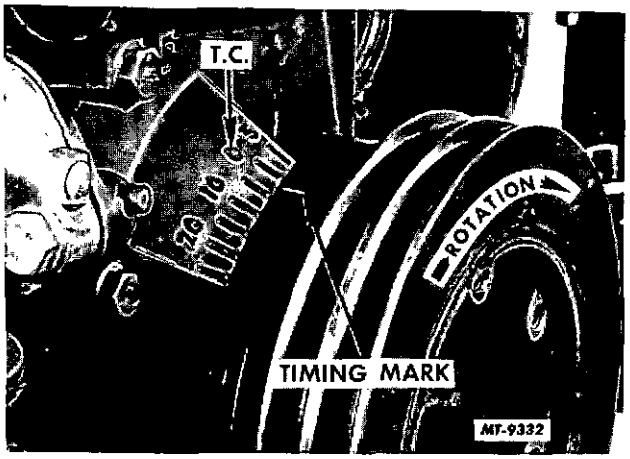

Fig. 3

Fuel Pump and Filter (Fig. 4)

The fuel pump on 8-cylinder engines is located on the right front side of the engine.

The in-line fuel filter should be replaced every 12 months.

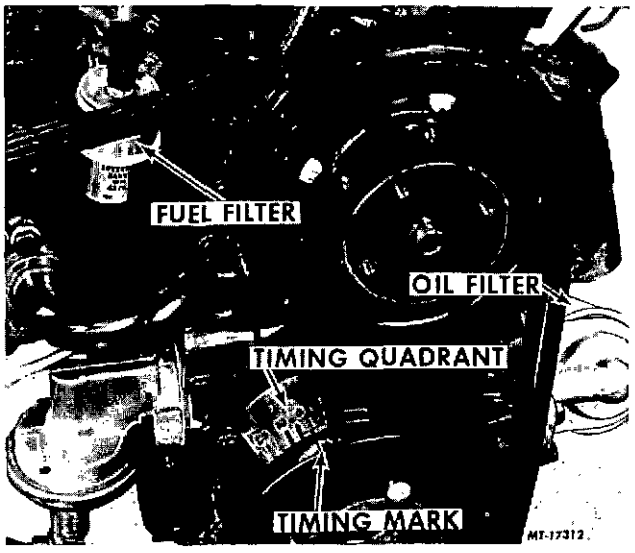

Fig. 4

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Oil Filter Replacement (Spin-on Type)

1. Remove oil filter assembly by turning counter-clockwise with the hands or a suitable tool. Clean filter mounting pad.

2. Coat the gasket on the new filter with a film of grease.

3. Place the new filter in position on the center tube. Hand tighten 1/2 to 3/4 of a turn after gasket first contacts base of mounting pad.

4. Start engine and run for at least five minutes to warm oil and check for leaks. Also check engine oil level.

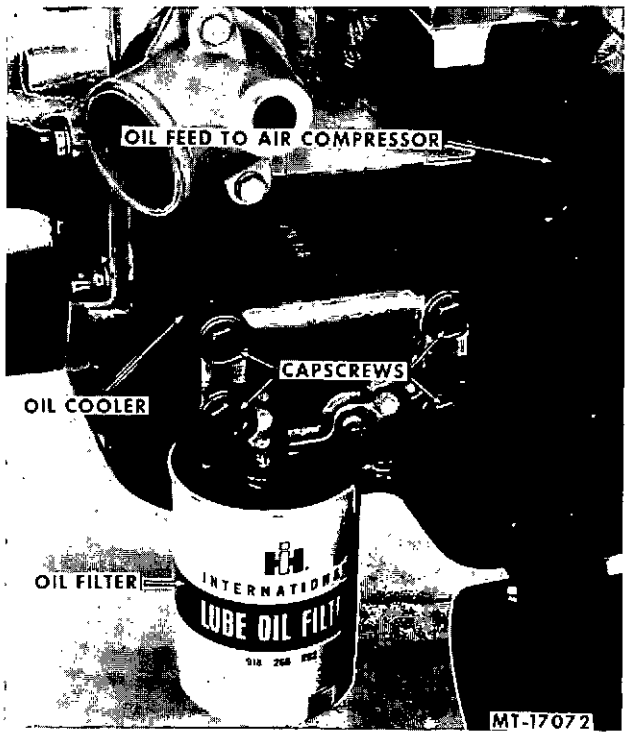

Fig. 6 Filter Removal

C-446 Engine Crankcase Refill Capacities

Engine Oil	7.6 Liters (8 Quarts)

Ignition Timing

When timing the engine, attach the timing light to the No. 1 spark plug and adjust distributor to obtain proper initial timing (see specifications and Fig. 5).

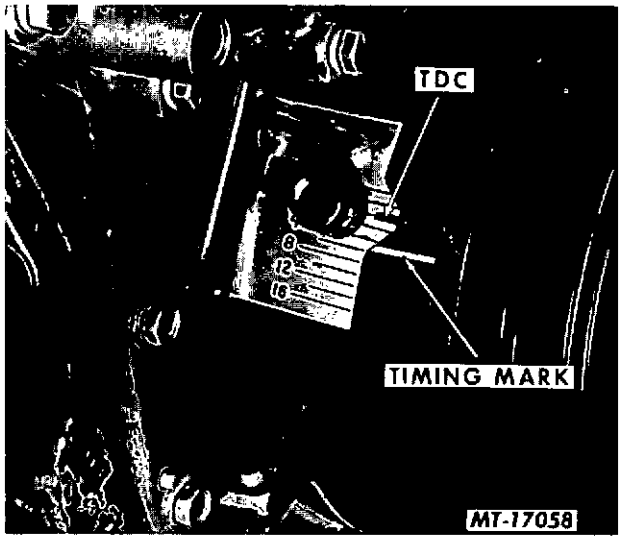

Fig. 5 Illustrating Timing Marks on Crankshaft Pulley Hub & Engine Front Cover

Fuel Pump and Filter

The fuel pump and fuel filter are located on the right front side of the engine. The in-line fuel filter should be replaced every 12 months.

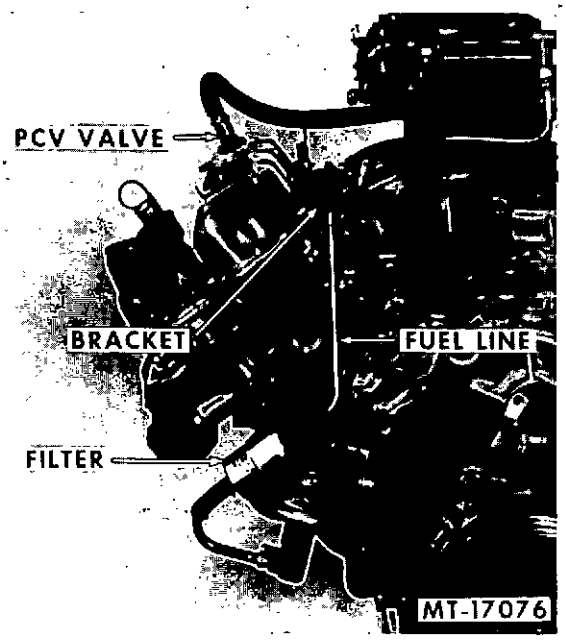

Fig. 7 Fuel Pump, Fuel Filter and PCV Valve

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C-549 Engine Crankcase Refill Capacities

Engine Oil	11.4 Liters (12 Quarts)

Ignition Timing

To assure satisfactory emission levels together with most efficient engine operation, ignition timing should be checked at regular intervals. Attach timing light to No. 1 spark plug.

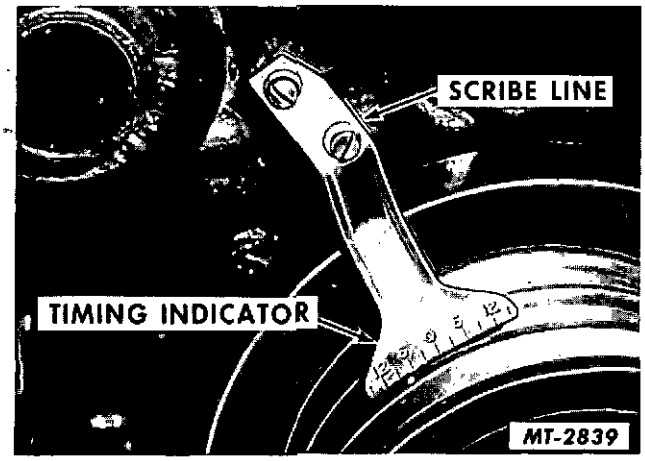

Fig. 8 C-549 Ignition Timing

Filter Cartridge Replacement (Fig. 9)

1. Loosen filter shell retaining bolt and washer; then remove filter body and filter cartridge.
2. Check condition of oil filter shell to base gasket. Replace if necessary.
3. Wash filter shell in cleaning fluid, making sure all sediment is removed from inside of filter shell.
4. Install new filter cartridge in shell over filter bolt and spring. Seal end of cartridge must be installed toward spring in bottom of shell.
5. Install filter shell with bolt, washer and spring to filter base; make sure filter shell seats on gasket in filter base. Tighten filter body retaining bolt to 40.6 - 47.4 N.m (30 - 35 ft lbs) torque.
6. Add two quarts of oil to engine to compensate for cartridge change.
7. Start engine and run for at least five minutes to warm oil and check for leaks. Also check engine oil level.

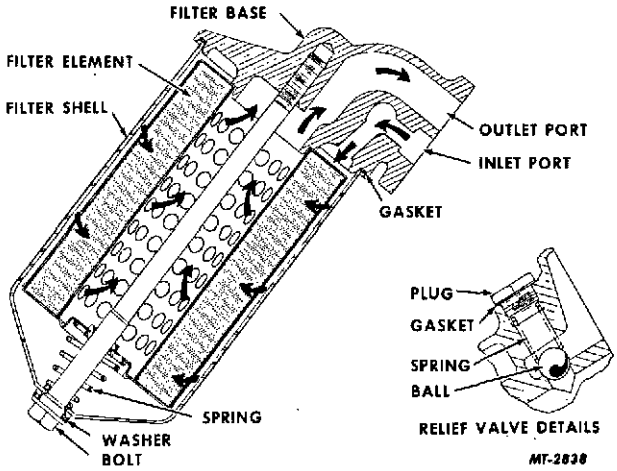

Fig. 9 Sectional View of Full Flow Filter.

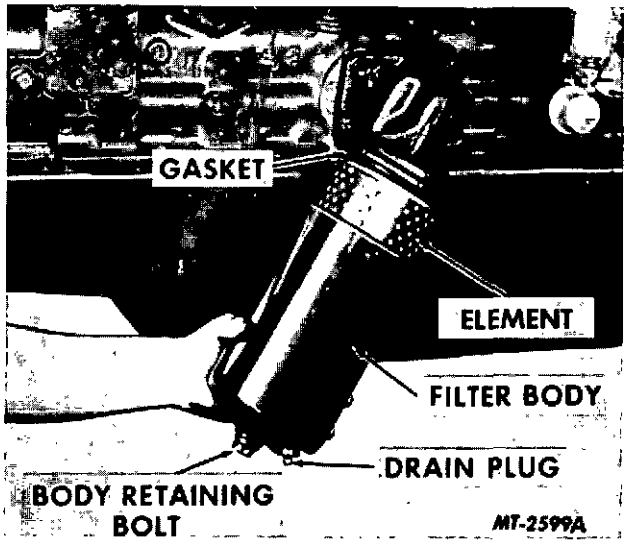

Fig. 10 Oil Filter

Accessory Drive Belt and Idler Pulley

Three conventional "V" belts are utilized on the engine to drive the various accessories. Two of these belts, driven from the crankshaft pulley, drive the water pump and fan pulley. These belts should be installed in pairs whenever either of the belts need replacement. An idler pulley provides the means of fan belt adjustment. The idler pulley runs on a double ball bearing shaft which has been prelubricated at assembly and is sealed against moisture and dirt.

Belt tightening is accomplished by loosening the idler pulley bracket clamp screws (1) and by means of a short lever (Fig. 11). The idler pulley (2) is moved against the belts to obtain the specified adjustment in both belts.

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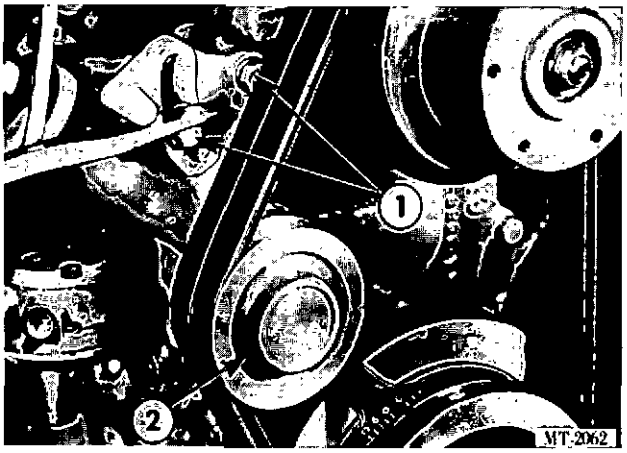

Fig. 11 Adjusting Fan Belts

The upper belt or belts driven from the water pump and fan hub pulley drive the alternator and/or air compressor. The belt or belts are tightened by moving the alternator on its mounting bracket. Loosen the alternator mounting bolts and the adjusting strap bolts; then move the alternator against the belt or belts until proper slack is obtained. Figs. 12 and 13 show the method of checking belt tension.

C-537 Engine Crankcase Refill Capacities

Engine Oil	13.2 Liters (14 Quarts)
Oil Filter, Each	.95 Liter (1 Quart)

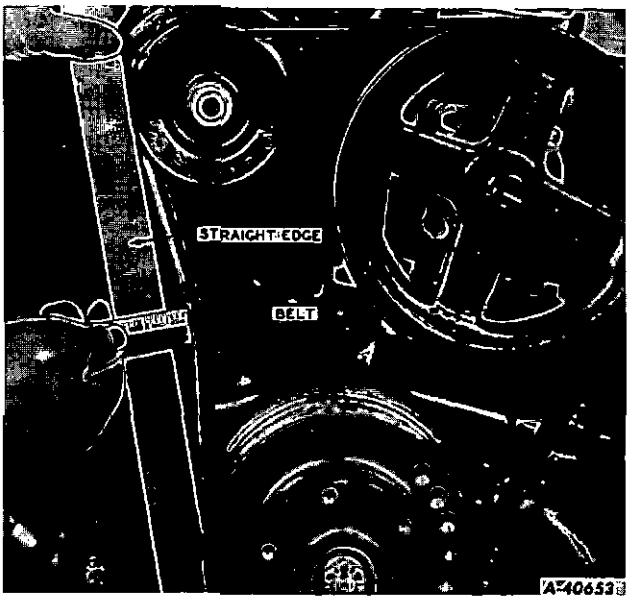

Fig. 12 Checking Belt Tension

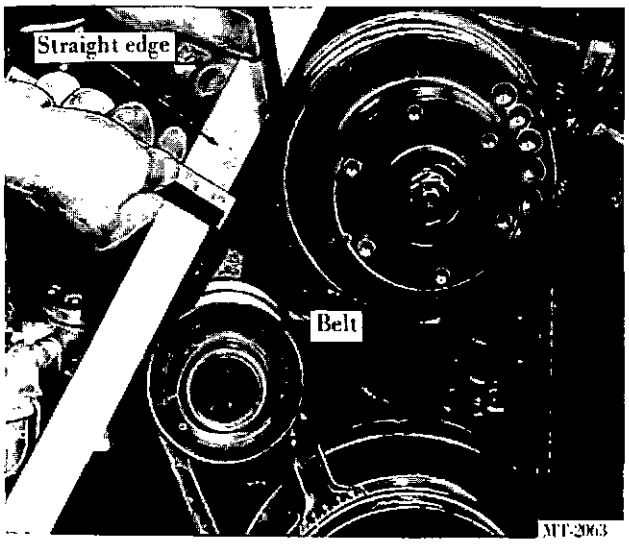

Fig. 13 Checking Belt Tension

Ignition Timing

To assure satisfactory emission levels together with most efficient engine operation, ignition timing should be checked at regular intervals. Attach timing light to No. 1 or No. 6 spark plug.

Procedure for servicing the spin-on type oil filter is as follows (2 filters on C-537 engine):

1. Remove oil fitler assembly by turning counterclockwise with the hands or a suitable tool. Clean filter mounting pad.
2. Coat the gasket on the new filter with a film of grease.
3. Place new filter in position on center tube. Hand tighten 1/2 to 3/4 of a turn after gasket first contacts base of mounting pad.
4. Start engine and run for at least five minutes to warm oil and check for leaks. Also check engine oil level.

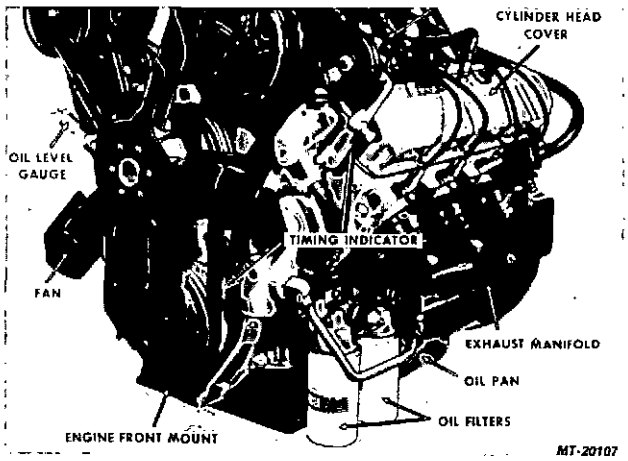

Fig. 14 C-537 Timing Mark and Oil Filters

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SPECIFICATIONS

ENGINE		
IH Model	C-152	C-196
Number of Cylinders	4	4
Bore	9.8 cm (3-7/8")	10.5 cm (4-1/8")
Stroke	8.2 cm (3-7/32")	9.3 cm (3-21/32")
Piston Displacement	2491 cm^3 (152 cu in)	3214.4 cm^3 (195 cu in)
Maximum Recommended RPM	4400	4000
Compression Ratio	8.19:1	8.02:1
Firing Order	1 - 3 - 4 - 2	1 - 3 - 4 - 2
Engine Weight, Dry	188.01 kg (414.5 lbs)	214.43 kg (476.5 lbs)

ELECTRICAL	
Electrical System (12 Volts)	Negative Ground
Spark Plug Type:	
Normal	RJ-10Y, CR 43S
Spark Plug Gap:	
RJ-10Y, CR 43S	.88 mm (.035")
Point Gap:	
New	.48 mm (.019")
Reset	.40 mm (.016")
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")
Dwell, Degrees:	
Standard Ignition	28 - 32
Electronic Ignition	24 - 34
Ignition Timing	5 Deg. BTDC @ 550 RPM
(Air Compressor Applications)	10 Deg. BTDC @ 1000 RPM
(Air Compressor Applications)	15 Deg. BTDC @ 1200 RPM
Idle Speed, RPM	525 - 575
Cranking Voltage	10.0 V
Cranking Coil Output	20 - 23 KV
Dwell Variation (@ 1000 RPM)	3 Deg. Max.
Cam Lobe Variation (@ 1000 RPM)	2 Deg. Max.
RPM Drop per Cylinder when Plug is Shorted (from 1000 RPM)	40 - 60
Coil Output (@ 2500 RPM)	20 KV Min.
Charging Voltage (@ 2500 RPM)	13.8 - 14.4 V
Timing Advance, Eng. Deg. ±2 Deg. (@ 2500 RPM)	
With Governor	----
Without Governor	33
Use No. 1 Cylinder for Timing	
Valves: Hydraulic Tappets No Adjustment Needed	

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SPECIFICATIONS

ENGINE

IH Model	C-304	C-345	C-392
Number of Cylinders	8	8	8
Bore	9.8 cm (3-7/8")	9.8 cm (3-7/8")	10.5 cm (4-1/8")
Stroke	8.2 cm (3-7/32")	9.3 cm (3-21/32")	9.3 cm (3-21/32")
Piston Displacement	4485.6 cm^3 (304 cu in)	5658 cm^3 (345 cu in)	6429 cm^3 (391 cu in)
Max. Recommended RPM	3900	3800	3600
Compression Ratio	8.19:1	8.28:1	8.0:1
Firing Order		1 - 8 - 4 - 3 - 6 - 5 - 7 - 2	
Engine Weight, Dry	277.92 kg (617.6 lbs)	288.27 kg (640.6 lbs)	295.11 kg (655.8 lbs)

ELECTRICAL

Electrical System (12 Volts)	Negative Ground
Spark Plug Type:	
Normal	RJ-6
Light	RJ-10Y
Spark Plug Gap:	
RJ-6	.76 mm (.030")
RJ-10Y	.88 mm (.035")
Point Gap - Std. Ignition	
New	.48 mm (.019")
Reset	.40 mm (.016")
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")
Dwell, Degrees:	
Standard Ignition	28 - 32
Electronic Ignition	24 - 34
Ignition Timing	TDC
Idle Speed, RPM	650 - 700
Cranking Voltage	10.0 V
Cranking Coil Output	20 - 23 KV
Dwell Variation (@ 1000 RPM)	3 Deg. Max.
Cam Lobe Variation (@ 1000 RPM)	2 Deg. Max.
RPM Drop Per Cylinder When Plug is Shorted (from 1000 RPM)	40 - 60
Coil Output (@ 2500 RPM)	20 KV Min.
Charging Voltage (@ 2500 RPM)	13.8 - 14.4 V

Timing Advance, Engine Degrees +2 Deg. (@ 2500 RPM)			
Without Governor	32	32	36
With Governor	30	26	31
Use No. 8 Cylinder for Timing			
Valves: Hydraulic Tappets No Adjustment Needed			

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SPECIFICATIONS

ENGINE	
IH Model	C-446
Number of Cylinders	8
Bore	10.5 cm (4.125")
Stroke	10.6 cm (4.180")
Piston Displacement	7392 cm^3 (446.9 cu in)
Maximum Recommended RPM	3600
Compression Ratio	8:1
Firing Order	1 - 2 - 7 - 3 - 4 - 5 - 6 - 8
Engine Weight, Dry	332 kg (737 lbs)
ELECTRICAL	
Electrical System (12 Volts)	Negative Ground
Spark Plug Type:	
Normal	RBN-4, R44 LT
Light	RBN-13Y, R44 LTS
Spark Plug Gap	.76 mm (.030")
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")
Dwell, Degrees:	
Electronic Ignition	
Ignition Timing	5 Deg. BTC
Idle Speed, RPM	525 - 575
Cranking Voltage	10.0 V
Cranking Coil Output	20 - 23 KV
RPM Drop per Cylinder when Plug is Shorted (From 1000 RPM)	40 - 60
Coil Output (@ 2500 RPM)	20 KV Min.
Charging Voltage (@ 2500 RPM)	13.8 - 14.4 V
Timing Advance, Eng. Deg. ±2 Deg. (@ 2500 RPM)	
Without Governor	29
With Governor	29
Governed Speed, RPM	3800
Use No. 1 Cylinder for Timing	
Valves: Hydraulic Tappets No Adjustment Needed	

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SPECIFICATIONS

ENGINE	
IH Model	C-549
Number of Cylinders	8
Bore	11.4 cm (4-1/2")
Stroke	10.9 cm (4-5/16")
Piston Displacement	8996 cm^3 (549 cu in)
Maximum Recommended RPM	3200
Compression Ratio	7.57:1
Firing Order	1 - 8 - 7 - 3 - 6 - 5 - 4 - 2
Engine Weight, Dry	494 kg (1090 lbs)
ELECTRICAL	
Electrical System (12 Volts)	Negative Ground
Spark Plug Type:	
Normal Duty	RJ-6; CR 43
Light Duty	RJ-10Y; CR 43S
Spark Plug Gap:	
RJ-6; CR 43	.76 mm (.030")
RJ-10; CR 43S	.88 mm (.035")
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")
Dwell, Degrees:	
Standard Ignition	28 - 32
Electronic Ignition	
Ignition Timing	7 Deg. BTDC
Curb Idle Speed, RPM	500 - 550
Cranking Voltage	10.0 V
Cranking Coil Output	20 - 23 KV
Dwell Variation (@ 1000 RPM)	3 Deg. Max.
Cam Lobe Variation (@ 1000 RPM)	2 Deg. Max.
RPM Drop per Cylinder when Plug is Shorted (From 1000 RPM)	30 - 50
Coil Output (@ 2500 RPM)	20 KV Min.
Charging Voltage (@ 2500 RPM)	13.8 - 14.4 V
Timing Advance, Eng. Deg. $\pm$2 Deg. (@ 2500 RPM)	19
Governed Speed, RPM	3400
Use No. 1 Cylinder for Timing	
Valves: Hydraulic Tappets No Adjustment Needed	

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SPECIFICATIONS

ENGINE	
IH Model	C-537
Number of Cylinders	8
Bore	11.8 cm (4.625")
Stroke	10.2 cm (4.0")
Piston Displacement	8811 cm^3 (537.7 cu in)
Maximum Recommended RPM	3200
Compression Ratio	7.5:1
Firing Order	1 - 8 - 7 - 3 - 6 - 5 - 4 - 2
Engine Weight, Dry	469 kg (1034 lbs)
ELECTRICAL	
Electrical System (12 Volts)	Negative Ground
Spark Plug Type:	
Normal	RN-11Y
Light	RN-12Y
Spark Plug Gap	.76 mm (.030")
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")
Dwell, Degrees:	
Electronic Ignition	24-34
Ignition Timing	7 Deg. BTC
Idle Speed, RPM	500 - 550
Cranking Voltage	10.0 V
Cranking Coil Output	20 - 23 KV
Dwell Variation (@ 1000 RPM)	
Cam Lobe Variation (@ 1000 RPM)	
RPM Drop per Cylinder when Plug is Shorted (From 1000 RPM)	
Coil Output (@ 2500 RPM)	20 KV Min.
Charging Voltage (@ 2500 RPM)	13.8 - 14.4 V
Timing Advance, Eng. Deg. ±2 Deg. (@ 2500 RPM)	
Without Governor	
With Governor	21
Governed Speed, RPM	3400
Use No. 1 or No. 6 Cylinder for Timing	
Valves: Hydraulic Tappets No Adjustment Needed	

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LUBRICATION INSTRUCTIONS

FOR GASOLINE ENGINES

Daily

1. Gasoline Engine: Crankcase oil level must be maintained between "Add" and "Full" marks on dipstick. Select oil viscosity grades from chart below.

Temperature	Straight Viscosity Grade	Multi Viscosity Grade
-7 to 49 C (20 to 120 F)	SAE 30	SAE 10W-30, 10W-40, 20W-40, 20W-30
-18 to 32 C (0 to 90 F)	SAE 20W	SAE 10W-30, 10W-40, 20W-40, 20W-30
-23 to 21 C (-10 to 70F)	SAE 10W	SAE 10W-30, 10W-40
Below -23 C (-10 F)	--------	SAE 5W-20, 5W-30

Use engine oils meeting service classification "SE" or "CC" (MIL-L-46152).

IMPORTANT

When a universal engine oil (SE-CD) is preferred, the engine oil must have passed the Volvo B-20 cam and tappet test and contain a minimum 0.1% alkyl zinc. IH #1 engine oil now meets this requirement.

1600 to 3200 km (1000 to 2000 Miles) or 40 Hours

2. Engine Crankcase and Oil Filter: If the engine break-in oil is drained at 1600 km (1000 miles) or 40 hours, the filter element should also be replaced. Refill crankcase using proper viscosity oil selected from chart.

Every 6400 km (4000 Miles), 4 Months or 100 Hours Of Operation, Whichever Occurs First

3. Engine Crankcase: Drain and refill (engine hot). More frequent oil changes are required depending upon the rate of oil contamination caused by extreme dusty conditions, multi-stop and cold weather operation. Select oil viscosity grades from chart.

4. Oil Filter--Engine: Remove oil filter assembly and replace with new assembly. Operate engine a few minutes and check filter for leaks. More frequent changes are required depending on the rate of oil contamination caused by extreme dusty conditions, multi-stop and cold weather operation.

4800 to 8400 km (3000 to 5000 Miles) or 75 to 125 Hours

5. Starting Motor: With oil cups or plugs, lubricate with 8 or 10 drops of medium engine oil. Do not overlubricate.

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LUBRICATION INSTRUCTIONS (Continued)

9600 km (6000 Miles), 4 Months or 150 Hours

6. Ignition Timing:	Check and adjust if necessary.
7. Spark Plugs:	Check, clean and gap.

19,200 km (12,000 Miles), 12 Months or 300 Hours

8. Fuel Filter:	Replace filter.
9. Spark Plugs:	Replace.
10. Distributor Points:	Inspect (where equipped).
11. High Tension Ignition Cables:	Inspect and/or test.
12. Crankcase Ventilating System:	Service.

UNIT REFILL CAPACITIES

	Engine Model	Capacity, Liters
Crankcase Engine Oil	C-152	4.7 (5 Quarts)
	C-196	4.7 (5 Quarts)
	C-304	7.6 (8 Quarts)
	C-345	7.6 (8 Quarts)
	C-392	7.6 (8 Quarts)
	C-446	7.6 (8 Quarts)
	C-549	11.4 (12 Quarts)
	C-537	13.2 (14 Quarts)

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LUBRICATIONS INSTRUCTIONS

FOR LPG or NG ENGINES

Daily

LPG or NG Engine: Crankcase oil level must be maintained between "Add" and "Full" marks on dipstick. Select oil viscosity grades from chart below. When using straight viscosity grades with LPG or NG fuels, oil additions should be one SAE Grade lighter than original fill.

Temperature	Straight Viscosity Grade	Multi Viscosity Grade
0 C and Up (32 F and Up)	SAE 30 or 40	SAE 10W-30, 10W-40, 20W-40
-12 to 0 C (10 to 32 F)	SAE 20W	SAE 10W-30, 10W-40
-23 to -12 C (-10 to 10 F)	SAE 10W	SAE 10W-30, 10W-40
Below -23 C (Below -10 F)	----	SAE 5W-20, 5W-30

It is the recommendation of International Harvester Company that IH low-ash engine oil or a low-ash or ashless API CC oil be used in the subject engines.

IMPORTANT

LPG and NG Engines: Low ash oils refer to oils containing ashless detergent/dispersant additives (not containing barium, calcium, or magnesium) and metal-organic oxidation inhibitors such as zinc dithiophosphate anti-wear agents. Ashless oils contain completely ashless additive formulations. These oils must pass API CC performance tests and have a 0.5% maximum sulfated ash content.

Scheduled Maintenance

After Every 500 Hours of Operation

1. Crankcase Oil Drain: Remove the oil pan drain plug and drain all the oil from the crankcase while the engine is warm; then replace the plug and refill with new oil to the "Full" mark on the level gauge (refer to UNIT REFILL CAPACITIES).

2. Engine Oil Filter: Replace the oil filter after every second oil change (500 hours of operation). Remove, discard and replace spin-on type filter.

3. Engine Oil: See UNIT REFILL CAPACITIES. When changing oil filter add sufficient oil to compensate for oil filter or filters. Use engine oils meeting API service classification "SE" or "CC" (MIL-L-46152) requirements. Do not use "SE-CD" (MIL-L-2104C) or series 3 oils.

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ENGINE SPEEDS

Optional engine speeds are available. The high idle and full load governed speeds for which this engine is equipped and adjusted is stamped on the chassis serial number plate on the flywheel housing (Fig. 1).

FUEL (GASOLINE)

Regular Engines are shipped with the ignition timing set for maximum power on the average regular grade of gasoline of 93 Research octane number as domestically available in the U.S.A.

LOW LEAD -- "Low lead" gasoline containing at least 0.5 gm. lead per gallon may be used.

NO LEAD -- Lead free gasoline is not recommended as it's use can cause excessive exhaust valve seat wear resulting in poor performance and possible engine failure.

For fuels of lower Research octane number, the timing may require retarding (approximately one degree retard from factory setting for each decrease of one octane number). Overseas fuels may, in many areas, be considerably lower in Research octane number than regular grade fuels obtainable in the U.S.A. Advancing the timing beyond the initial factory setting is not recommended and may only result in adverse effects. There is no particular advantage in using a fuel having a higher anti-knock value than the engine requires.

FUEL (LPG)

It is recommended that LP gas fuel meeting the Natural Gas Processor's Association (NGPA) specification for propane HD5 be used if available.

OPERATION

Before Starting a New Engine

The following steps must be observed.

1. Check the cooling system level and fill if necessary.

2. Check the oil in the engine crankcase, the air cleaner oil cup (wet type - if equipped), and power take-off (if equipped) to be sure they are filled to the correct levels with the proper grades of oil for the prevailing temperature.

   Be sure battery is connected properly.

3. Connect the battery cable to the "BAT" terminal on the cranking motor solenoid and to the positive (+) terminal on the battery. Connect the ground strap to the negative (-) terminal on the battery.

4. Connect the alternator cable to the terminal on the alternator.

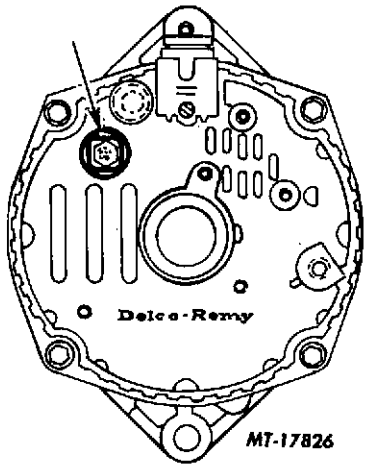

Fig. 15 Alternator Connections

LUBRICATION WHEN SHIPPED

Engine

The crankcase was filled at the factory with engine oil for operation in an air temperature range of -23 C to +32 C (-10 F to +90 F). For operation above or below this range, change to correct lubricant shown on "LUBRICANT SPECIFICATIONS AND CAPACITIES CHART".

PRECAUTIONS

General

Your engine is designed to operate on one of the following fuels: gasoline, liquefied petroleum or natural gas. Do not attempt to operate this unit on a fuel other than that for which it is equipped.

Do not operate the engine under load until it is thoroughly warmed up. Never operate the engine at more than the regular governed speed. Excessive speeds are harmful.

Do not attempt to adjust the velocity type governor. The velocity type governor is set at the factory. If the governor does not function properly, consult your authorized International Engine Distributor or Dealer for repair or replacement.

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CAUTION

For personal protection, observe the following safety precautions.

Never operate the engine at more than the regular governed speed shown on the serial number plate. Excessive speeds are harmful and dangerous. Do not rework or modify engine flywheel.

Never operate an engine in an enclosed building unless the exhaust is properly ventilated.

Because of fire hazards and insurance regulations, do not use gasoline for cleaning parts, especially when service is performed inside buildings. A less flammable fluid, such as a commercial solvent or kerosine, should be used.

Never attempt to clean or oil the engine while the engine is operating.

Liquefied Petroleum Gas or Natural Gas Engines

CAUTION

Safety precautions in the handling of butane-propane cannot be over-emphasized. There are state, county or city laws, ordinances, and fire regulations covering the utilization of liquefied petroleum gas or natural gas. Such laws, ordinances and fire regulations on this subject must be adhered to in addition to the safety rules given below.

Where local rules are more stringent than these given, the local rules are to be given priority.

These rules apply to servicing any engine using liquefied petroleum gas (butane-propane) or natural gas for engine fuel regardless of the nature of the work to be performed.

Select a location for servicing these engines where there will be good air circulation. This is to avoid accumulation of gas-air mixtures in and about the engine caused by undetected leaks.

Such location must be as far as possible from steam cleaners, hot water cleaners, hot dip tanks, etc., and other devices operating with an open flame.

Shut off the main valves at the fuel tanks and allow the engine to run until all fuel in the system, from the tank to the engine, is exhausted. In the event the engine is inoperative, shut the valve at the tank. Vent the fuel system of liquefied petroleum or natural gas outside the building before moving the engine into the shop.

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

A fire extinguisher (dry powder or carbon dioxide) must be placed adjacent to the mechanic's working area, handy for immediate use. When liquefied petroleum gas 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.

After completing service work and before starting the engine, allow air to circulate around the engine to remove any possible gas accumulation.

Never use liquefied petroleum gas from the fuel tanks for cleaning parts. 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.

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

a. All threaded connections should be treated with an insoluble lubricant (Permatex or aviation gasket maker). Replace worn or defective fittings.

b. After connecting the fuel system, check it for leaks. Leaks are not permissible. Odorants, which are strong smelling compounds (an odor similar to spoiled cabbage), are added to liquefied petroleum gas as warning agents to indicate the leakage of even small quantities of gas.

c. A lather of soap, brushed on with a soft brush, will indicate the presence of leaks, which are dangerous and wasteful. Never use an open flame to check for leakage.

Pay particular attention to short lengths of rubber hose used anywhere in the piping system to relieve stress and vibration.

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Any necessary work on liquefied petroleum gas or natural gas fuel tanks must be performed by qualified concerns who normally service such containers and who are familiar with local regulations, inspections and tests after any repairs are made.

It is important to remember that all liquefied petroleum gas systems are pressurized. Be certain that the tank valves are tightly closed and all fuel has been exhausted from the lines before starting any repair work on the fuel system.

PREPARING THE ENGINE FOR EACH DAY'S WORK

Fuel System (Gasoline)

Fill the main fuel tank. Use a gasoline conforming to the specifications as shown on page 16. DO NOT USE DIRTY FUEL.

CAUTION

Never fill the fuel tank when near an open flame or when the engine is operating. Keep the funnel or hose nozzle, used for pouring in the fuel, in contact with the metal of the tank to avoid the possibility of an electric spark igniting the gas. Do not light matches near gasoline, as the air within a radius of several feet is permeated with a highly explosive vapor.

Cooling System

Do not start the engine until the cooling system is filled with coolant.

Lubrication

Be sure that the oil level in the crankcase is up to the "FULL" mark on the crankcase oil level gauge. Refer to the "LUBRICATION GUIDE" for complete requirements.

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ELECTRICAL SYSTEM

Precautions

The electrical generating system now incorporates a direct diode rectified generator (alternator w/integral regulator) which requires special handling and procedures different from those associated with the old style DC generator.

> **CAUTION**
>
> Before working on any part of the electrical system, disconnect the battery ground cable until all electrical work has been completed.

Repair or replace all broken wires immediately. All terminals must be clean and securely fastened; never paint connections.

Alternator w/Integral Regulator

The alternator incorporates a built in transistorized voltage regulator. The alternator requires no lubrication since its bearings are *factory lubricated for life and require attention* only at time of major overhaul. The integral regulator is sealed by the manufacturer.

The unit electrical system is negative ground. Be certain the ground polarity is correct when:

a. Installing a new battery.

b. Connecting a battery charger.

c. Using a booster.

Failure to observe proper polarity will result in damage to the alternator.

Never use a fast charger as a booster to start the engine.

Never unhook a battery terminal while the engine is running.

Never disconnect the alternator cable while the engine is running.

Do not polarize the alternator.

Do not short across or ground any terminals of the alternator or regulator.

Voltage Regulator (Fig. 16)

This engine is equipped with a transistor type voltage regulator. This regulator incorporates a voltage adjustment that can be used to maintain the battery in a satisfactory charge condition, thereby obtaining maximum battery life.

When to Adjust the Regulator

1. If battery uses too much water at normal setting (position "2" on the cap aligned with the arrow) reduce the voltage setting by aligning position "LO" on the cap (2) with the arrow.

2. If the battery is consistently under charged at the normal setting (position "2" on the cap aligned with the arrow), increase the voltage setting by aligning the "3" position on the cap with the arrow. If further increase is desired, align the "HI" position on cap with arrow.

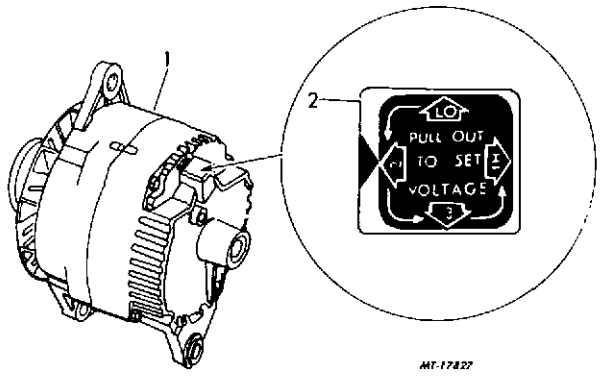
If either of the conditions in Steps 1 or 2 persists after making the adjustment, consult your authorized International Engine Distributor or Dealer.

Adjustment

1. To adjust the regulator setting, remove voltage adjustment cap (2) from alternator.

2. Position the cap until the desired setting is aligned with the arrow on the alternator. Refer to Steps 1 and 2 under the "Voltage Regulator" for the desired setting.

3. Reinstall the cap in the alternator.



1. ALTERNATOR
2. CAP, Voltage Adjustment

Fig. 16 Voltage Adjustment Cap

Cranking Motor

The cranking motor does not require lubrication, except during overhaul.

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IH ELECTRONIC IGNITION SYSTEM

Service Precautions

The following precautions must be observed when performing service operations on the electronic ignition system:

1. Do not use a test lamp to check continuity of the distributor sensor unit. The fine wire (No. 38 gauge) used in construction of the sensor coil will be damaged beyond repair if subjected to a current exceeding 40 milliamps (.040 amp).

2. Do not connect distributor sensor or tester switch SE-2503 to a 12 volt circuit. When making tests, be sure to make test connections as shown under IGNITION SYSTEM OPERATION AND TROUBLE SHOOTING TEST.

3. Damage to ignition system components can result from incorrect wiring connections. Whenever engine wiring harness is disconnected from electronic ignition control and/or ignition coil, wires should be marked or tagged to assure correct reconnection.

   Electronic ignition control and ignition coil primary wiring connections are shown in Fig. 17. Engine wiring circuits vary between vehicle models. For circuit identification, refer to appropriate vehicle wiring diagrams in Service Manual.

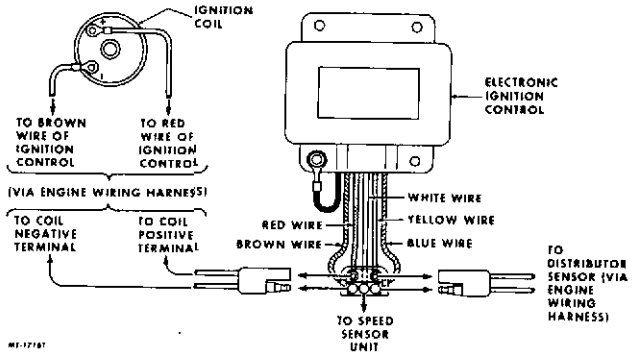

Fig. 17 Ignition Control and Coil Primary Wiring

4. Multi-wire connectors on electronic ignition system components are treated with a special conductive lubricating/sealing compound (grease). Its purposes are to lubricate the metal contact surfaces and to prevent entry of moisture into the connection. The lubricant/sealer should not be cleaned from the connector terminals.

   At the time of ignition system service, if the terminals appear dry or if ignition system components are being replaced, the connectors should be protected by filling the female cavities of the connectors with lubricant/sealer before assembly. The lubricant/sealer compound is available through IH parts outlets under part number 472141-C1.

5. In the event of ignition coil replacement, only ignition coil IH part number 191455-R91 should be used on vehicles equipped with the IH electronic ignition system.

   Use of incorrect ignition coil could result in damage to the electronic ignition control.

ADJUSTING DISTRIBUTOR AIR GAP

1. Adjust trigger wheel-to-sensor air gap as follows:

   a. Rotate trigger wheel until one tooth is aligned with centerline of sensor (trigger wheel tooth perpendicular to flat surface of sensor)(Fig. 18).

   b. Using feeler gauge, measure air gap between sensor and end of tooth (Fig.18). Move sensor as needed to obtain specified air gap (0.2 mm - .008"). Tighten sensor mounting screw and recheck air gap.

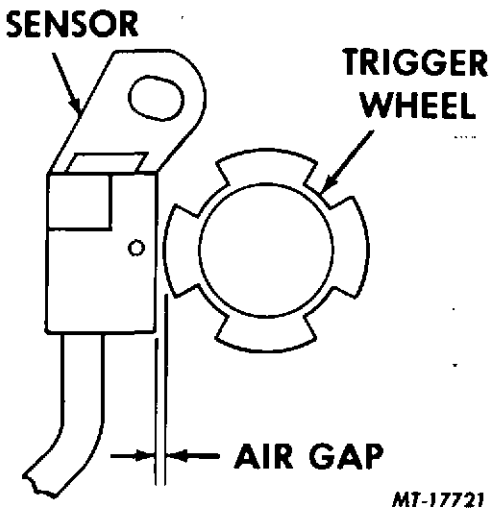

Fig. 18 Trigger Wheel-to-Sensor Air Gap

Use dwell meter that will read electronic ignition system dwell.

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2. Connect dwell meter to engine. Operate engine at specified curb idle speed and observe dwell reading. If dwell reading is not within specified limits, stop engine and adjust trigger wheel-to-sensor air gap to obtain specified dwell. Dwell decreases as sensor is moved closer to trigger wheel and increases as sensor is moved away from trigger wheel. Dwell is affected approximately one-half (1/2) degree per 0.025 mm (.001") of sensor movement.

3. Operate distributor at 300 RPM (with 12-13 volts primary input) and observe dwell reading. Dwell should be within specified limits.

   a. If dwell reading is within specified limits, trigger wheel-to-sensor gap is satisfactory.

   b. If dwell reading is not within specified limits, loosen sensor mounting screw and adjust trigger wheel-to-sensor air gap as required to obtain specified dwell. Move sensor toward trigger wheel to decrease dwell or away from trigger wheel to increase dwell. Dwell is affected approximately one-half (1/2) degree per .001" of sensor movement. After correct dwell is obtained, tighten sensor mounting screw.

DIAGNOSTIC CHECK LIST

FOR IH ELECTRONIC IGNITION SYSTEM

REFERENCES

Service Manual, Electrical Section:
CTS-2665P (1975, 1976 Vehicles)

EQUIPMENT REQUIRED

DC Voltmeter.

Jumper Wire 912-18 inches long with clip at each end.

Tester Switch SE-2503.

Insulated Pliers (grippers) for handling high tension cable.

1. INSPECT WIRING

   a. Check sensor wiring connectors.

   b. Inspect ignition primary circuit.

   c. Be sure dash panel connector terminals are clean and tight (locking tangs engaged).

   d. Inspect secondary (high tension) cables.

   e. Be sure ignition wires are routed correctly.

   f. Be sure ignition control (module) mounting bolts are tight.

2. TEST BATTERY VOLTAGE

   a. Test and record battery voltage.

Spec.	As Found
12-13V	

   If necessary, charge or replace batter.

3. TEST PRIMARY VOLTAGE

   a. Connect voltmeter between coil positive (+) terminal and ground.

   b. Turn ignition "ON" and record voltage.

Spec.	As Found
12-13V	

   If voltage equals battery voltage, proceed to Step 4.

   If voltage is noticeably less than battery voltage, a high resistance exists between battery and coil. Make necessary corrections.

4. TEST SPARK AT PLUG

   a. Disconnect cable from one spark plug.

   b. Using insulated pliers hold cable terminal about 1/2 inch away from engine.

   c. Crank engine and observe for spark.

   If spark occurs, ignition system is satisfactory.

   If no spark occurs, reconnect cable to spark plug and proceed to Step 5.

5. TEST SPARK AT DISTRIBUTOR CAP

   a. Disconnect cable from center terminal of distributor cap.

   b. Push boot back and clip end of jumper cable over ignition cable 1/4-1/2 inch away from metal terminal. Ground other end of jumper wire to engine.

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c. Crank engine and observe for spark between jumper wire clip and cable terminal.

If spark occurs, check for faulty distributor cap, rotor or spark plug cables.

If no spark occurs, leave jumper wire in place and proceed to Step 6.

6. TEST SENSOR

a. Disconnect distributor from engine wiring harness. Plug tester switch into wiring harness.

b. Turn ignition "ON". Press tab of tester switch and observe for spark between jumper wire clip and cable terminal.

If spark occurs, replace distributor sensor unit.

If no spark occurs, disconnect tester switch and proceed to Step 7.

7. TEST SENSOR WIRING CIRCUIT

a. Disconnect distributor wiring connector from ignition control (module). Plug tester switch into ignition control.

b. Turn ignition "ON". Press tab on tester switch and observe for spark between jumper wire clip and cable terminal.

If spark occurs, replace wiring circuit between ignition control and distributor.

If no spark occurs, disconnect tester switch, reconnect distributor wiring circuit to control and proceed to Step 8.

8. TEST IGNITION CONTROL AND COIL

a. Connect voltmeter between coil negative (-) terminal and ground.

b. Turn ignition "ON" and record voltage.

Spec.	As Found
5-8V	

If voltage is under 5 volts or over 8 volts, replace coil.

c. Disconnect distributor from engine wiring harness. Plug tester into wiring harness.

d. With ignition "ON", press tab on tester switch and observe voltmeter. Voltage should increase to battery voltage.

Spec.	As Found
12-13V	

e. Release tab on tester switch and observe voltmeter. Voltage should drop to 5-8 volts.

If voltage does not switch up and down, replace electronic ignition control (module).

If voltage switches up and down but spark does not jump between jumper wire clip and cable terminal, replace coil.

9. RETEST SPARK AT PLUG

a. After replacement of components, retest for spark at plug, Step 4.

b. Disconnect test equipment. Make sure wiring connectors are clean and tight.

10. CHECK DWELL

a. Connect dwell meter to engine.

b. Operate engine at idle speed and record dwell.

Spec.	As Found
26-32	

If necessary, adjust dwell.

11. CHECK TIMING

a. Connect timing light to engine.

b. Operate engine at idle speed and check timing.

(Distributor vacuum hose disconnected and plugged.)

If necessary, adjust timing.

Sensor Wiring Connector Check

Intermittent or complete failure of the electronic ignition system may be caused by excessive resistance at the molded, two-way connectors which connect the distributor sensor and the electronic ignition control (module) to the engine wiring harness (distributor sensor circuit).

High resistance at these connectors can result from loose physical fit between male and female terminals or oxidation (corroding) of terminals due to interaction of dissimilar materials in terminals of wiring harness and sensor and ignition control. In some cases oxidation is aggravated by a lack of lubricant/sealer (grease) in connectors permitting entry of moisture.

When diagnosing ignition system problems, always check for poor contact at the molded, two way connectors before condemning the distributor

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sensor and/or the electronic ignition control (module). Sometimes engine can be started by re-establishing contacting through the connector, either by disconnecting and reconnecting the plug or by squeezing or wiggling the connector. This indicates a faulty connector which should be replaced.

To ease replacement of wiring harness connectors, a substitute sensor wiring cable (with improved connector terminals) to bypass the existing distributor-to-module circuit in the engine wiring harness is available through service parts channels under IH part number 480085-C91.

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GENERAL PROCEDURE FOR STORING CARBURETED ENGINES

AND

STARTING ENGINES THAT HAVE BEEN IN STORAGE

STORING THE ENGINE

When the engine is not to be used for a period of time, it must be stored in a dry and protected place. Leaving equipment outdoors, exposed to the elements, will result in materially shortening its life.

The following procedure must be followed when the engine is placed in storage for 30 days or more.

Refer to the maintenance procedures and recommended lubricants for each individual model.

It is recommended that caution be taken in starting an engine that has been in storage. Refer to the procedure shown under "STARTING ENGINES THAT HAVE BEEN IN STORAGE" on the following page.

1. Thoroughly wash or clean the engine.
2. Run the engine long enough to warm the oil in the crankcase. Drain the crankcase, change the lubricating oil filter element and fill the crankcase.
3. Completely lubricate the rest of the engine.
4. Drain the fuel from the fuel tank and carburetor and clean out the fuel pump filter.

NOTE: Present-day grades of gasoline have a tendency to form gum; therefore, it is necessary that the gasoline tank and carburetor be completely drained of fuel when the engine is to be out of service for more than two weeks. These gum deposits can be dissolved with a mixture of one part alcohol and one part benzol, or with acetone.

5. Remove the spark plugs and pour one tablespoonful of Grade-50 lubricating oil into each cylinder. Crank the engine two or three times to distribute the oil over the cylinder walls; then reinstall the spark plugs.
6. Drain and clean the cooling system. Install a "RADIATOR DRAINED" tag.

NOTE: If the cooling system will be exposed to freezing temperatures during storage and water only was used during operation, the cooling system must be filled with an anti-freeze solution while at operating temperature and then drained to prevent residual water damage. Refer to the anti-freeze table to select a solution suitable for the lowest temperature that the cooling system will be exposed to during storage.

If anti-freeze solution cannot be used, the residual water retained by capillary attraction inside the cooler tubes must be blown out with dry compressed air through one of the drain cocks or plugs, preferably the one on the cooler. DO NOT RELY ONLY ON DRAINING THE WATER.

7. Remove and clean the crankcase ventilator metering valve if the engine is so equipped.
8. Completely service the air cleaner.
9. Remove the air cleaner intake cap and store it in a clean dry place. Cover or plug the exhaust pipe and the air cleaner pipe.
10. Remove the battery and store it in a cool, dry place above freezing (+32°F). The battery must be fully charged at the time of storage. Check the battery liquid level at least once a month for water level and specific gravity. Never allow the battery to run down below 3/4 full charge while in storage.

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STORING THE ENGINE - Continued

Liquefied Petroleum and Natural Gas Engines

Follow the same procedure used for preparing the gasoline engines for storage, except as follows:

1. Close the supply valve on the fuel line. Run the engine until it stops from lack of fuel.
2. Disconnect the fuel supply source and plug up the opening.
3. Drain the fuel regulator of water.
4. Replace the fuel filter element on liquefied petroleum gas engines.

STARTING ENGINES THAT HAVE BEEN IN STORAGE

1. Install a fully charged battery and be sure the proper connections are made.
2. Remove the spark plugs and pour a mixture of one-half gasoline and one-half light lubricating oil into each cylinder; one ounce (two tablespoonfuls) per cylinder is sufficient.
3. Remove the valve housing cover and flush the valve and valve operating mechanism with the same mixture (leave covers off until step 14).
4. Crank the engine rapidly until the excess oil has been blown out of the spark plug holes. This operation will loosen any tight piston rings and wash old, gummy oil from valves and pistons.
5. Drain and flush out the crankcase with kerosene or flushing oil and fill with the specified lubricating oil. Be sure a new element has been installed in the lubricating oil filter.
6. Remove the exhaust pipe and the air cleaner opening plugs and/or covers.
7. AIR CLEANER (WET TYPE ONLY): Remove and clean the oil cup.
8. Install the air intake cap.
9. Install the spark plugs after cleaning and setting the gaps.
10. Be sure the cooling system drains are closed and fill the cooling system. Check for leaks and loose connections. Remove the "RADIATOR DRAINED" tag.
11. If the fuel lines have been disconnected from the engine, remove the plugs from the fuel inlet. Remove the covers from the fuel inlet lines. Reconnect the fuel inlet lines being sure the connections are tight.
12. Fill the fuel tank/s.
13. Start the engine and let it run slowly; observe if any valves are sticking. If so, pour a small quantity of kerosene on the valve stems until loose.

CAUTION

DO NOT RUN THE ENGINE RAPIDLY OR OPERATE IT AT HIGH SPEED IMMEDIATELY AFTER STARTING. KEEP THE DOORS WIDE OPEN OR MOVE THE ENGINE OUTSIDE THE STORAGE ROOM IMMEDIATELY TO AVOID DANGER FROM EXHAUST GAS.

14. Install the valve housing cover. Tighten the valve cover bolts.
15. After the engine has been run long enough to clean the excess oil out of the cylinders, the spark plugs should be removed and checked for oil fouling. If fouled, clean and reinstall them in the engine.

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INTERNATIONAL HARVESTER COMPANY
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