SUBJECT INDEX

SUBJECT	PAGE	SECTION
Description and Specifications	4	1
Engine Fuel System, Governor, and Engine Controls	15	2
Engine Air Intake System	60	3
Engine Cooling System	68	4
Engine Lubricating System	90	5
Electrical System	110	6
Instruments	122	7
Engine	125	8
Engine Clutch and Torque Converter	200	9
Transmission, Bevel Gear, and Drive Shaft Universal Joint	234	10
Steering Clutches and Controls Tractors prior to S/N 5154 having dry-type steering clutches. For tractors with oil-type steering clutches see Sec. XXIV.	270	11
Steering Brakes Tractors prior to S/N 5154 having dry-type brakes. For tractors having oil-type steering clutches and power brakes see Section XXIV.	297	12
Final Drives	304	13
Truck Frames	323	14
Drawbar	342	15
Tracks	344	16
Main Frame and Equalizing Spring	350	17
Fender and Seat Group	354	18
Special Equipment	355	19
General Maintenance Instructions	359	20
Fits and Tolerances	364	21
Trouble Shooting	393	22
Special Tools	411	23
Oil Type Steering Clutches and Power Brakes (Effective Tractor S/N 5154 & up)		24

SECTION I — DESCRIPTION AND SPECIFICATIONS

Topic Title	Topic No.	Page No.
General Description	1	4
General Specifications	2	7
Specifications of Lubricants	3	10
Specifications of Fuel	4	12
Fuel Storage	5	13
Tractor and Engine Serial Numbers	6	14

1. GENERAL DESCRIPTION

The description given herein and the information contained in this manual pertains to the models HD 16A and HD 16D tractors (standard models without a torque converter), and to the models HD 16AC and HD 16DC tractors (standard models with a torque converter), unless otherwise stated. Tractors prior to Serial No. 4001, are powered by a 6 cylinder, 4 stroke cycle, naturally aspirated "Allis-Chalmers" model HD 844 diesel engine. Tractors Serial No. 4001 and above, are powered by a 6 cylinder, 4 stroke cycle, naturally aspirated "Allis-Chalmers" model 16000 diesel engine.

The models HD 16A and HD 16D tractors are track-type tractors having approximate shipping weights of 31,500 and 32,700 pounds respectively. The models HD 16AC and HD 16DC tractors are track-type tractors having approximate shipping weights of 31,600 and 32,800 pounds respectively.

The standard models HD 16A, HD 16D, HD 16AC, and HD 16DC tractors are equipped with hydraulic steering controls; wrap-around radiator guard; 20 inch, heat treated, integral grouser track shoes; positive seal heavy-duty truck wheels, track idlers, and track support rollers; full width crankcase guard; truck wheel, track idler, and track sprocket guards; muffler; front pull hook; 24 volt electric starting and lighting equipment; oil pressure, fuel pressure, temperature, and ammeter gages; suction-type fan (models HD 16A and HD 16D tractors), pusher-type fan (models HD 16AC and HD 16DC tractors); decelerator pedal (models HD 16AC and HD 16DC tractors Serial No. 4001 and above); and front bumper.

On models HD 16A and HD 16D tractors, power from the engine is transmitted through a single plate, over-center type engine clutch to the transmission through a drive shaft universal joint assembly. From the transmission the power is transmitted to the bevel gear, and from the bevel gear through the steering clutches to the final drives and the track drive sprockets. The transmission provides 6 forward and 3 reverse speed ranges. At rated engine speed of 1600 R.P.M. (governed at full load), the transmission provides maximum forward speeds ranging from 1.4 M.P.H. in low gear to 5.8 M.P.H. in high gear and reverse speeds ranging from 1.5 M.P.H. in low reverse to 4.5 M.P.H. in high reverse.

On models HD 16AC and HD 16DC tractors, power from the engine is transmitted through a single plate, over-center type engine clutch to the torque converter, which automatically multiplies the engine torque to meet the varying load requirements. The power is transmitted from the torque converter to the transmission through a drive shaft universal joint assembly. From the transmission the power is transmitted to the bevel gear, and from the bevel gear through the steering clutches to the final drives and the track drive sprockets. The transmission provides 3 forward and 2 reverse speed ranges. At rated engine speed of 1800 R.P.M. (governed at full load), the transmission in conjunction with the torque converter provides maximum forward speeds ranging from 2.5 M.P.H. in low gear to 7.2 M.P.H. in high gear and reverse speeds ranging from 3.2 M.P.H. in low reverse to 5.5 M.P.H. in high reverse.

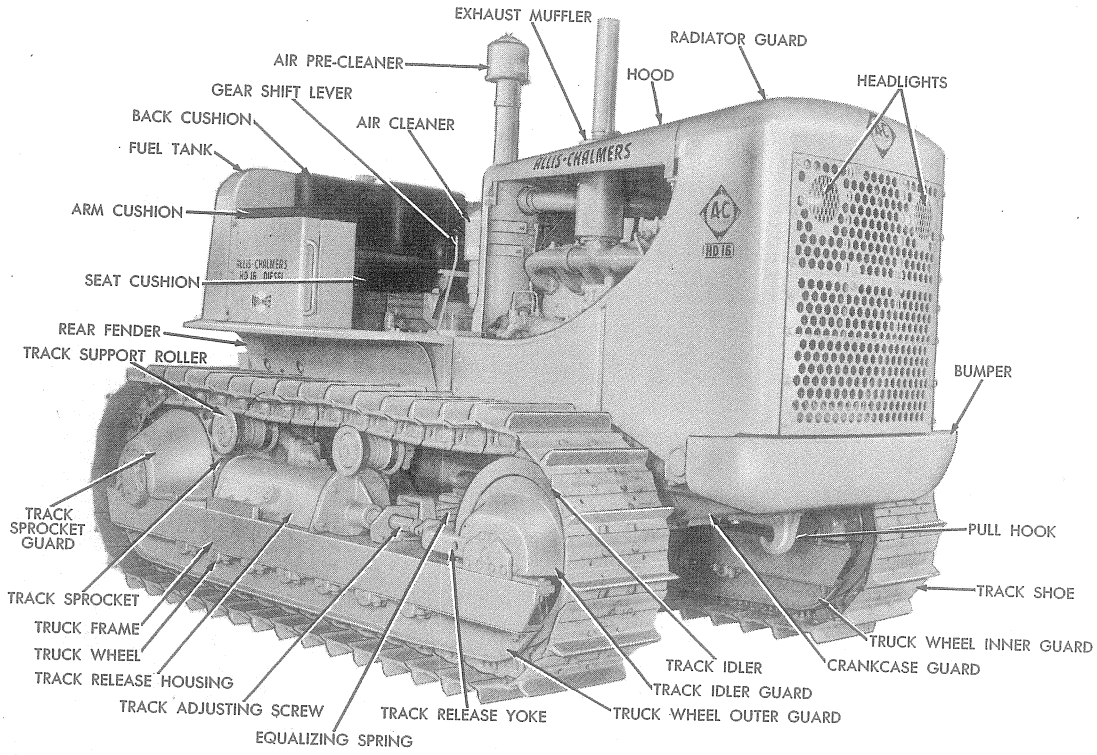

Fig. 1 — HD 16DC Tractor (Serial No. 4001 and Above)

Hydraulic steering controls, mechanical self-energizing brakes, a wide and adjustable operator's seat, and an unobstructed view of the front of both tracks assure easy, positive control of the tractor at all times.

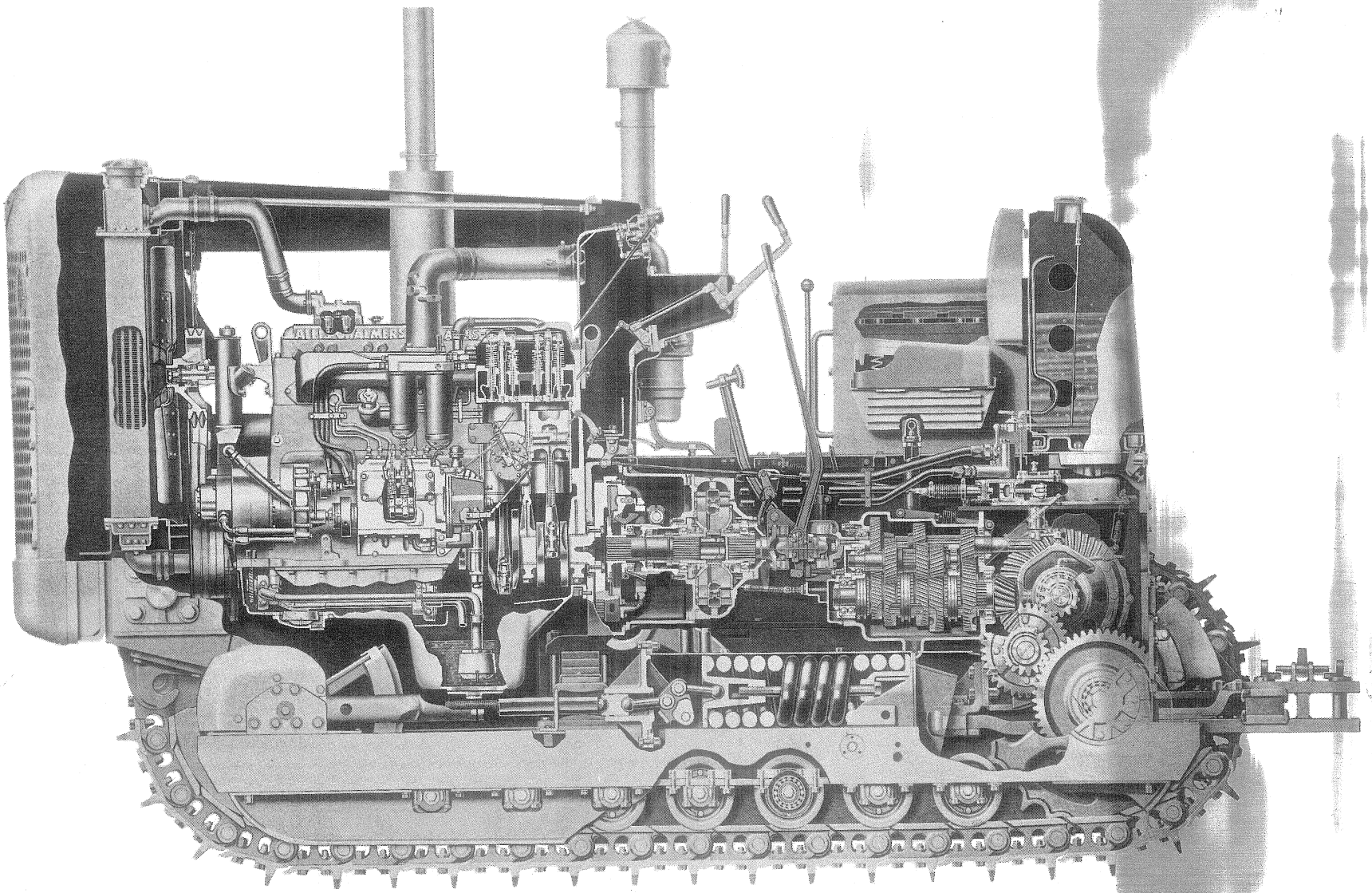

Fig. 2 — HD 16 Tractor — Sectional View
(Serial No. 4001 and Above)

2. GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS:

Overall Length:
- HD 16A, HD 16AC, HD 16D, HD 16DC and HD 16FC ..... 14 ft. 10 1/16 in.
- HD 16 GC (Bucket Down) ..... 19 ft. 4 in.

Overall Height (Without Stacks):
- HD 16A, HD 16AC, HD 16D, HD 16DC, and HD 16FC ..... 7 ft. 5 13/16 in.
- HD 16GC ..... 8 ft. 3 1/2 in.

Overall Width (With Standard Track Shoes):
- HD 16A, HD 16AC, HD 16D, and HD 16DC ..... 8 ft. 0 in.
- HD 16FC ..... 8 ft. 10 in.
- HD 16GC ..... 9 ft. 3 in.

Ground Clearance ..... 14 3/8 in.
Drawbar Height (Center Line of Jaw) ..... 17 7/8 in.
Lateral Drawbar Movement ..... 35 in.

Shipping Weight (Approximate):
- HD 16A ..... 31,500 lbs.
- HD 16AC ..... 31,600 lbs.
- HD 16D ..... 32,700 lbs.
- HD 16DC ..... 32,800 lbs.
- HD 16FC ..... 33,340 lbs.
- HD 16GC ..... 48,600 lbs.

Number of Track Shoes (Each Track):
- HD 16A and HD 16AC 38
- HD 16D, HD 16DC, and HD 16FC 41
- HD 16GC 43

Height of Grouser:
- HD 16A, HD 16AC, HD 16D, HD 16DC, and HD 16FC ..... 2 19/32 in.
- HD 16GC ..... 7/8 in.

Diameter of Track Shoe Shoulder Bolt ..... 5/8 in.
Diameter of Track Pins ..... 1 3/4 in.
Diameter of Track Pin Bushings ..... 2 5/8 in.

Length of Track on Ground:
- HD 16A and HD 16AC ..... 8 ft. 5/16 in.
- HD 16D, HD 16DC, and HD 16FC ..... 9 ft. 3/32 in.
- HD 16GC ..... 9 ft. 8 in.

Width of Standard Track Shoe ..... 20 in.

Maximum Width of Track Shoes Available:
- *HD 16A, HD 16AC, HD 16D, HD 16DC, and HD 16FC ..... 26 in.
- **HD 16GC ..... 20 in.

Ground Contact Area (Standard Shoes):
- HD 16A and HD 16AC ..... 3853 sq. in.
- HD 16D, HD 16DC, and HD 16FC ..... 4324 sq. in.
- HD 16GC ..... 4639 sq. in.

Ground Pressure (Standard Shoes):
- HD 16A and HD 16AC ..... 8.2 P.S.I.
- HD 16D and HD 16DC ..... 7.6 P.S.I.
- HD 16FC ..... 7.7 P.S.I.
- HD 16GC ..... 10.5 P.S.I.

Tread Width (Center to Center of Tracks):
- HD 16A, HD 16AC, HD 16D, and HD 16DC ..... 74 in.
- HD 16FC and HD 16GC ..... 84 in.

*Extra wide shoes materially decrease the life of any track assembly. Twenty-four inch or twenty-six inch shoes should be used only when requirements will justify the resulting decreased life of the track assembly.

**Full grousers are recommended only for extreme traction conditions such as snow or ice.

MAXIMUM TRACTOR SPEEDS (at rated engine speed):

HD 16A and HD 16D	
1st Forward	1.4 M.P.H.
2nd Forward	2.1 M.P.H.
3rd Forward	3.0 M.P.H.
4th Forward	3.9 M.P.H.
5th Forward	4.5 M.P.H.
6th Forward	5.8 M.P.H.
1st Reverse	1.5 M.P.H.
2nd Reverse	3.5 M.P.H.
3rd Reverse	4.5 M.P.H.
HD 16AC, HD 16DC, HD 16FC, and HD 16GC	
1st Forward	2.5 M.P.H.
2nd Forward	4.3 M.P.H.
3rd Forward	7.2 M.P.H.
1st Reverse	3.2 M.P.H.
2nd Reverse	5.5 M.P.H.

STEERING:

Method	Clutches
Controls	Hydraulic
Turning Radius:	
HD 16A and HD 16AC	9 ft. 4 in.
HD 16D and HD 16DC	9 ft. 4 3/8 in.

ENGINE:

Make	"Allis-Chalmers" Diesel
Model:	
HD 16A and HD 16D (tractors prior to Serial No. 4001)	HD 844
HD 16AC, HD 16DC, HD 16FC, and HD 16GC (tractors prior to Serial No. 4001)	HD 844C
HD 16A, HD 16AC, HD 16D, HD 16DC, HD 16FC, and HD 16GC (tractors Serial No. 4001 and above)	16000
Type	4 Stroke Cycle (Naturally Aspirated)
Lubrication	Full Pressure
Fuel Used	Diesel Fuel
Fuel Supplied by	"American Bosch" Fuel Injection Pump
Number of Cylinders	6
Compression Ratio (Tractors Prior to Serial No. 4001)	14.15:1
Compression Ratio (Tractors Serial No. 4001 and Above)	14.5:1
Bore	5¼ in.
Stroke	6½ in.
Piston Displacement	844 cu. in.
Crankshaft Rotation (viewed from fan end)	Clockwise
Number of Main Bearings	7
Rated R.P.M. (governed at full load):	
HD 16A and HD 16D	1600 R.P.M.
HD 16AC, HD 16DC, HD 16FC, and HD 16GC	1800 R.P.M.
Low Idle Speed R.P.M. (All Engines)	525 to 550 R.P.M.
High Idle Speed R.P.M.:	
Tractors Prior to Serial No. 4001 Without Torque Converter	1715 (+ or − 25) R.P.M.
Tractors Prior to Serial No. 4001 with Torque Converter	1915 (+ or − 25) R.P.M.
Tractors Serial No. 4001 and Above Without Torque Converter	1685 (+ or − 25) R.P.M.
Tractors Serial No. 4001 and Above with Torque Converter	1925 (+ or − 25) R.P.M.
Valve Timing (All Engines):	
Intake Valve Opens B.T.D.C.	20°
Intake Valve Closes A.B.D.C.	40°
Intake Valve Open — Duration	240°
Exhaust Valve Opens B.B.D.C.	45°
Exhaust Valve Closes A.T.D.C.	15°
Exhaust Valve Open — Duration	240°

ENGINE — Continued

Firing Order	1 - 5 - 3 - 6 - 2 - 4
Generator Speed (Approximate)	1.6 x Crankshaft Speed
Fuel Transfer Pump Speed:	
HD 844 and HD 844C (Tractors Prior to Serial No. 4001)	2.25 x Crankshaft Speed
16000 (Tractors Serial No. 4001 and Above)	2.0 x Crankshaft Speed
Fuel Injection Pump Speed	0.5 x Crankshaft Speed
Fuel Injection Pump Timing Gage Thickness (Tractors Prior to Serial No. 4001)	.215"
Fuel Injection Pump Timing:	
HD 844 and HD 844C (Tractors Prior to Serial No. 4001)	16° B.T.D.C.
16000 (Tractors Serial No. 4001 and Above Without Torque Converter)	24° B.T.D.C.
16000 (Tractors Serial No. 4001 and Above With Torque Converter)	28° B.T.D.C.
Tachometer Drive Shaft Speed	1.5 x Crankshaft Speed
Hydraulic Pump Speed	1.5 x Crankshaft Speed
Water Pump Speed	1.5 x Crankshaft Speed

TORQUE CONVERTER:

Make	"Twin Disc"
Type	Three Stage
Torque Ratio Increase (At Stall)	4.5:1
Fluid Used	Diesel Fuel
Fluid Supplied	Under Pressure from Fuel Transfer Pump

CAPACITIES (Approximate):

	Metric Measure	U. S. Standard Measure
Cooling System:		
HD 844 (Tractors Prior to Serial No. 4001 Without Torque Converter)	59.6 liters	15¾ gals.
HD 844C (Tractors Prior to Serial No. 4001 With Torque Converter)	68.1 liters	18 gals.
16000 (Tractors Serial No. 4001 and Above Without Torque Converter)	56.7 liters	15 gals.
16000 (Tractors Serial No. 4001 and Above With Torque Converter)	64.4 liters	17 gals.
Crankcase and Filters:		
HD 844 and HD 844C (Tractors Prior to Serial No. 4001)	28.4 liters	7½ gals.
16000 (Tractors Serial No. 4001 and Above)	26.5 liters	7 gals.
Transmission Case:		
Tractors Without Torque Converter	30.3 liters	8 gals.
Tractors With Torque Converter	32.2 liters	8½ gals.
Final Drives (Each)	20.8 liters	5½ gals.
Fuel Tank (Tractors Without Torque Converter)	378.5 liters	100 gals.
Fuel Tank and Torque Converter System	416.3 liters	110 gals.
Usable Fuel Tank Capacity (Tractors With Torque Converter)	378.5 liters	100 gals.
Track Release Housing (Each)	17.2 liters	4½ gals.
Air Cleaner	4.7 liters	1¼ gals.
Steering Hydraulic System:		
Tractors Prior to Serial No. 4001	9.5 liters	2½ gals.
Tractors Serial No. 4001 to Serial No. 5154	8.5 liters	2¼ gals.
Transmission, Bevel Gear, and Steering Clutch Compartments:		
Tractors Serial No. 5154 and Above With Torque Converter	98.4 liters	27 gals.
Tractors Serial No. 5154 and Above Without Torque Converter	102.1 liters	26 gals.
Fuel Injection Pump Oil Sump (Tractors Prior to Serial No. 4001)	.9 liter	1 qt.
Governor Oil Sump (Tractors Prior to Serial No. 4001)	.1 liter	¼ pt.
Track Support Roller (Each)	1.0 kg.	2 lbs.
Track Idler (Each)	2.0 kg.	4 lbs.
Truck Wheels (Each)	.9 kg.	1¾ lbs.

NOTE: The Allis-Chalmers Manufacturing Company reserves the right to make changes in the above specifications or to add improvements at any time without notice or obligation.

3. SPECIFICATIONS OF LUBRICANTS

A. Engine Crankcase Lubricant

USE NON-CORROSIVE "DIESEL" ENGINE CRANKCASE OIL CONTAINING ADDITIVES WHICH WILL PREVENT SLUDGE OR GUM DEPOSITS.

Use oils of the following viscosities:

Atmospheric Temperature	Viscosity
32° F. and above	Use SAE 30
0° F. to 32° F.	Use SAE 20W
0° F. and below	Use SAE 10W

The oil should meet the American Petroleum Institute (API) Diesel classification of "For Service DS" or "Series 3."

"For Service DS" or "Series 3" oils contain additives which promote general cleanliness within the engine and prevent the formation of sludge, hard carbon, and varnish deposits on/or within engine parts.

Detergent type oils will become darker in color within a short period of operation. The darkening of the oil is due to minute particles of carbon being suspended in the oil. One of the primary functions of a detergent type oil is to hold the carbon particles in suspension; therefore, darkening of the oil is normal and should not cause concern.

Suppliers of lubricants recognize the importance of the qualities required for use in our equipment and they are cooperating fully to assure the use of only those oils which fulfill these requirements. The lubricant supply source is to be held responsible for the results obtained from their product.

Proper operation and maintenance of the engine are necessary to obtain the desired results from the lubricating oil. NOTE: *If "For Service DS" or "Series 3" oil is not available through your oil distributor in the viscosities recommended, use oil of the viscosity recommended by the particular oil distributor and/or supplier.*

B. Fuel Injection Pump and Governor Lubricant

On tractors prior to Serial No. 4001, lubricate the fuel injection pump and governor with oil of the same viscosity as that used in the engine crankcase. Effective with tractor Serial No. 4001 the fuel injection pump and governor are pressure lubricated from the engine lubricating system.

C. Air Cleaner

Use the same viscosity oil in the air cleaner as used in the engine crankcase. CAUTION: *Do not use an oil that foams.*

D. Final Drive and Track Release Housing Lubricant (All Tractors) and Transmission Lubricant (Tractors Prior to Serial No. 5154 with Dry-Type Steering Clutches and Brakes)

Lubricate these assemblies with SAE Regular Type Gear Lubricant (straight mineral oil) or a good quality engine crankcase oil purchased from a reputable oil company. CAUTION: *Do not use Extreme Pressure (EP) Gear Lubricant.*

Use oils of the following viscosities:

Atmospheric Temperature	Viscosity
Above 32° F.	SAE 90 Gear Lube or SAE 50 Crankcase Oil
32° F. and below	SAE 80 Gear Lube or SAE 30 Crankcase Oil

E. Steering Hydraulic System (Tractors Prior to Serial No. 5154 with Dry-Type Steering Clutches and Brakes)

Use a good quality non-foaming, rust and oxidation inhibited hydraulic oil having a viscosity of 150-185 S.U.S. at 100° F. or a good quality SAE 10W engine crankcase oil. For operation below 0° F., use hydraulic oil of the above quality with a —20° F. maximum pour point, or SAE 10W diluted 10% to 20% with kerosene.

F. Transmission, Bevel Gear, Brakes, and Steering System (Tractors Serial No. 5154 and Above with Oil-Type Steering Clutches and Power Brakes)

A good quality Automatic Transmission Fluid "Type A," purchased from a reputable oil company, is recommended for all atmospheric temperature ranges.

For operations ABOVE 32° F., a good quality non-foaming SAE 10W engine crankcase oil may be used if desired. NOTE: *Automatic Transmission Fluid "Type A" MUST be used for operation below* 32°F.

G. Truck Wheel, Track Idler, and Track Support Roller Lubricant

These assemblies are lubricated for life at the time of assembly and no further lubrication service is required except when these assemblies are being reassembled after repair.

Lubricate these assemblies with a grease that meets certain definite specifications.

The type of grease used for lubricating these assemblies must:

1. Have good pumpability and cold temperature characteristics.
2. Have a minimum effect on the synthetic rubber seal boots.
3. Be an extremely stable grease both mechanically and chemically that will not deteriorate excessively with long usage.

Detailed specifications of the grease are as follows:

Worked Penetration (60 strokes)
(ASTM-D-217) ..... 355 to 385
Worked Penetration
(10,000 strokes) ..... 400 max.
Dropping Point °F. (ASTM-D-566) 180
Water Content % (ASTM-D-128) ... 1.0 max.
Ash Content % (ASTM-D-128) ..... 1.5 max.
Acidity or Alkalinity %
(ASTM-D-218) ..... 0.3 max.
Fillers ..... None
Corrosion (Federal Spec. 5304.2) ..... None
Norma-Hoffman Oxidation Test:
Pressure Drop, psi,
100 hours at 210° F. ..... 5 max.
Viscosity of Oil S.U.S. at 210° F. ... 45 to 58
Aniline Point of Oil, °F. (ASTM-611) . 225 min.

Contact your local supplier for a grease which meets these specifications. The source of supply of the lubricant used is to be held responsible for the results obtained from their products.

H. Pressure Gun Lubricant

Use a ball and roller bearing lubricant with a minimum melting point of 300° F. This lubricant should have a viscosity range so as to assure easy handling in the lubricating gun at the prevailing atmospheric temperature and MUST be waterproof.

4. SPECIFICATIONS OF FUEL

The "Diesel" fuel should be a natural distillate petroleum oil and must have certain qualities in order to ignite and burn at the proper rate and temperature. Field experience has shown that the fuel best suited for this engine closely approximates the following specifications:

Gravity API	30 — 35
Viscosity Saybolt Universal at 100° F.	35 — 40
Flash Point	150° F.
Diesel Index	48.5 to 65.5
Cetane Number	46 to 60
Pour Point	0° F.
Volatility 90%	650° F. Max.
End Point 98%	
Summer	700° F. Max.
Winter	600° F. Preferable
Sediment and Water	Trace
Ash	.02 of 1% Max.
Conradson Carbon	.03 of 1% Max.
Sulphur	½ of 1% Max.

For satisfactory fuel flow through lines and filters in cold weather, the pour point of the fuel must be at least 10° F. below the prevailing atmospheric temperature.

The API gravity of a fuel varies with its specific gravity. The low API fuels are desirable because they have a high specific gravity and more heat units per gallon. However, the higher the API gravity, the better will be the ignition quality of the fuel.

The ignition quality of a fuel is expressed as a "cetane number." The higher the cetane number, the higher the quality of the fuel. The higher cetane fuel shortens the ignition delay period to facilitate starting and improve combustion. The "Diesel" index number, which is a close approximation of the cetane number, is a field method to represent ignition quality.

The distillation 90% point and the end point are important. High volatility is required to enable vaporization of the fuel, clean combustion, and low residue formation.

The flash point of a fuel has no quality significance, but is important with respect to safety in storage and handling of the fuel.

It is important that the fuel be within the specified limits for ash, carbon, water, sediment content, etc., to prevent excessive wear and damage to engine parts.

It is also important that the fuel has lubricating properties so that the fuel injection pump and fuel injection nozzles are adequately lubricated. At times it may be necessary to use fuel with no lubricating properties. If this occasion arises, add one quart of SAE 10 engine oil to every 10 gallons of fuel. When the proper fuel is again available, the fuel system must be drained before the proper fuel is added.

CAUTION: *The sulphur content of "Diesel" fuel should be as low as possible. The fuel should not contain a sulphur content of more than ½ of 1%.*

Generally speaking, a No. 2 "Diesel" fuel purchased from a reputable source will meet the above specifications.

5. FUEL STORAGE

The importance of proper storage of fuel cannot be too strongly stressed. Storage tanks, drums or service tanks must be free from rust, scale, sediment, or any other foreign matter which will contaminate the fuel. Contaminated fuel will clog the engine fuel filters and eventually damage the fuel injection pump and the fuel injection nozzles.

A portable storage tank provides the best method for storing fuel on the job. In such a tank, the sediment and water can easily be drained and the fuel can be pumped into the tractor fuel tank with a minimum of handling. Consult your nearest "Allis-Chalmers" dealer for details about this type of storage tank. Since condensation will occur in the storage tank, it is very important that a sediment sump be provided in the bottom of the tank so that water and sediment can be drained daily.

Fuel should be allowed to settle at least 48 hours in a storage container before it is added to the fuel tank of the tractor. It is advisable to use a pump and draw the fuel from the storage tank, or barrel, rather than to drain it from the bottom of the fuel container. Where conditions are such that drums must be used to supply fuel, it is advisable to have enough drums to allow sufficient time for the fuel to settle. The fuel thus left in a number of drums can be collected into one drum and used after the usual time allowed for settling. In this manner the sediment and foreign matter will be disposed of and no fuel will be wasted. Whenever drums are used for fuel storage they should be covered or placed under shelter so that the fuel will not become contaminated by water, which will enter through the filler plugs when it rains, even though the plugs are tight.

The fuel tank of the tractor should be filled at the end of the day's run rather than at the start; this will reduce the water content, as a full tank is less subject to condensation.

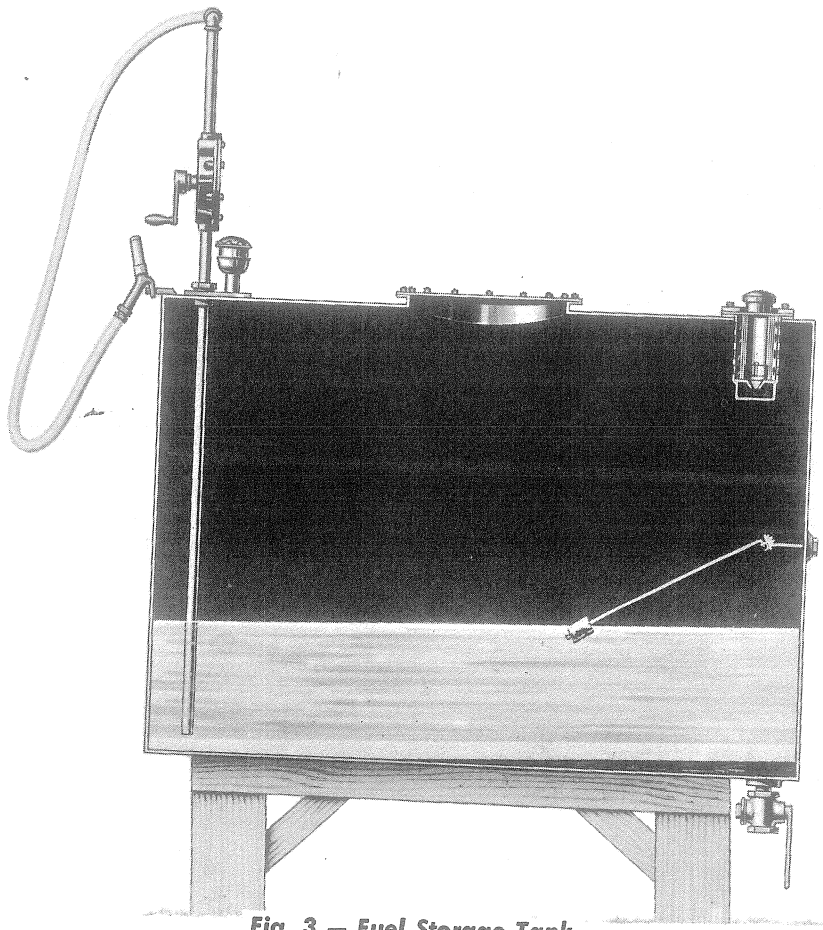

Fig. 3 — Fuel Storage Tank

6. TRACTOR AND ENGINE SERIAL NUMBERS

On all parts orders and in all correspondence relative to the tractor it is necessary that both the tractor and engine serial numbers be given. This information will properly identify the particular tractor or engine and will assure obtaining the correct replacement parts.

The tractor serial number is stamped in the rear face of the steering clutch housing (Fig. 4) and is also stamped on a serial number plate attached to the cowl.

On tractors prior to Serial No. 4001, the engine serial number is stamped on a serial number plate attached to the left side of the cylinder block and is also stamped on the right side of the cylinder block, directly behind the lubricating oil filters (Fig. 5).

On tractors serial No. 4001 and above, the engine serial number is stamped on a serial number plate attached to the left side of the cylinder block (Fig. 6) and is also stamped on the right hand side of the cylinder block directly above the center of the water inlet manifold; it is also stamped on the serial number plate attached to the cowl.

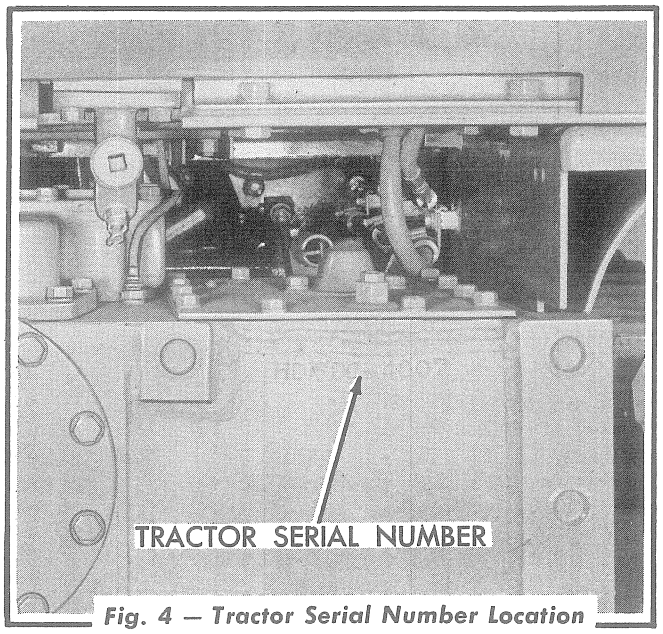

Fig. 4 — Tractor Serial Number Location

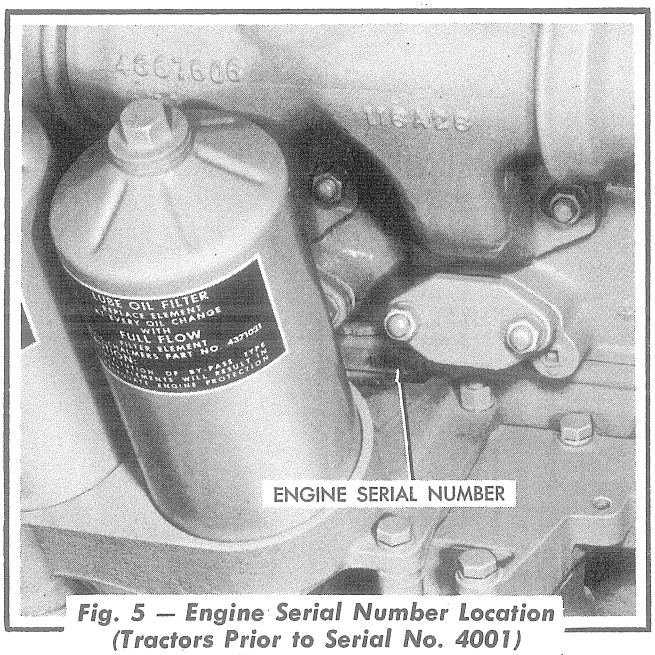

Fig. 5 — Engine Serial Number Location (Tractors Prior to Serial No. 4001)

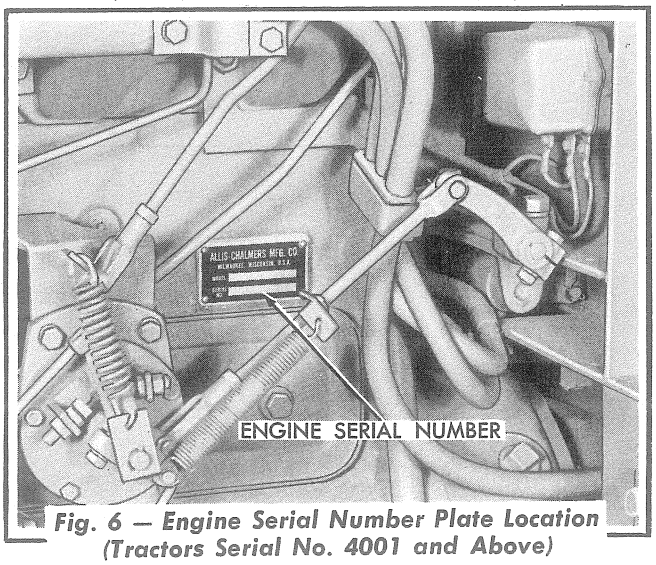

Fig. 6 — Engine Serial Number Plate Location (Tractors Serial No. 4001 and Above)

Topic Title	Topic No.	Page No.
General Description	1	15
Checking of Fuel System	2	19
Fuel Tank and Fuel Filters	3	23
Fuel Transfer Pump	4	27
Fuel Injection Nozzles	5	30
Fuel Injection Nozzle Sleeves	6	42
Fuel Injection Pump and Governor	7	43
Engine Controls	8	54

1. GENERAL DESCRIPTION

On tractors without a torque converter, the engine fuel system consists basically of a fuel tank, first stage fuel filter, fuel transfer pump, second stage fuel filter, fuel injection pump, fuel injection nozzles, fuel pressure gage, and fuel lines. On tractors with a torque converter, the fuel system also consists of a torque converter fluid heat exchanger and a fuel return line filter. There are two fuel pressure systems; the low pressure system and the high pressure system.

The low pressure system on tractors without a torque converter consists of the fuel tank, first stage fuel filter, fuel transfer pump, second stage fuel filter, fuel pressure gage, and the fuel return line extending from the fuel sump of the fuel injection pump to the fuel tank.

The low pressure system on tractors with a torque converter, consists of the fuel tank, first stage fuel filter, fuel transfer pump, second stage fuel filter, fuel pressure gage, the torque converter fluid system, and the fuel lines.

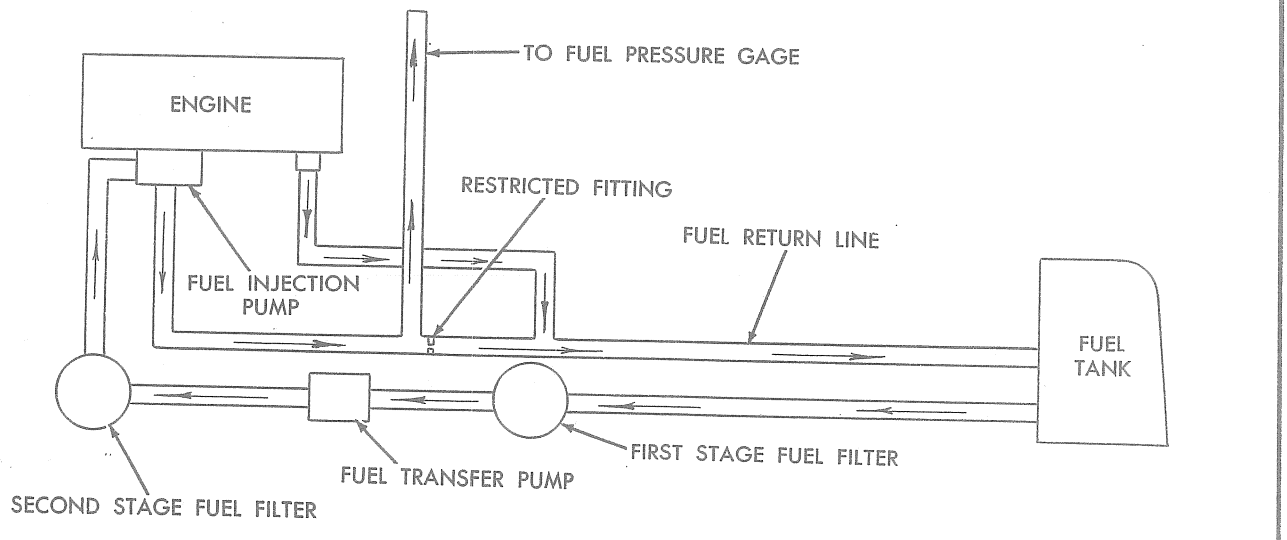

Fig. 1 — Fuel Flow — Schematic Diagram (Tractors Prior to Serial No. 4001 Without Torque Converter)

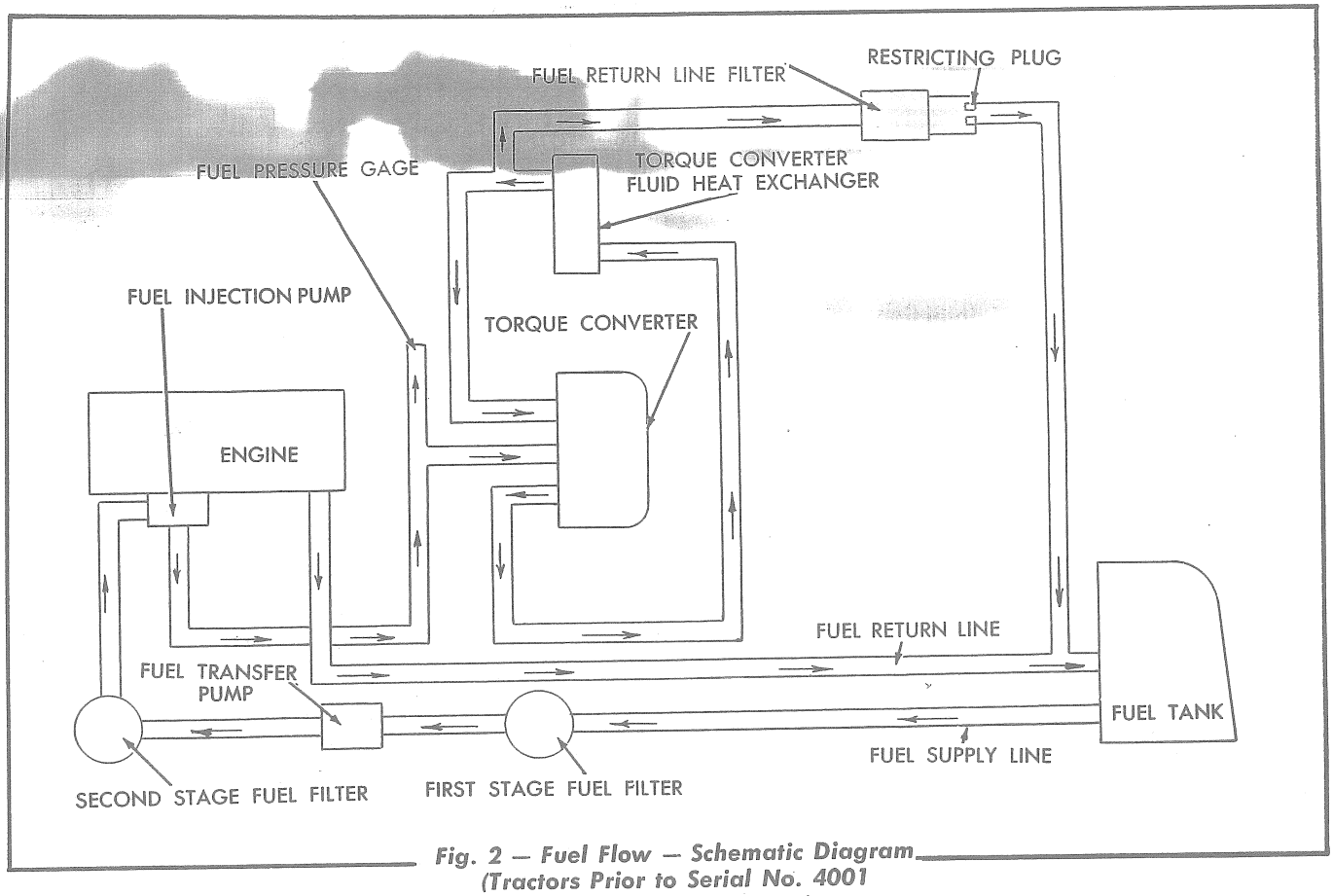

Fig. 2 — Fuel Flow — Schematic Diagram
(Tractors Prior to Serial No. 4001
with Torque Converter)

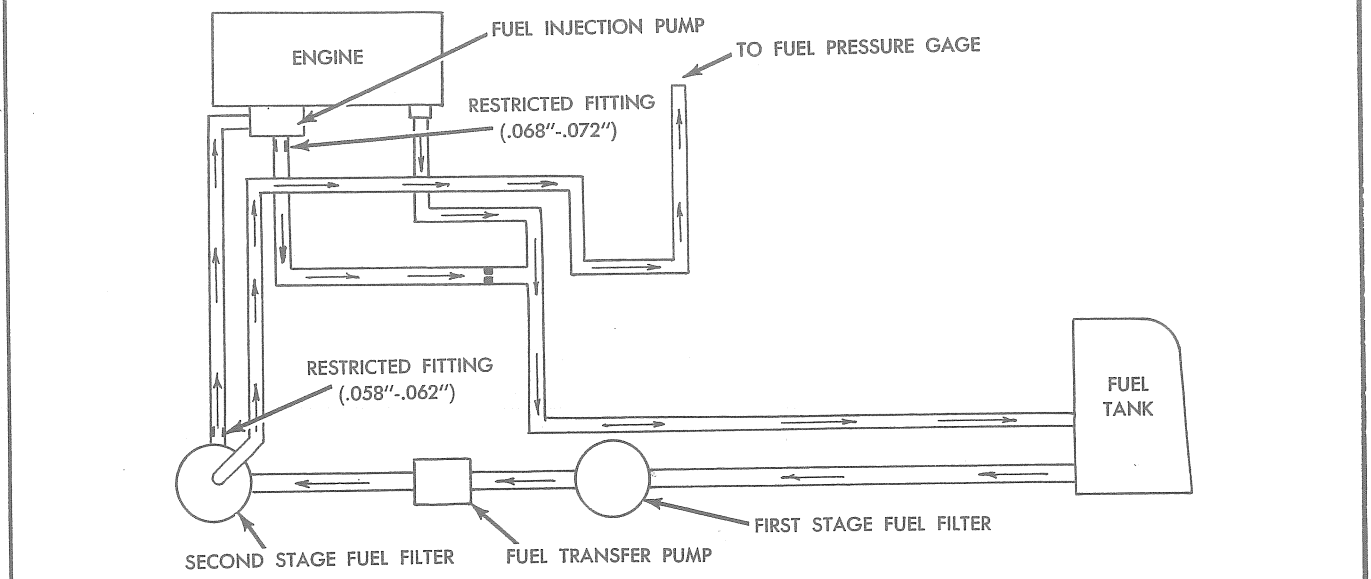

Fig. 3 — Fuel Flow — Schematic Diagram
(Tractors Serial No. 4001 and Above
Without Torque Converter)

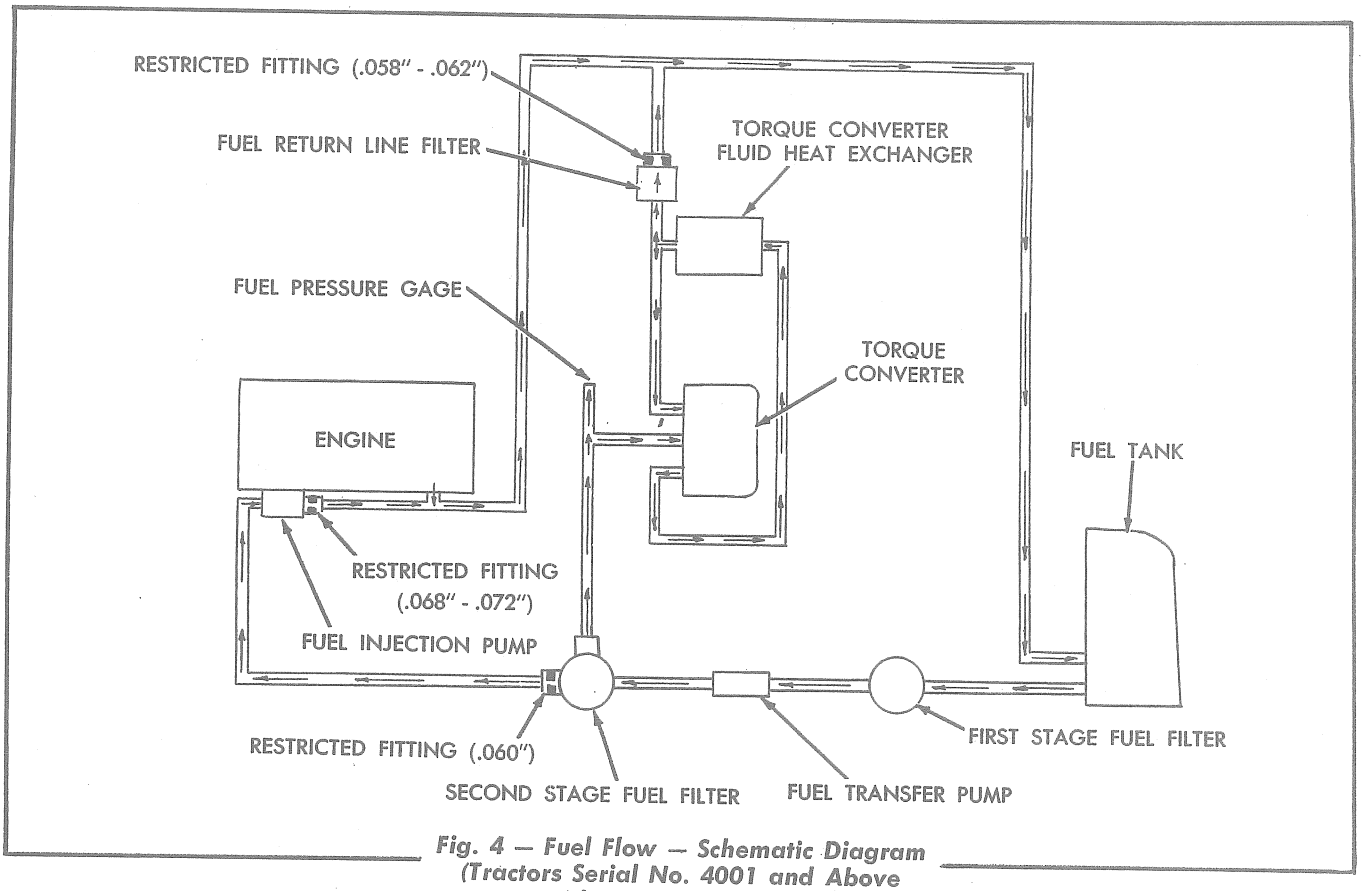

Fig. 4 — Fuel Flow — Schematic Diagram (Tractors Serial No. 4001 and Above with Torque Converter)

On tractors prior to Serial No. 4001, fuel is drawn from the fuel tank, through the first stage fuel filter, by the fuel transfer pump. The fuel is then forced, by the fuel transfer pump, through the second stage fuel filter and into the fuel sump of the fuel injection pump. More fuel is supplied to the fuel sump of the fuel injection pump than is needed for engine operation. On tractors with a torque converter the excess fuel passes from the fuel sump of the injection pump and through the torque converter fluid supply line to the torque converter, is circulated through the torque converter, fluid heat exchanger, passes through the fuel return line filter, and is returned to the fuel tank through a fuel return line. A pressure of 30 to 60 P.S.I. is maintained within the torque converter and the low pressure fuel system by a restricting plug located in the fuel return line filter assembly. On tractors without a torque converter, the excess fuel delivered to the fuel sump of the fuel injection pump, by the fuel transfer pump, is returned to the fuel tank through the fuel return line. A pressure of 30 to 60 P.S.I. is maintained within the low pressure fuel system by a restricted tee fitting in the fuel return line.

On tractors Serial No. 4001 and above, fuel is drawn from the fuel tank, through the first stage fuel filter, by the fuel transfer pump. The fuel is then forced, by the transfer pump, through the second stage fuel filter and through a drilled passage in the filter head. A .058" to .062" restricted fitting in the front of the drilled passage in the filter head allows a pre-determined amount of fuel to be supplied to the fuel sump of the fuel injection pump. On tractors with a torque converter, the remaining amount of fuel from the drilled passage in the filter head passes through a fitting in the rear of the fuel filter head and through the torque converter fluid hose to the torque converter. The fuel delivered to the torque converter is circulated through the torque converter and the torque converter fluid heat exchanger, passes through the fuel return line filter and is returned to the fuel tank through the fuel return line. A pressure of 30 to 60 P.S.I. is maintained in the torque converter fluid system by a .058" to .062" restricting plug located in the fuel return line filter assembly. On tractors without a torque converter the fuel outlet at the rear of the filter head, for the torque converter fluid supply

hose, is plugged with a 3/8" N.P.T. pipe plug. More fuel is supplied to the fuel sump of the fuel injection pump than is needed for engine operation; the excess fuel passes through a .068" to .072" restricted fitting in the upper rear of the injection pump and returns to the top of the fuel filter head and through the fuel return line to the fuel tank. The restricted fitting, located in the upper rear of the fuel injection pump, maintains a pressure of approximately 15 to 20 P.S.I. in the fuel sump of the injection pump.

The high pressure fuel system consists of the fuel injection pump, fuel injection nozzles (one for each cylinder), and all the fuel injection lines connecting the fuel injection pump to the fuel injection nozzles. The fuel supplied to the fuel sump of the fuel injection pump is metered and forced under high pressure by the fuel injection pump through the fuel injection lines to the fuel injection nozzles, from which the fuel enters into the engine combustion chambers.

There is a certain amount of fuel seepage between the lapped surfaces of each fuel injection nozzle valve and its body, which is necessary for lubrication. This leakage of fuel accumulates around the spindle and in the spring compartment of each fuel injection nozzle. On tractors prior to Serial No. 4001, this accumulated fuel passes through a fuel return manifold and is returned to the fuel tank through the fuel return line. On tractors Serial No. 4001 and above, this accumulated fuel passes through a fuel return manifold, located in each valve rocker arm housing. A fuel return line assembly, connecting the two fuel return manifolds, returns the fuel to the front of the fuel filter head. Fuel returned to the filter head from the fuel return manifolds and the fuel injection pump passes through a drilled passage in the filter head and is returned to the fuel tank through the fuel return line.

All engines are equipped with an "American Bosch" (Model APE 6BB) multiple-plunger, constant stroke, cam actuated type, heavy-duty fuel injection pump. On tractors prior to Serial No. 4001, the pump is equipped with 11 mm. plungers and is timed for port opening, 16° B.T.D.C. (end of fuel injection into cylinders). On tractors Serial No. 4001 and above the pump is equipped with 10 mm. plungers and is timed for port closing, 28° B.T.D.C. on tractors with a torque converter and 24° B.T.D.C. on tractors without a torque converter (start of fuel injection into cylinders). The purpose of the fuel injection pump is to meter the fuel accurately and deliver it precisely at a definite moment in the engine cycle, and under high pressure, to the fuel injection nozzles. The fuel injection pump is controlled by a mechanical-centrifugal type (type "GVB") governor.

The function of the fuel injection nozzles is to direct the metered quantity of fuel, received from the fuel injection pump, into the engine combustion chambers in a definite spray pattern and in such a manner as to produce the most efficient engine performance. The valve of each fuel injection nozzle is operated hydraulically by the pressure of the fuel delivered by the fuel injection pump.

2. CHECKING OF FUEL SYSTEM

A. General

Insufficient supply of fuel to the engine is indicated by "missing" or uneven running of the engine, excessive vibration, stalling when idling, or loss of power. Before performing any of the following checks, be sure there is an ample supply of fuel in the fuel tank and the fuel tank shut-off valve is in the open position. Open the drain cocks in the first and second stage fuel filter shells and allow any water or sediment to drain; close the filter drain cocks as soon as clean fuel runs out.

B. Check for Admission of Air Into Fuel System

Remove the vent screw located in the top of the second stage fuel filter retaining nut. Crank the engine with the starter and observe the fuel emerging from the vent screw opening. Fuel containing bubbles, flowing from the vent screw opening, indicates that air is being drawn into the system on the suction side of the fuel transfer pump. Correct this condition by tightening any loose low pressure fuel line connections, filter connections, and filter shell retaining nuts. Also, check for any damaged fuel lines. After correcting the above condition, vent the fuel injection pump (refer to Paragraph C below).

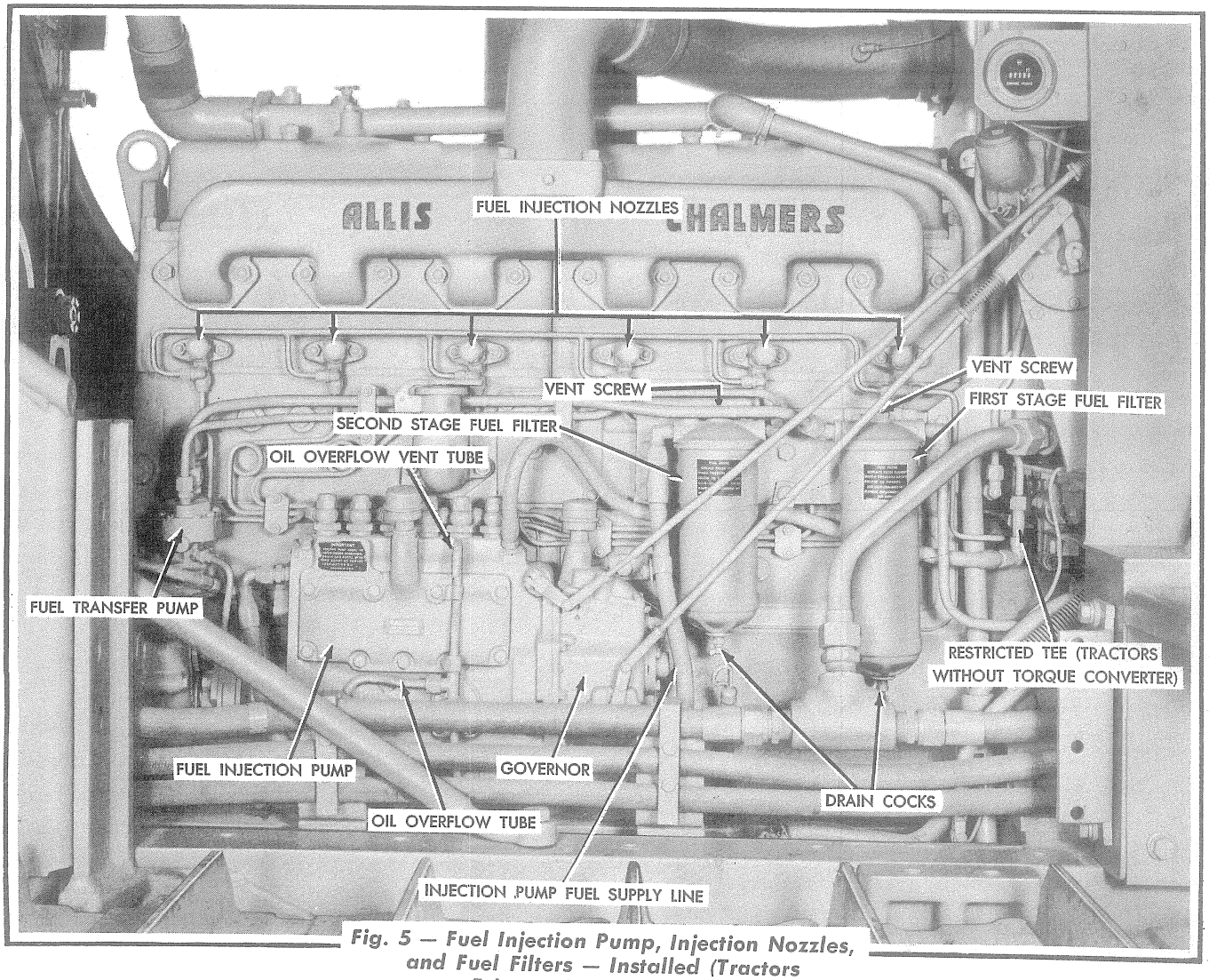

Fig. 5 — Fuel Injection Pump, Injection Nozzles, and Fuel Filters — Installed (Tractors Prior to Serial No. 4001)

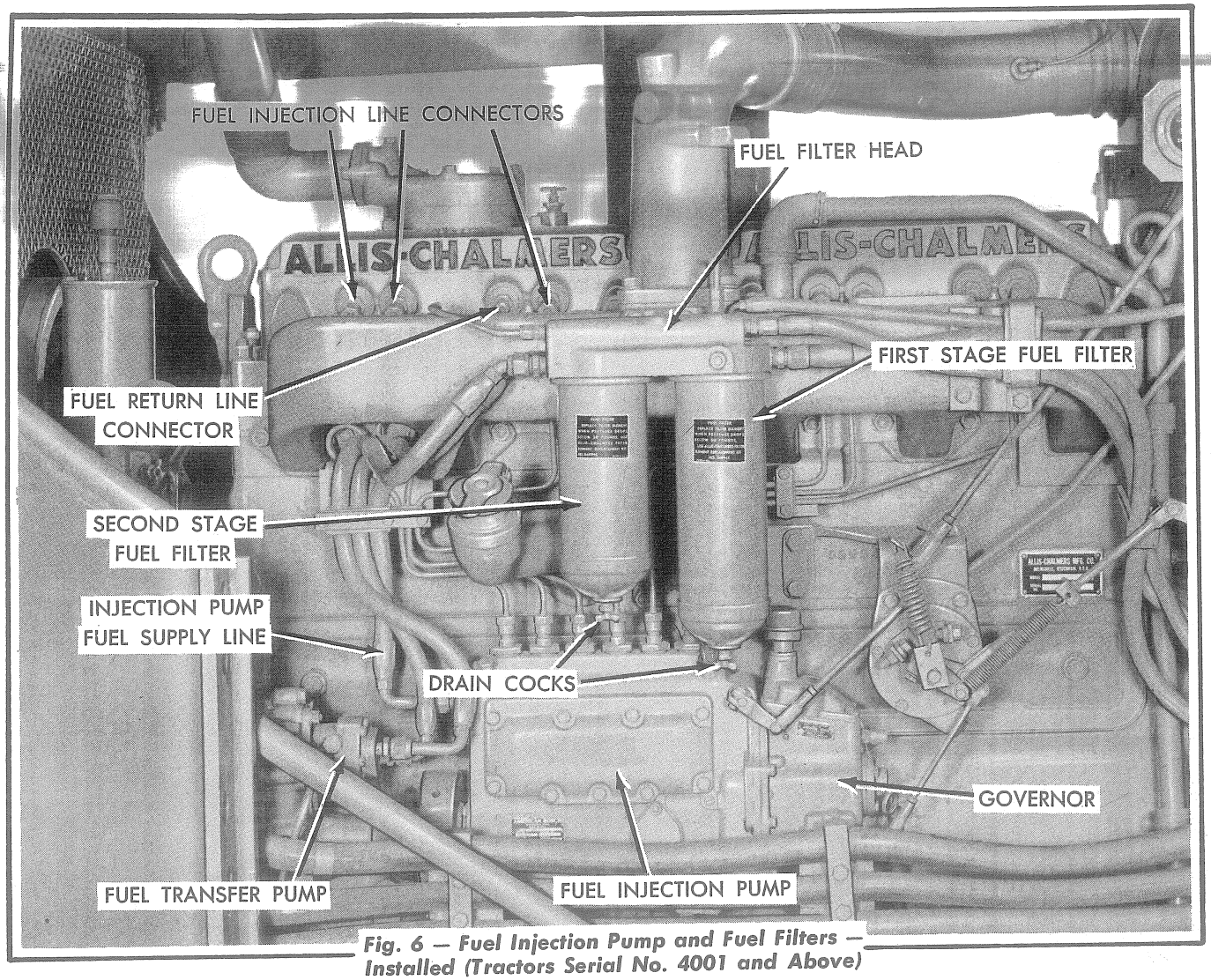

Fig. 6 — Fuel Injection Pump and Fuel Filters — Installed (Tractors Serial No. 4001 and Above)

C. Check for Clogged Fuel Filters and Clogged or Collapsed Fuel Lines

Remove the vent screw from the top of the second stage fuel filter retaining nut and crank the engine with the starter. If a full flow of fuel is not obtained from the vent screw opening, a clogged first stage filter element, or a clogged or collapsed fuel line is indicated. If this condition exists, remove and replace the first stage fuel filter elements or clean or replace the clogged or damaged fuel line. If a full flow of fuel was obtained through the vent screw opening in the second stage fuel filter, install and tighten the vent screw.

On tractors prior to Serial No. 4001, disconnect the fuel line from the upper rear of the fuel injection pump. Crank the engine with the starter and check for a full flow of fuel from the fuel injection pump: If a full flow of fuel is not obtained from the fuel injection pump, a clogged second stage fuel filter is indicated. If this condition exists, remove and replace the second stage fuel filter element. Connect the fuel line to the upper rear of the fuel injection pump.

On tractors Serial No. 4001 and above, with a torque converter, disconnect the torque converter fluid supply line (Fig. 7) from the rear of the fuel filter head. On tractors Serial No. 4001 and above, without a torque converter, remove the $\frac{3}{8}$" N.P.T. pipe plug from the rear of the fuel filter head. Crank the engine with the starter and check for a full flow of fuel from the rear of the filter head. If a full flow of fuel is not obtained, a clogged second stage fuel filter is indicated. If this condition exists, remove and replace the second stage fuel filter element. Connect the torque converter fluid supply line or, on tractors without a torque converter, install the $\frac{3}{8}$" N.P.T. pipe plug in the rear of the fuel filter head.

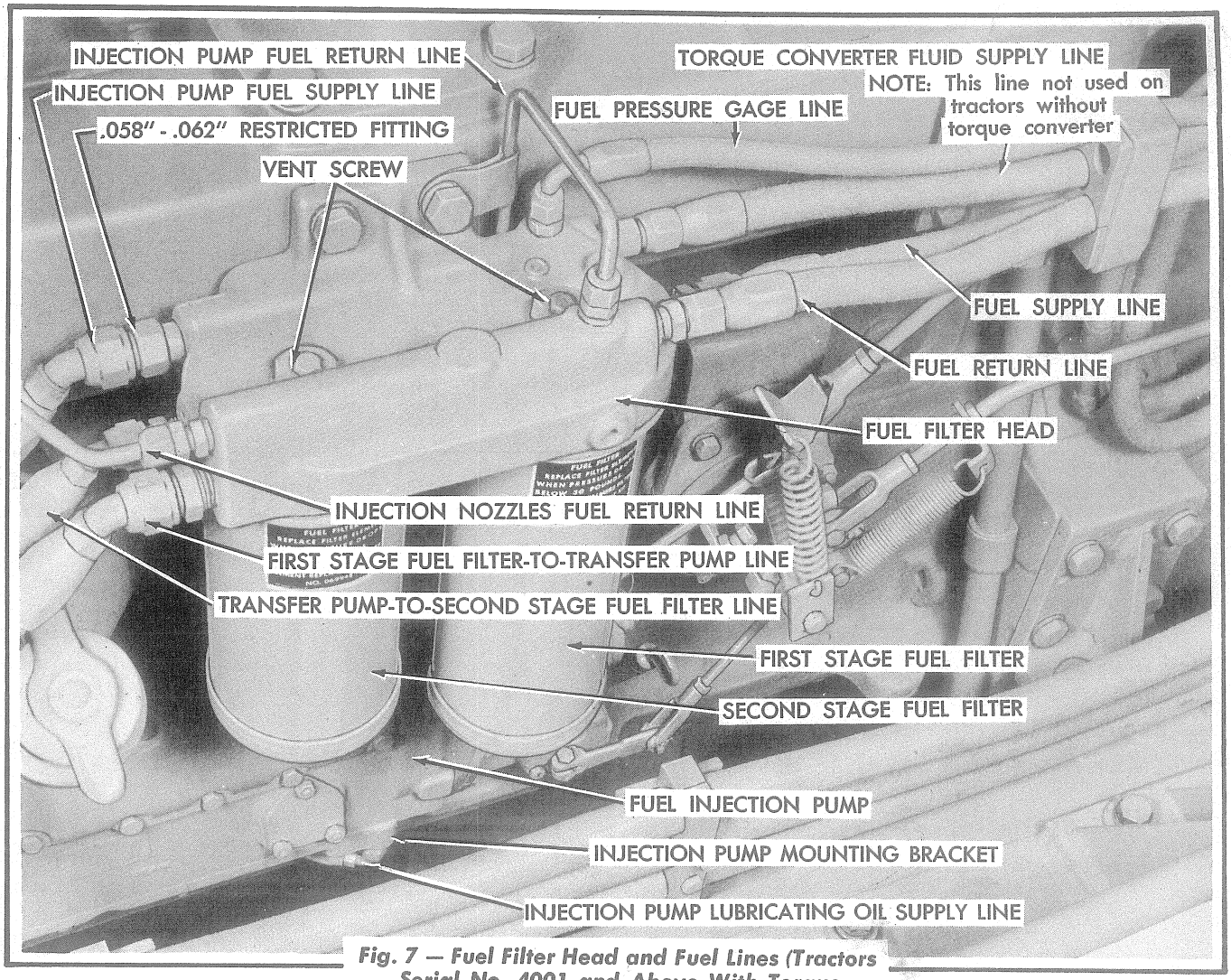

Fig. 7 — Fuel Filter Head and Fuel Lines (Tractors Serial No. 4001 and Above With Torque Converter Shown — Tractors Without Torque Converter Similar)

D. Check for Malfunctioning of Fuel Transfer Pump

Start the engine and operate at approximately one-half throttle. Observe the fuel pressure gage located in the instrument panel. The gage should indicate a pressure of 30 to 60 P.S.I. If the gage indicates a pressure below 30 P.S.I., stop the engine and disconnect the fuel return line at the fuel tank. Start the engine and operate at approximately one-half throttle. A full stream of fuel should flow from the end of the fuel return line. If the gage indicates a pressure below 30 P.S.I., and little or no fuel is observed from the end of the fuel return line, a malfunctioning fuel transfer pump is indicated and the pump must be removed, inspected, and repaired or replaced.

E. Excessively High Fuel Pressure

On tractors prior to Serial No. 4001, without a torque converter, the restricted tee fitting in the fuel return line (Fig. 5) should be removed periodically and cleaned. Clogging of the restricted tee fitting will be indicated by excessively high fuel pressure. Do not enlarge the hole in the restricted fitting when cleaning.

On tractors Serial No. 4001 and above, without a torque converter, the .058" — .062" restricted fitting in the front of the filter head (Fig. 7) should be removed periodically and cleaned. Clogging of the restricted fitting will be indicated by excessively high fuel pressure. Do not enlarge the hole in the restricted fitting when cleaning. Install the fitting

in the front of the fuel filter head and connect the injection pump fuel supply line.

On tractors with a torque converter, the fuel return line filter assembly (Fig. 8) secured to a mounting bracket located at the rear of the fluid heat exchanger should be removed periodically, disassembled, and cleaned. Clogging of the filter and restricting plug will be indicated by excessively high fuel pressure, air in the system causing "sluggishness" of the torque converter, and uneven running of the engine. When cleaning the filter assembly, do not enlarge the hole in the restricting plug. The specified diameter of the orifice in the plug is .058" — .062".

A pressure relief valve is installed in the body of the fuel transfer pump to prevent high fuel pressure. If this relief valve sticks, excessively high fuel pressure will develop and will be indicated by the fuel pressure gage. When this occurs, the pressure relief valve should be removed, inspected, and the reason for its sticking eliminated.

F. Check for Malfunctioning Fuel Injection Nozzles

"Missing" or uneven running of the engine and loss of power are an indication of malfunctioning fuel injection nozzle or nozzles.

On tractors prior to Serial No. 4001, locate the malfunctioning fuel injection nozzle or nozzles as follows: Run the engine at low idle speed and "cut-out" each fuel injection nozzle in turn by loosening the fuel injection line nut attaching the fuel injection line to its corresponding fuel injection nozzle. CAUTION: *Keep hands away from loosened nuts while performing this test.* A decrease in engine speed with the line nut loosened indicates that the nozzle for that cylinder is functioning properly. If the engine speed does not decrease, the nozzle is malfunctioning. The malfunctioning nozzle should be removed for testing, adjustment, and repair.

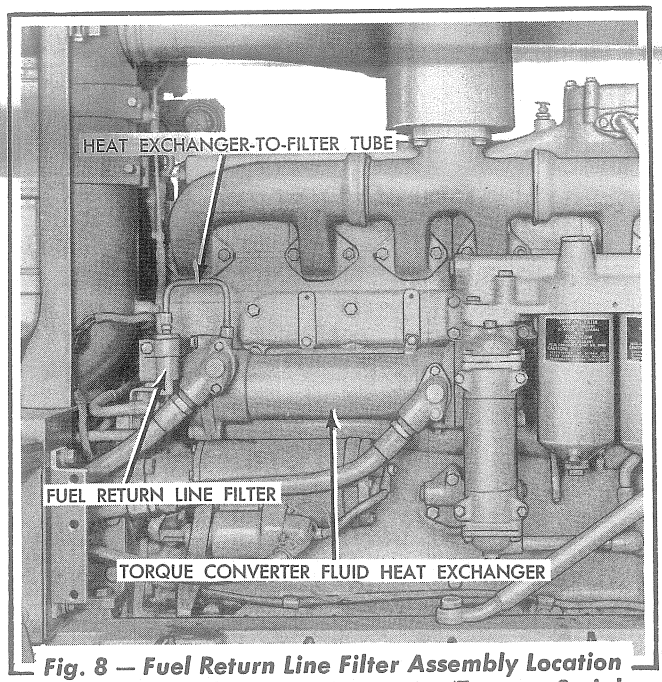

Fig. 8 — Fuel Return Line Filter Assembly Location — Tractors with Torque Converter (Tractors Serial No. 4001 and Above Shown — Tractors Prior to Serial No. 4001 Similar)

On tractors Serial No. 4001 and above, the malfunctioning fuel injection nozzle may be located in the same manner as described above, however, each fuel injection nozzle is "cut-out" in turn by loosening the fuel injection line nut attaching the fuel injection line to the fuel injection pump.

G. Check for Inoperative Fuel Injection Pump

If all the possible causes for insufficient fuel supply have been eliminated, and the engine still runs unevenly and normal engine performance is not obtained, the fuel injection pump will be considered at fault and should be replaced. The "faulty" fuel injection pump (with governor) should be taken to your nearest "Allis-Chalmers" Construction Machinery Dealer for repairs and testing. IMPORTANT: *Do not replace the fuel injection pump before making certain that all other possible causes for improper engine operation have been eliminated.*

3. FUEL TANK AND FUEL FILTERS

A. Fuel Tank and Drain Elbow

A drain elbow, located at the bottom of the fuel tank, provides a means for draining the tank when flushing and also acts as a sediment sump. Open the drain cock in this elbow before the engine is started at the beginning of the day's operation in warm weather, or shortly after the end of the day's operation in freezing weather, and allow any water and sediment to drain; close the drain cock when clean fuel runs out. Drain and flush the fuel tank when a large accumulation of rust and scale is evident. To drain the fuel tank, remove the plug from the drain elbow.

B. Fuel Tank Removal and Installation

1. Removal

a. Remove the nuts and plain washers securing the back cushions to the fuel tank and remove the back cushions.

b. Remove the cable clips securing the battery connecting cable to the fuel tank.

c. Close the fuel tank shut-off valve located at the lower front side of the fuel tank. Disconnect the fuel supply line from the fuel tank shut-off valve and disconnect the fuel return line from the fuel tank. Protect all openings of the fuel tank and the disconnected fuel lines against entrance of dirt.

d. Remove the capscrews, lockwashers, and nuts securing the fuel tank to the front and rear tank supporting channels.

e. Using suitable lifting facilities, remove the fuel tank from the tractor. When lowering the tank to the ground, place wooden blocks under each side of the fuel tank to protect the fuel shut-off valve and drain cock.

2. Installation

Install the fuel tank by a direct reversal of the removal procedure, making certain that the tank mounting pads are properly positioned between the bottom of the tank and the tank supporting channels.

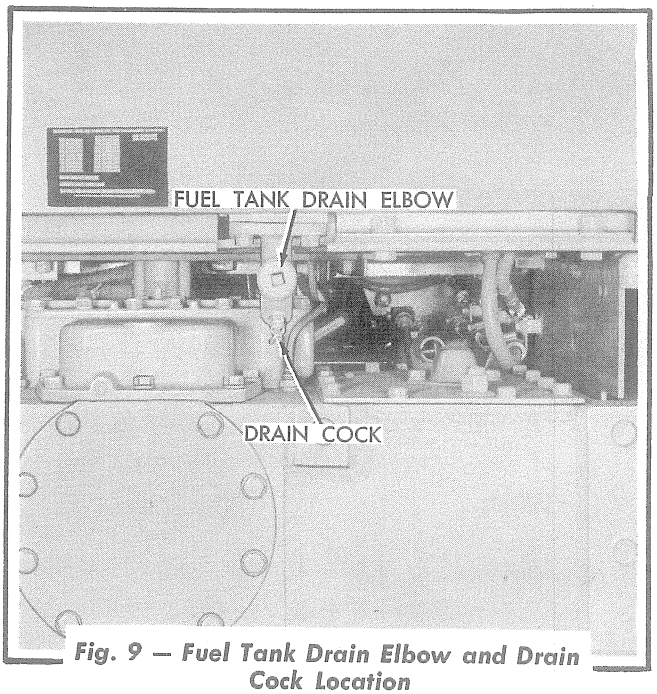

Fig. 9 — Fuel Tank Drain Elbow and Drain Cock Location

C. First Stage and Second Stage Fuel Filters

1. Description

The first stage and the second stage fuel filters (Fig. 5 or 6) each contain a replacement type element. Dirt and sediment is collected by the first stage fuel filter and prevented from entering the fuel transfer pump. Any dirt or sediment passing through the first stage fuel filter and the fuel transfer pump is collected by the second stage fuel filter and prevented from entering the fuel injection pump. A drain cock is provided in the bottom of each fuel filter shell for draining any water or sediment collected.

2. Service

Open the drain cock in the bottom of each fuel filter shell daily, before the start of the day's operation in warm weather or shortly after the end of the day's operation in freezing weather, and allow any water or sediment to drain. Close the drain cocks as soon as clean fuel runs out. Remove and discard the filter element in each filter and

install new elements after every 300 to 500 hours of operation (more often if conditions warrant), or when the fuel filters become clogged and a pressure of less than 30 pounds is indicated by the fuel pressure gage. Clogged filter elements are usually indicated by irregular engine performance.

3. To Replace First Stage Fuel Filter Element (Figs. 10 and 11).

a. Close the fuel tank shut-off valve. Clean all dirt from around the filter head and shell. Loosen the vent screw in the top of the filter and the drain cock in the bottom of the filter shell and allow the filter to drain.

b. Loosen the hex-retaining nut in the filter head until it is free from the shell center-bolt and remove the filter shell from the filter head.

c. Discard the old filter element and shell gasket. Thoroughly wash and dry the interior of the filter shell.

d. Install a new filter element (from the element replacement kit) and push it down firmly so that the up-turned edge of the seat plate, attached to the bottom of the shell center-bolt, is firmly impressed into the bottom of the filter element.

e. Install a new shell gasket (from the element replacement kit) in position in the lip of the shell. Hold the filter shell in position under the filter head and engage the threads of the hex-retaining nut with the shell center-bolt and tighten the hex-retaining nut securely. Close the filter drain cock.

f. Fill the fuel tank so that the fuel level is high enough to fill the fuel filter by gravity. Open the fuel tank shut-off valve and allow the filter to fill with fuel. Tighten the filter vent screw when fuel flows from around the loosened vent screw.

4. To Replace Second Stage Fuel Filter Element

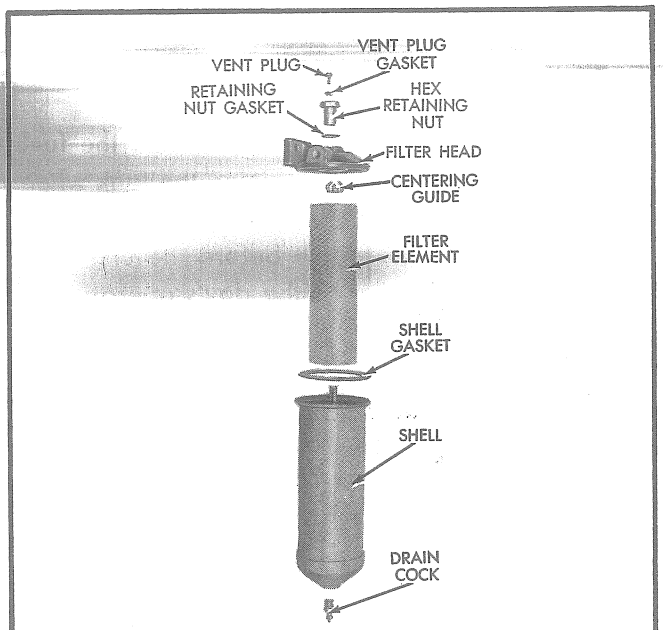

Fig. 10 — First Stage Fuel Filter Details (Tractors Prior to Serial No. 4001)

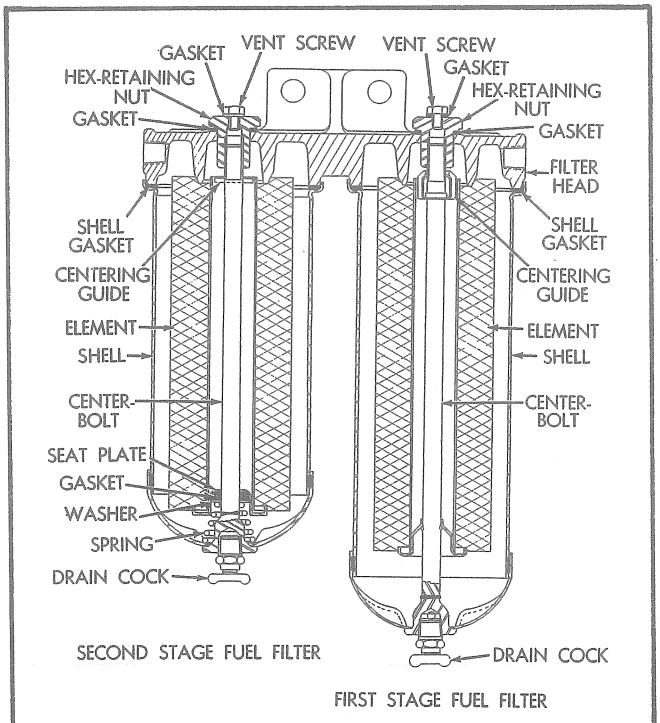

Fig. 11 — First and Second Stage Fuel Filter Details (Tractors Serial No. 4001 and Above)

a. Clean all dirt from around the filter head and shell. Loosen the vent screw in the top of the filter and the drain cock in the bottom of the filter and allow the filter to drain.

b. Loosen the hex-retaining nut in the filter head until it is free from the shell center-bolt and remove the filter shell from the filter head.

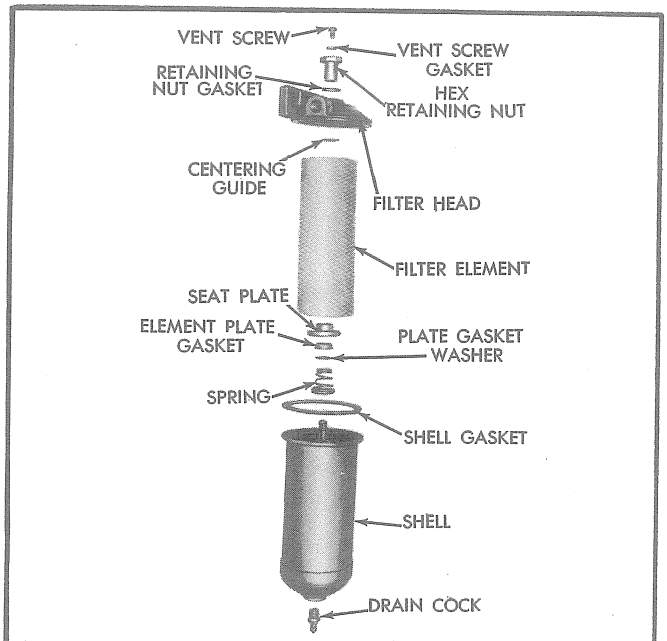

Fig. 12 — Second Stage Fuel Filter Details (Tractors Prior to Serial No. 4001)

c. Discard the filter element, shell gasket, element plate gasket, and the washer. Remove and save the centering guide, spring, and the seat plate.

d. Thoroughly clean the inside of the shell assembly, spring, centering guide, and the seat plate.

e. Install the spring and plate gasket washer in position on the center-bolt, pushing them down firmly until seated. Install a new element plate gasket (furnished with the element replacement kit) and push it down over the center-bolt until it contacts the washer. Be sure that the chamfered side of this gasket is toward the top of the filter. Place the seat plate in position on the center-bolt and push it down until the gasket and the washer are up inside the recess in the seat plate. Screw the centering guide back in position on the top of the center-bolt.

f. Install the new filter element (from the element replacement kit) and push it down firmly so that the upturned edge of the seat plate, located at the bottom of the center-bolt of the shell assembly, is firmly impressed into the bottom of the filter element.

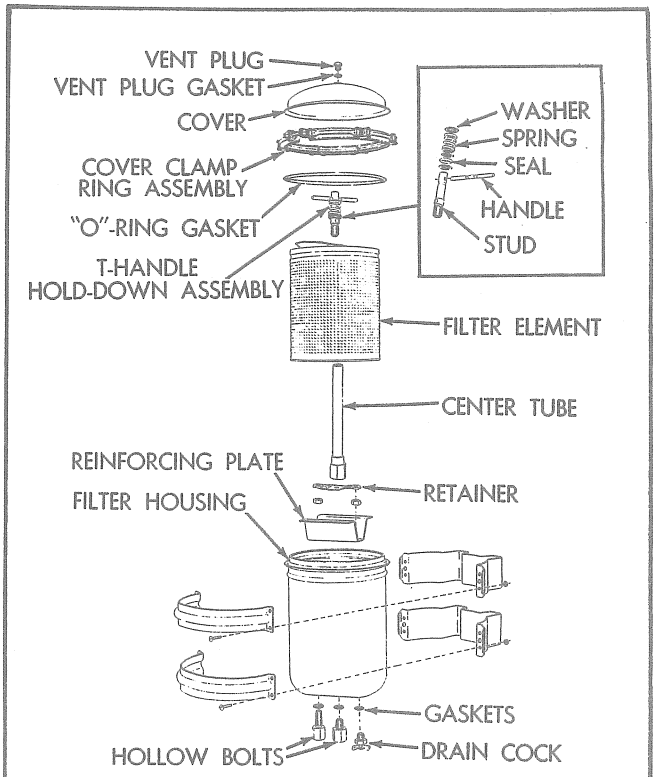

Fig. 13 — Heavy-Duty Fuel Filter Details

g. Close the filter drain cock and place a new shell gasket in position in the lip of the shell. Fill the shell with CLEAN fuel and hold the shell assembly up in position against the filter head. Engage the threads of the hex-retaining nut with the center-bolt and tighten the nut securely.

h. Crank the engine with the starter until fuel flows from around the loosened filter vent screw, then tighten the filter vent screw. Start the engine and check for fuel leaks; correct any leaks found.

IMPORTANT: *Keep filter parts clean when changing the fuel filter elements. To assure maximum protection, replace the filter elements every 300 to 500 hours of operation, or more often if conditions warrant.*

D. Heavy-Duty Fuel Filter (Special Equipment)

On tractors equipped with a Heavy-Duty fuel filter, service as follows: Loosen the drain cock located in the bottom of the fuel filter housing, before the engine is started at the beginning of the day's operation in warm weather or shortly after the end of the day's operation in freezing weather, and allow the water or sediment to drain. Tighten the drain cock when clean fuel runs out. Remove and discard the old filter element and install a new one after every 300 to 500 hours of operation, or when the fuel pressure drops below 30 pounds per square inch with the engine running at high idle.

E. Replacement of Heavy-Duty Fuel Filter Element

1. Close the fuel tank shut-off valve.

2. Open the drain cock in the bottom of the fuel filter housing and allow the fuel to drain from the filter. Remove the cover clamp ring and lift the cover from the housing. Do not damage the cover "O"-ring gasket.

3. Unscrew the T-handle hold-down assembly from the shell center-tube and remove the T-handle hold-down assembly. Remove the filter element from the housing by lifting with the pull-out bail. Discard the filter element.

4. Thoroughly clean the interior of the fuel filter housing and close the drain cock.

5. To assure leak-proof sealing, examine the center-tube seat at each end of the new filter element to see that the seats are in good condition and clean. Insert the new filter element into position in the filter housing and press the filter element down firmly.

6. Install the T-handle hold-down assembly and tighten securely.

7. Install a cover "O"-ring gasket and place the cover in position on the filter housing. Install the cover clamp ring and tighten securely.

8. Fill the fuel tank so that there will be sufficient fuel in the tank to fill the fuel filter by gravity. Open the fuel tank shut-off valve.

9. Remove the vent plug from the filter cover and allow the filter to fill with fuel by gravity. Install and tighten the vent plug when fuel flows from the vent plug opening.

10. Observe for fuel leaks at the filter cover, vent plug, and the drain cock. Correct any leaks found.

CAUTION: *Use only a "DIESELPAK" filter element in the Heavy-Duty Filter.*

4. FUEL TRANSFER PUMP

A. Description

The engine is equipped with a positive displacement, gear-type fuel transfer pump mounted on the engine accessory drive housing cover as shown in Figs. 5 and 6. The fuel transfer pump, on tractors prior to Serial No. 4001, is driven at 2.25 times crankshaft speed from the upper end of the accessory drive transfer pump driving shaft by means of a coupling; the direction of rotation of the pump is clockwise when viewed from the drive end of the pump. The fuel transfer pump on tractors Serial No. 4001 and above, is driven at 2.0 times crankshaft speed from the accessory drive transfer pump driven gear assembly by means of a coupling fork; the direction of rotation of the pump is counterclockwise when viewed from the drive end of the pump.

The purpose of the fuel transfer pump is to supply fuel under low pressure to the fuel sump of the fuel injection pump, and on tractors with a torque converter, to the fluid system of the torque converter. Excess fuel supplied by the fuel transfer pump is returned to the fuel tank through the fuel return line.

The fuel transfer pump is provided with a spring loaded, plunger-type pressure relief valve (Fig. 14). The pressure relief valve by-passes fuel back to the inlet side of the pump when the outlet pressure exceeds 47 to 60 P.S.I. This valve normally does not open since its purpose is to relieve excessive pressure in case clogging occurs in the second stage fuel filter, fuel return lines, or on tractors with a torque converter, the fuel return line filter.

B. Removal of Fuel Transfer Pump

If it becomes necessary to repair or replace the fuel transfer pump it may be removed as follows:

1. Disconnect the fuel lines from the pump.
2. Remove the nuts and lockwashers attaching the pump to the accessory drive housing cover and remove the pump as an assembly.

C. Disassembly of Fuel Transfer Pump

The pressure relief valve assembly may be removed from the pump stator, without disassembly of the other parts of the pump, by removing the relief valve plug and jarring the valve parts from the stator.

If the relief valve only is to be inspected, no further disassembly is necessary. If the pump is to be disassembled proceed as follows:

1. Remove the fuel drain line from the pump. Remove the screws attaching the pump housing to the stator and install capscrews 1/4" NC x 3" long, so that the heads of the capscrews extend out from the pump housing.
2. Holding the pump assembly in the hand, tap the heads of the capscrews with a soft hammer, separating the stator and housing. CAUTION: *DO NOT PRY THE STATOR AND HOUSING APART.*
3. Remove the pump driven gear.
4. Remove the pump shaft and driving gear from the stator, using care to prevent damage to the pump shaft seals.
5. Remove the dowel pins from the pump housing if necessary.
6. If it is necessary to remove the shaft seals, drive or press the seals out of the stator.

D. Inspection of Fuel Transfer Pump Parts

1. Wash all the parts in clean fuel or solvent and inspect them carefully. New shaft seals should be installed when the pump is reassembled.
2. Inspect the pump gears. If the gears are slightly worn on the involute surfaces, they should be replaced. If the pump is operated until an appreciable amount of wear is noticeable, the delivery capacity of the pump will be affected. The shear pin holding the driving gear to the pump shaft must be tight. Replace any worn or damaged parts.

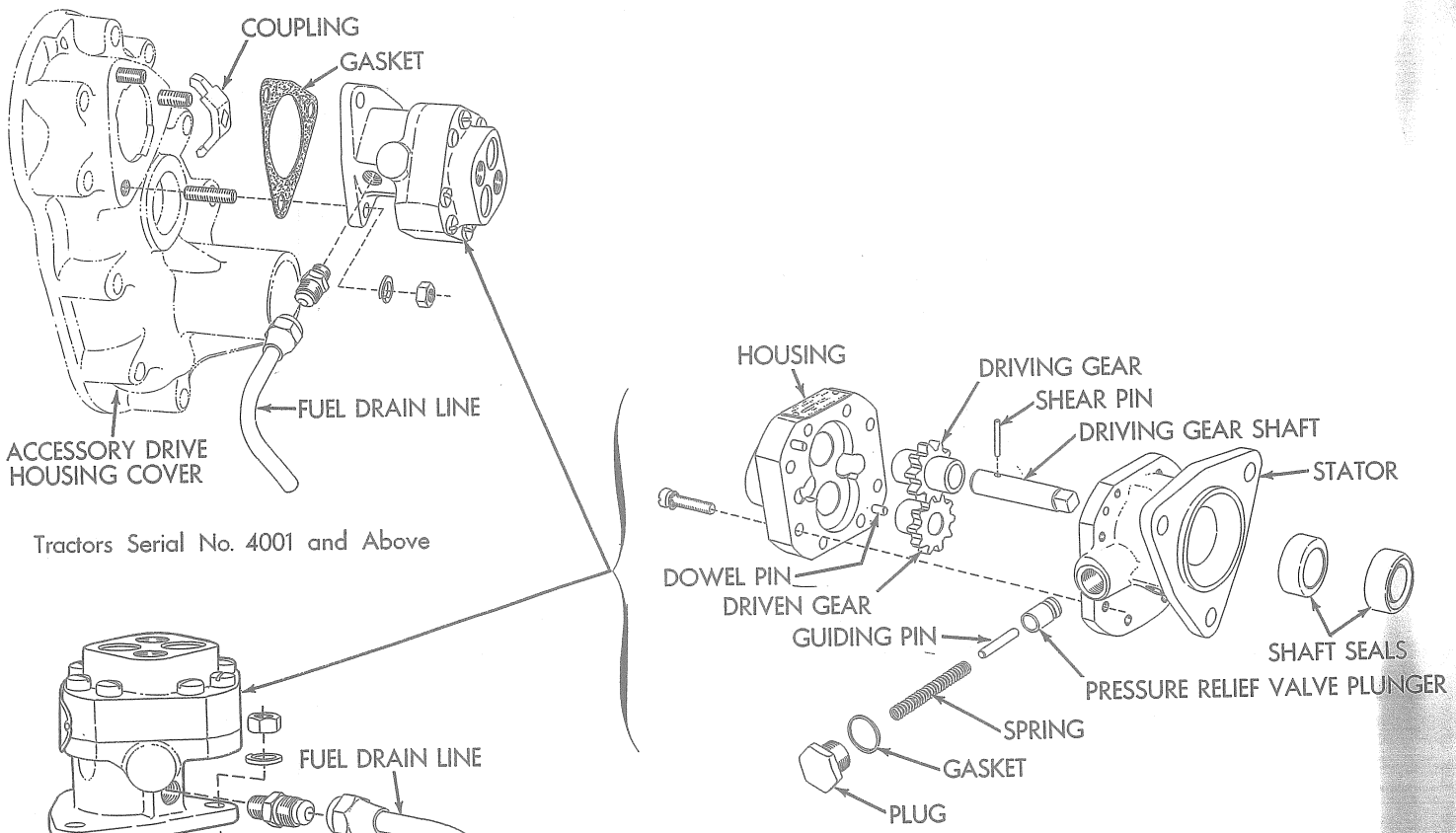

Fig. 14 — Fuel Transfer Pump Details

3. Check the fit of the gear hubs in the bores of the stator and housing. If the stator and housing are worn or scored, the entire pump must be replaced.

4. Inspect the surfaces inside the stator and housing contacted by the gear faces. If the surfaces show excessive wear or are scored, the entire pump must be replaced.

5. Check the pressure relief valve plunger. If the plunger does not form a tight seal on its seat in the stator, lap the plunger and seat using fine grain lapping compound. A piece of wood about the size of a pencil may be used as a holder for hand lapping. Use only a small amount of compound so that only the seat of the plunger and the seat in the stator is lapped. Thoroughly wash all the lapping compound and foreign material off the plunger and out of the stator after lapping. It is recommended that a new plunger spring be used when the valve is reassembled.

E. Assembly of Fuel Transfer Pump

1. Install a pump shaft seal in the stator, with the sealing lip of the seal directed toward the pump housing end of the stator. Install the other pump shaft seal in the stator with the sealing lip of the seal directed toward the mounting flange end of the stator.

2. Lubricate the pump driving gear shaft and seals and install the pump shaft (with driving gear pinned in place) in the stator. Push the shaft through the seals using care not to damage the sealing lips of the seals.

3. Install the driven gear in place in the housing. Lubricate the gears with light engine oil.

4. Coat the mating machined surfaces of the stator and the pump housing with a commercial non-hardening sealing compound. CAUTION: *Do not allow any sealing compound inside the pump*. Place the pump housing in position on the stator, turn the pump shaft to mesh the gear teeth, and push the parts together. Install the attaching screws with lockwashers and tighten securely.

5. Turn the pump shaft and test it for bind. The shaft should turn smoothly, with a slight drag, but should not bind or have tight spots.

6. Lubricate and install the pressure relief valve parts, making certain that the parts are installed in their proper sequence (Fig. 14). Install the fuel drain line.

F. Installation of Fuel Transfer Pump

Install the fuel transfer pump on the accessory drive housing cover by a direct reversal of the removal procedure, making certain that the gasket used between the transfer pump and the accessory drive housing cover is in good condition. Be sure the coupling used to couple the transfer pump driving gear shaft to the accessory drive is in good condition and properly installed (refer to Fig. 14).

5. FUEL INJECTION NOZZLES

A. General

Each cylinder of the engine is provided with a fuel injection nozzle of the closed, differential-needle, hydraulically-operated type. The function of each fuel injection nozzle is to direct the metered quantity of fuel, received from the fuel injection pump, into the corresponding combustion chamber of the engine in a highly atomized, pre-determined spray pattern and in such a manner as to produce the most efficient engine performance.

Pintle type spray nozzles are used on tractors prior to Serial No. 4001 and hole type spray nozzles having four equally spaced holes; .35 mm. in diameter, are used on tractors Serial No. 4001 and above.

Each fuel injection nozzle consists of two assemblies; the injection nozzle holder assembly and the injection nozzle assembly. The holder assembly is used to hold the injection nozzle in its correct position in the cylinder head and to provide a means of conducting fuel, received from the fuel injection pump, to the nozzle. The holder consists of a steel holder body, spindle, spindle spring and spring seat, spring retainer nut, pressure adjusting screw, nozzle protection cap, and a nozzle retaining nut. The nozzle consists of a nozzle valve and a valve body. The nozzle valve is operated hydraulically within the valve body by fuel delivered under pressure by the fuel injection pump.

B. Operation

The metered quantity of fuel under pressure, delivered by the fuel injection pump, enters the fuel inlet passage of the injection nozzle holder body, passes through the holder body fuel duct into the nozzle body fuel duct via the annular groove in the top of the nozzle body, and then into the pressure chamber above the nozzle valve seat. At the instant the pressure of the fuel in the pressure chamber exceeds the pressure exerted on the spindle and the nozzle valve by the spindle spring, the nozzle valve is lifted off its seat and the fuel is forced through the orifice(s) in the end of the valve body and into the corresponding combustion chamber of the engine. The nozzle valve is returned to its seat by the pressure exerted by the spindle spring, as soon as the fuel injection pump has ceased to deliver fuel to the nozzle.

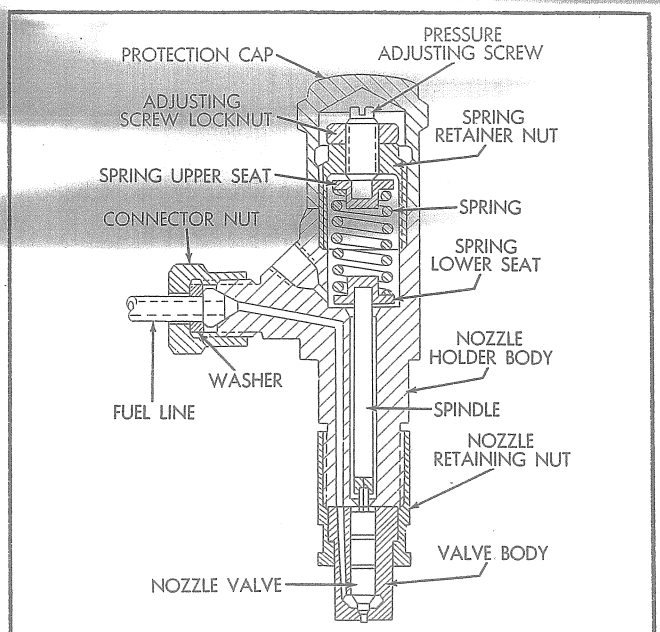

Fig. 15 — Fuel Injection Nozzle — Sectional View (Tractors Prior to Serial No. 4001)

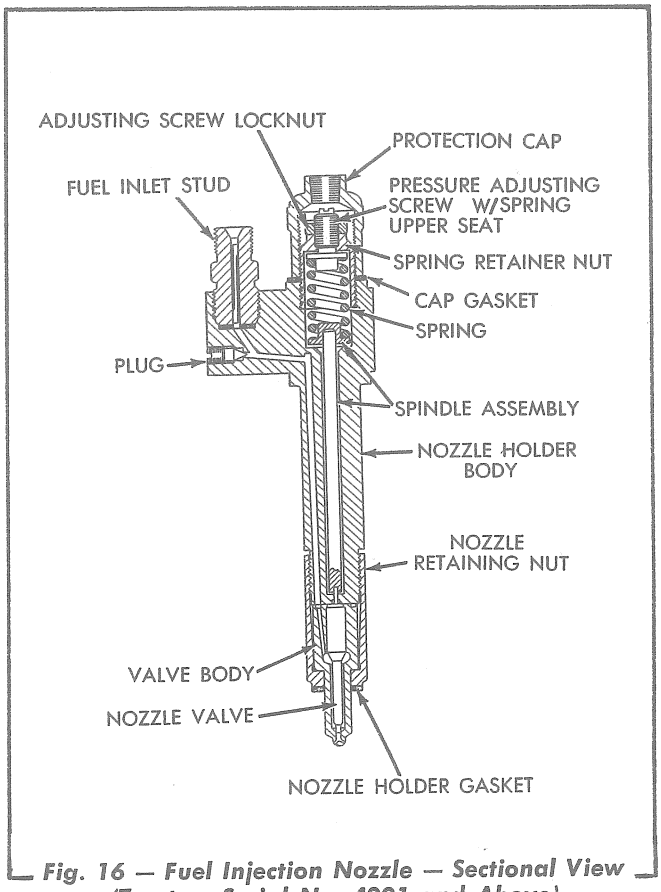

Fig. 16 — Fuel Injection Nozzle — Sectional View (Tractors Serial No. 4001 and Above)

There is a certain amount of fuel seepage between the lapped surfaces of each nozzle valve and valve body, which is necessary for lubrication. This leakage of fuel accumulates around the spindle and in the spring compartment of the fuel nozzle, and is returned through the fuel return manifold(s) to the fuel return line extending to the fuel tank.

C. Service

The fuel injection nozzles should be removed after approximately every 2000 hours of operation, tested and adjusted if necessary.

D. Removal of Fuel Injection Nozzles from Engine (Tractors Prior to Serial No. 4001)

1. Thoroughly clean the fuel injection nozzles and the surrounding area before removing the nozzles.

2. Disconnect the fuel return manifold and the fuel injection lines from the nozzles. CAUTION: *Do not bend the lines when disconnecting. Cover the ends of the disconnected lines to prevent the entrance of dirt.*

3. Remove the nozzle protection cap (Fig. 17) from the nozzle. Remove the nuts and lockwashers securing the nozzle to the cylinder head.

4. A nozzle puller adapter and slide hammer puller (similar to the ones shown in Fig. 17) are used to pull the fuel injection nozzles.

   a. Turn the nozzle puller adapter onto the fuel injection nozzle as shown. NOTE: *Make certain that the puller adapter is turned onto the nozzle as far as possible, then tighten with a wrench.*

   b. Turn the end of the slide hammer into the puller adapter as shown and tighten the jam nut. Before pulling the nozzle from the cylinder head, bump inward (lightly) on the nozzle with the slide hammer to loosen the nozzle, then pull the nozzle from the cylinder head. CAUTION: *Use care when removing a nozzle to prevent striking the nozzle tip against a hard object, which could result in damage to the tip.*

   c. Remove the slide hammer puller and nozzle puller adapter. Reinstall the nozzle protection cap in position on the nozzle.

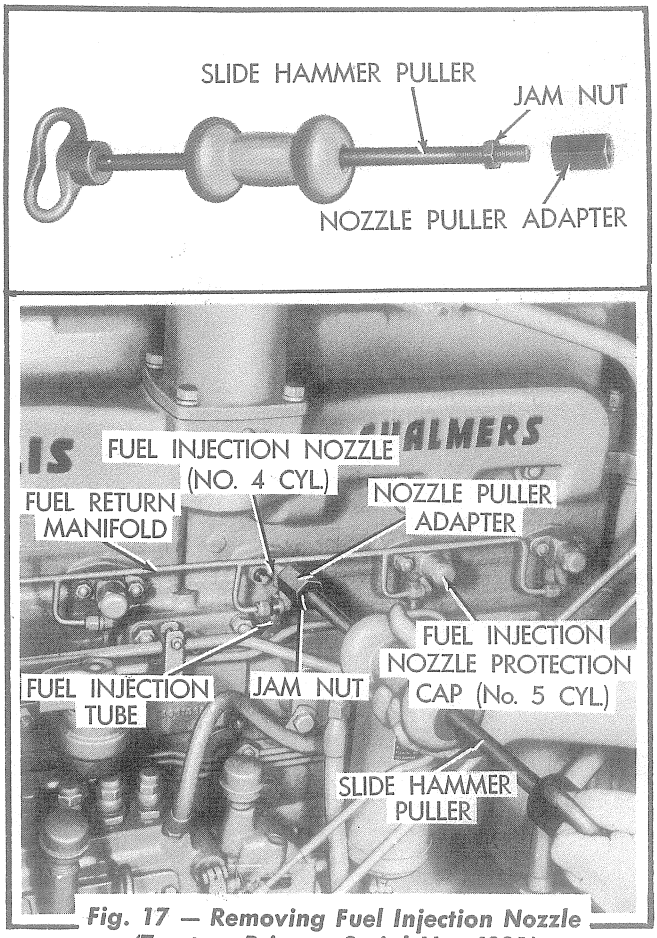

Fig. 17 — Removing Fuel Injection Nozzle (Tractors Prior to Serial No. 4001)

E. Removal of Fuel Injection Nozzles from Engine (Tractors Serial No. 4001 and Above)

1. Remove the engine hood. Thoroughly clean the valve rocker covers and the surrounding area.

2. Remove the valve rocker cover nuts, rocker cover nut sealing washers and the rocker covers.

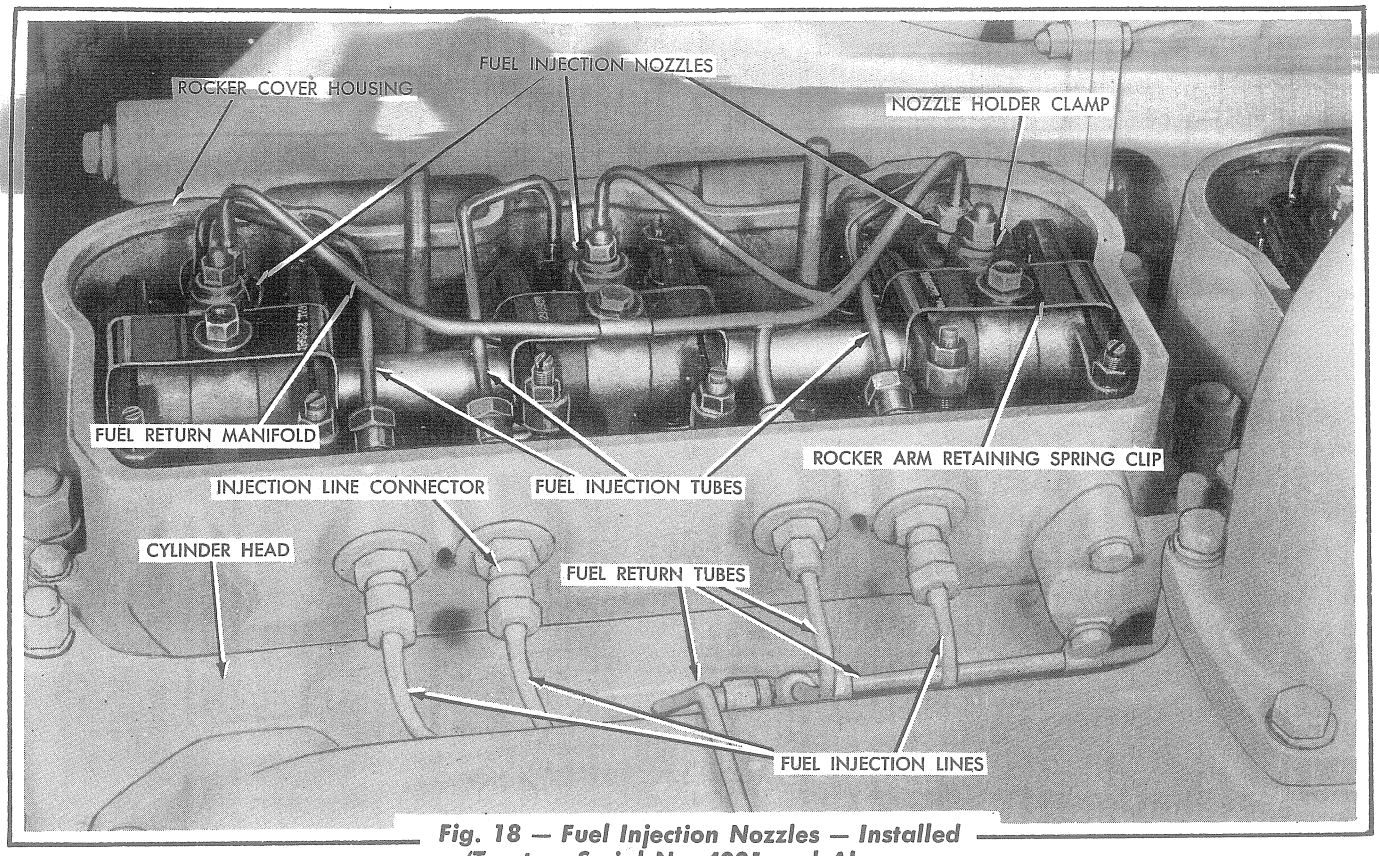

Fig. 18 — Fuel Injection Nozzles — Installed (Tractors Serial No. 4001 and Above — Front Cylinder Head Shown)

3. Disconnect and remove the fuel return manifolds. Using a fuel injection tube nut wrench, similar to the one shown in Fig. 19, loosen the injection tube nuts from the top of the fuel injection nozzles. Loosen the fuel injection tube nuts from the fuel injection line connectors, free the injection nozzle end of the tubes and remove the tubes from the engine. IMPORTANT: *Cover all fuel openings to prevent the entrance of dirt.*

4. Remove the nut and lockwasher securing the rocker arm retaining spring clips (Fig. 18) and remove the clips. Remove the nut and washer securing the nozzle holder clamps and remove the clamps. Using a large screwdriver, or a small pry bar as shown in Fig. 20, pry up on the nozzle protection cap and pull the nozzles from the cylinder heads. CAUTION: *Use care when removing an injection nozzle to prevent striking the nozzle tip.*

5. Cover the openings in the cylinder heads to prevent the entrance of dirt.

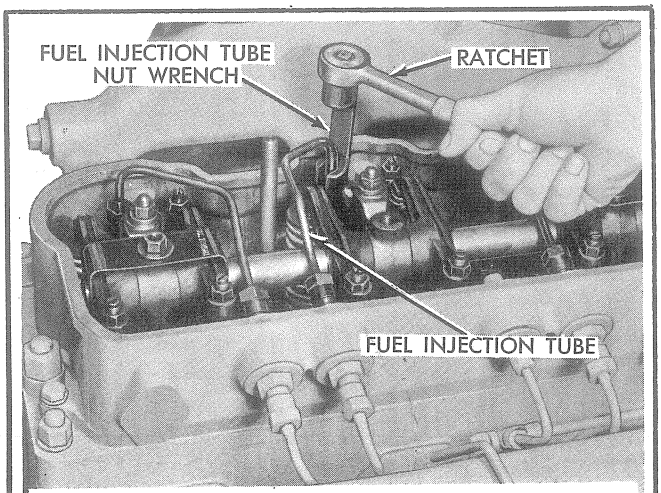

Fig. 19 — Removing Fuel Injection Tube (Tractors Serial No. 4001 and Above)

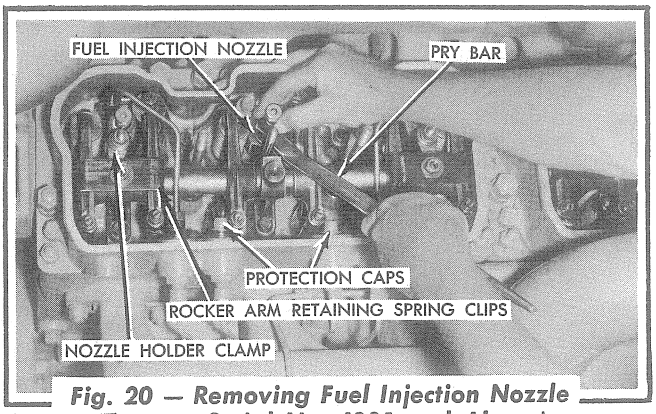

Fig. 20 — Removing Fuel Injection Nozzle (Tractors Serial No. 4001 and Above)

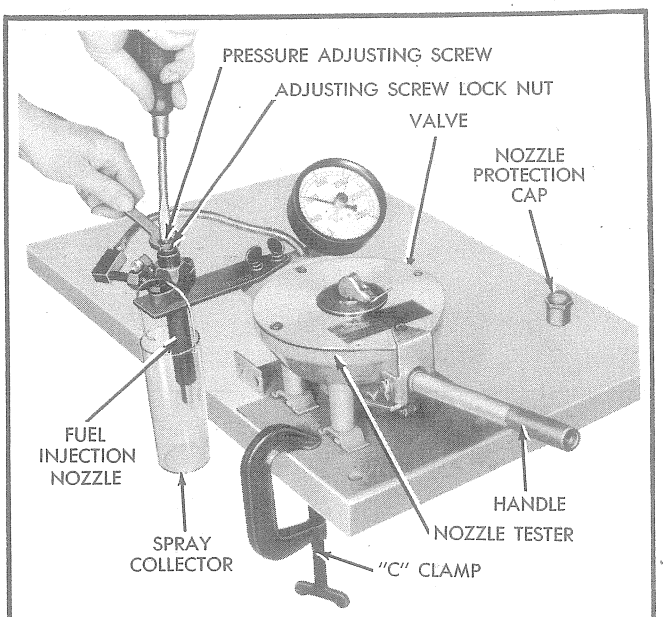

Fig. 21 — Adjusting "Popping" Pressure of Fuel Injection Nozzle (Tractors Prior to Serial No. 4001)

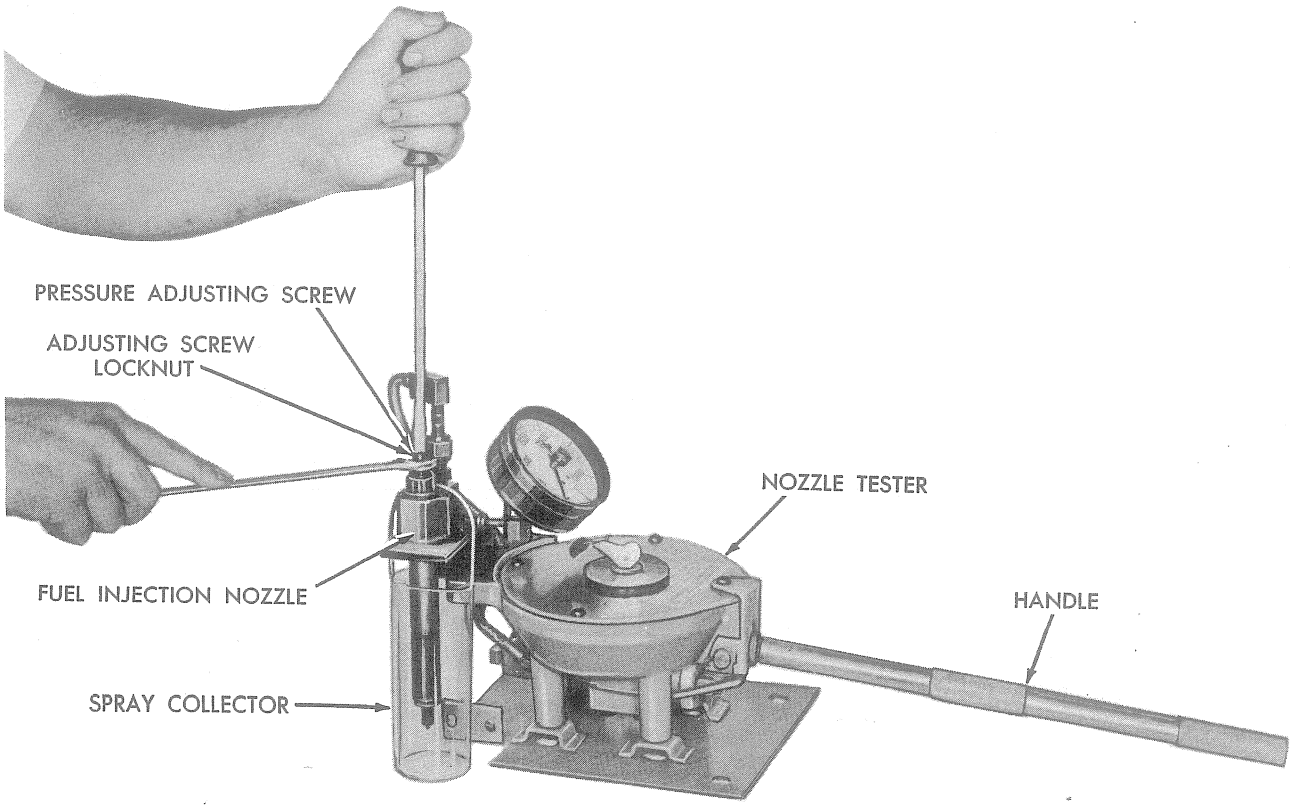

Fig. 22 — Adjusting "Popping" Pressure of Fuel Injection Nozzle (Tractors Serial No. 4001 and Above)

F. Testing and Adjusting Fuel Injection Nozzles

The procedure for testing and adjusting the fuel injection nozzles used in tractors prior to Serial No. 4001 and for those used in tractors Serial No. 4001 and above, is basically the same. To test and properly adjust the fuel injection nozzles, a special nozzle tester similar to the one shown in Figs. 21 and 22 is required. A tester nozzle holder is available for each type of nozzle.

CAUTION: *ALWAYS KEEP THE HANDS AWAY FROM THE NOZZLE TIP WHEN "POPPING" A NOZZLE, AS THE FINELY ATOMIZED FUEL FROM THE NOZZLE TIP IS EJECTED WITH SUCH FORCE THAT IT WILL PENETRATE THE SKIN AND MAY CAUSE BLOOD POISONING.*

Test and adjust each fuel injection nozzle as follows:

1. Bolt or clamp the base plate of the nozzle tester to a work bench.

2. Turn the valve handle of the nozzle tester to the open position. Loosen the tester filler cap to prevent an air lock in the tester. Operate the tester handle until fuel flows from the end of the tester fuel line, then close the tester valve.

3. Install and connect the fuel injection nozzle to the nozzle tester. Install the spray collector over the valve end of the nozzle.

4. Open the valve of the nozzle tester. Operate the tester handle a few quick strokes and observe the "popping" pressure of the fuel injection nozzle, indicated by the pressure gage of the nozzle tester. The specified "popping" pressure for the pintle type nozzles used in tractors prior to Serial No. 4001 is 2000 P.S.I. for a used nozzle and 2100 P.S.I. for a new nozzle, or a nozzle having a new spring. The specified "popping" pressure for the hole type nozzles used in tractors Serial No. 4001 and above is 2450 — 2550 P.S.I. and the minimum popping pressure is 2350 P.S.I.

   Adjust the fuel injection nozzle to obtain the specified "popping" pressure (if necessary) as follows:

   a. Remove the protection cap from the upper end of the fuel injection nozzle and loosen the adjusting screw lock nut.

   b. While operating the tester handle, turn the pressure adjusting screw IN to increase or OUT to decrease the "popping" pressure until the specified "popping" pressure is obtained. When the specified "popping" pressure is obtained, hold the adjusting screw from turning and tighten the adjusting screw lock nut.

5. Dry the tip of the fuel injection nozzle. Operate the tester handle slowly until the pressure is approximately 50 pounds below the popping pressure and observe the tip of the nozzle for fuel leakage. If the nozzle does not leak or dribble, the nozzle valve is seating properly on its seat in the valve body. If drops of fuel collect at a pressure less than 50 pounds below the popping pressure, the nozzle valve is not seating properly in the valve body; the valve body and valve must be removed for cleaning and inspection (refer to Paragraph H below).

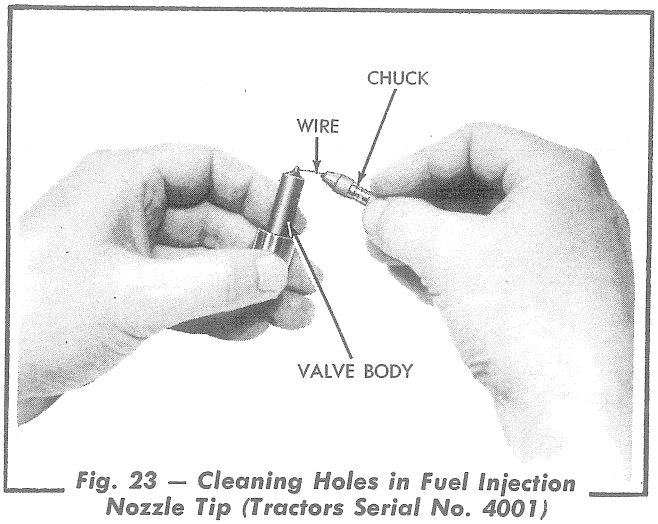

Fig. 23 — Cleaning Holes in Fuel Injection Nozzle Tip (Tractors Serial No. 4001)

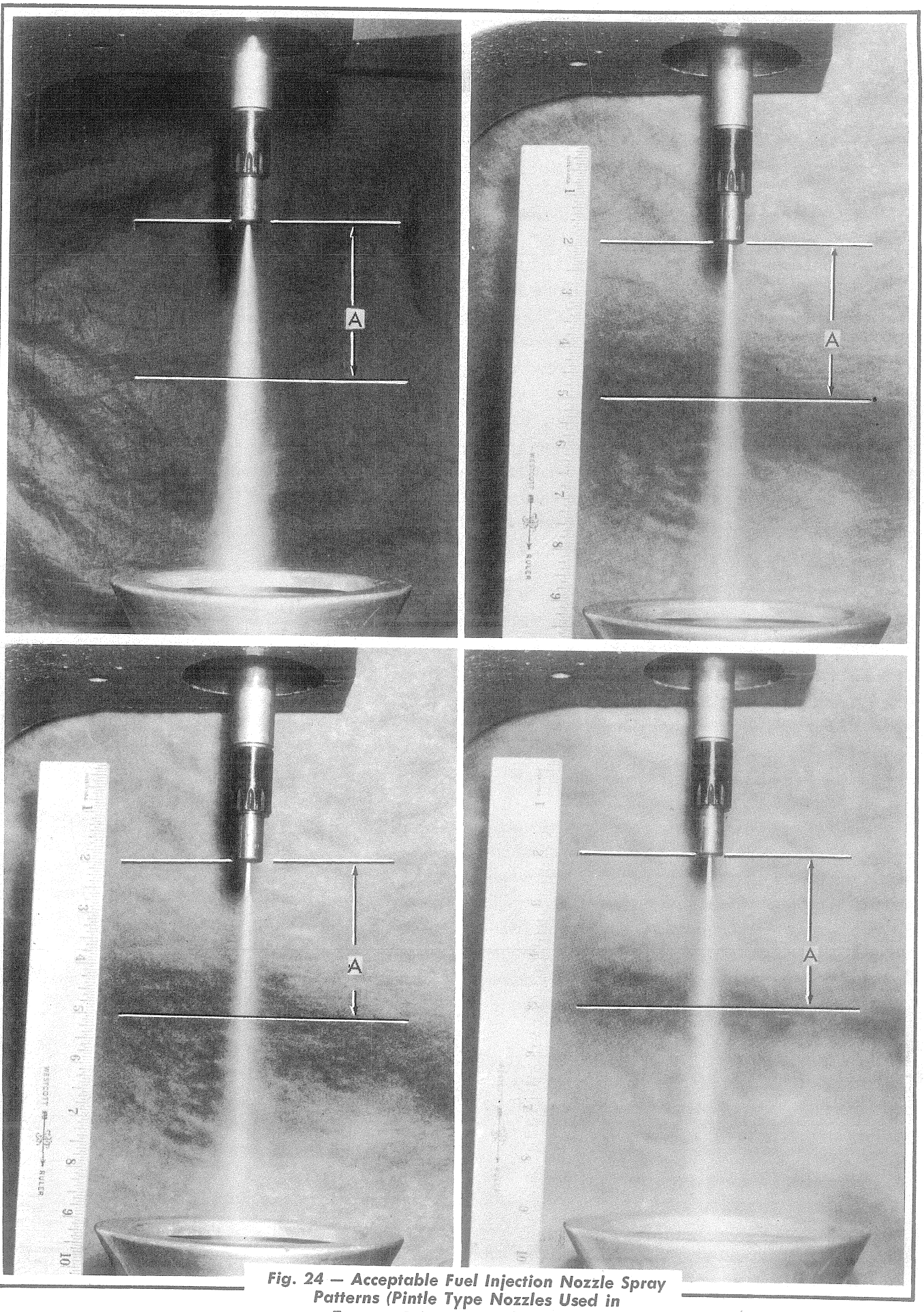

Fig. 24 — Acceptable Fuel Injection Nozzle Spray Patterns (Pintle Type Nozzles Used in Tractors Prior to Serial No. 4001)

6. If the fuel injection nozzle proved satisfactory when subjected to the fuel leakage test above, the spray pattern should be examined. Operate the tester handle at a speed of approximately 100 strokes per minute and observe the nozzle spray pattern (refer to Paragraph G below).

G. Fuel Injection Nozzle Spray Patterns

The fuel injection nozzles used in tractors Serial No. 4001 and above, are equipped with a hole type nozzle tip having four equally spaced .35 mm. holes. The size and spacing of the holes determines the spray pattern and if fuel is being discharged evenly through all four holes in the nozzle tip at the specified popping pressure, the spray pattern is considered satisfactory. If fuel is not being discharged evenly from all four holes in the nozzle tip, a plugged hole or holes is indicated, and the valve body and nozzle valve must be removed and the holes cleaned, using a .013" diameter wire as shown in Fig. 23.

The fuel injection nozzles used in tractors prior to Serial No. 4001, are equipped with a pintle type nozzle tip. Acceptable spray patterns for the pintle type tip may vary greatly in appearance as shown in the following illustrations. The results so far as engine life and performance are concerned are not affected by the various *acceptable* spray patterns.

In deciding whether a spray pattern is acceptable or whether the valve body and nozzle valve must be removed for cleaning and inspection, the spray pattern area only within approximately the first 3 inches from the tip should be considered; horizontal lines have been added to the illustrations to indicate this area as "A." The spray pattern beyond the first 3 inches is not important for any practical purposes.

The spray patterns shown in Fig. 24 are acceptable and considered very good. Nonacceptable spray patterns are shown in Fig. 25.

H. Cleaning and Inspection of Fuel Injection Nozzle

Before starting the disassembly of a fuel injection nozzle, it is of the utmost importance to have a clean work bench, clean washing fluid containers, clean tools, and clean hands. Cleanliness is emphasized because injection nozzle service troubles are, in most instances, due to dirt entering the nozzles. Use clean paper on the work bench and as the nozzle is disassembled, place the components in a container of clean diesel fuel as a protection against dirt and corrosion.

When more than one fuel injection nozzle is disassembled, keep the parts of each nozzle separate. Complete disassembly of the injection nozzle holder is seldom necessary. As the nozzle valve and the nozzle valve body are lapped together to become mated parts, they must be kept together; if replacement of either part is necessary, both parts must be replaced as matched sets.

1. Removal, Cleaning, and Installation of Fuel Injection Valve and Valve Body

In most cases where service to a fuel injection nozzle is necessary, only the disassembly and cleaning of the nozzle valve and valve body is required to place the nozzle in good operational condition. Remove, clean, and inspect the valve body and valve as follows:

a. Before disassembly, thoroughly wash the injection nozzle assembly to remove any loose dirt or carbon.

b. On nozzles used in tractors prior to Serial No. 4001, place the nozzle in position in an injection nozzle holding fixture, similar to the one shown in Fig. 29, then clamp the holding fixture in a vise. On nozzles used in tractors Serial No. 4001 and above, clamp the nozzle in a vise having copper jaws or similar protective material.

c. Remove the nozzle protection cap from the upper end of the nozzle. Loosen the adjusting screw lock nut and turn the adjusting screw out sufficiently to release the spring tension on the spindle spring.

d. Using a suitable socket or box wrench, loosen and remove the nozzle retaining nut. Remove the nozzle valve body and valve from the retaining nut. Start the nut

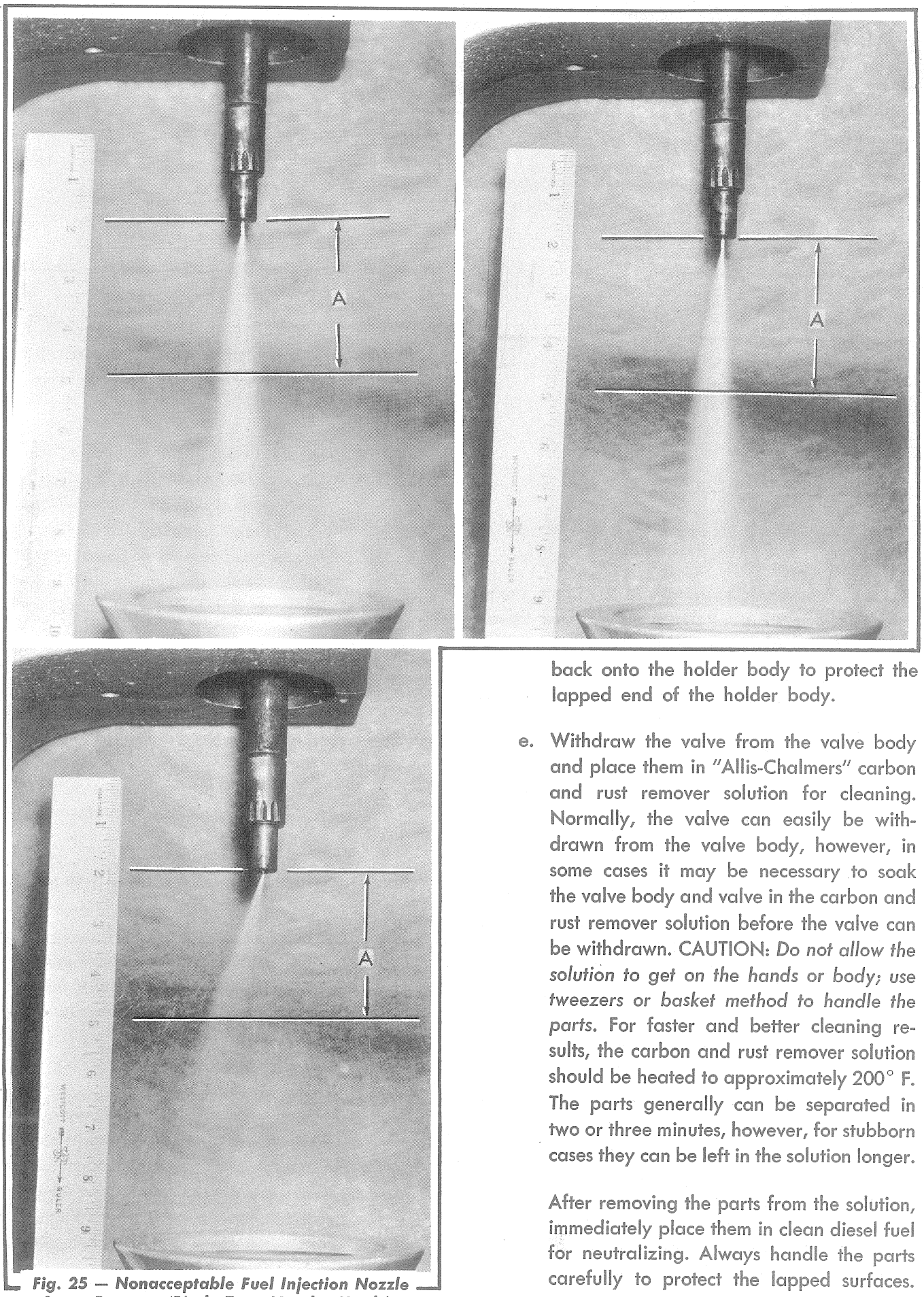

Fig. 25 — Nonacceptable Fuel Injection Nozzle Spray Patterns (Pintle Type Nozzles Used in Tractors Prior to Serial No. 4001)

back onto the holder body to protect the lapped end of the holder body.

e. Withdraw the valve from the valve body and place them in "Allis-Chalmers" carbon and rust remover solution for cleaning. Normally, the valve can easily be withdrawn from the valve body, however, in some cases it may be necessary to soak the valve body and valve in the carbon and rust remover solution before the valve can be withdrawn. CAUTION: *Do not allow the solution to get on the hands or body; use tweezers or basket method to handle the parts.* For faster and better cleaning results, the carbon and rust remover solution should be heated to approximately 200° F. The parts generally can be separated in two or three minutes, however, for stubborn cases they can be left in the solution longer.

After removing the parts from the solution, immediately place them in clean diesel fuel for neutralizing. Always handle the parts carefully to protect the lapped surfaces.

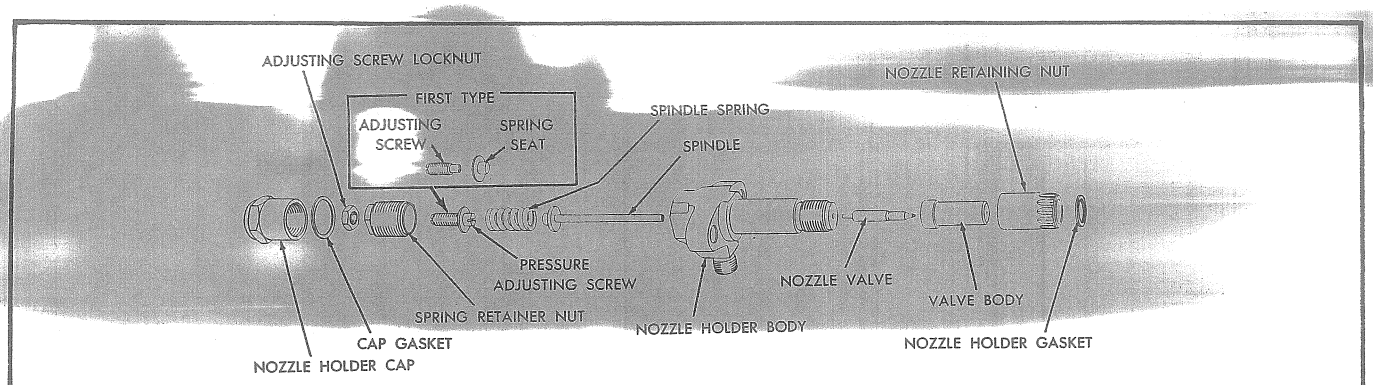

Fig. 26 — Fuel Injection Nozzle Details (Tractors Prior to Serial No. 4001)

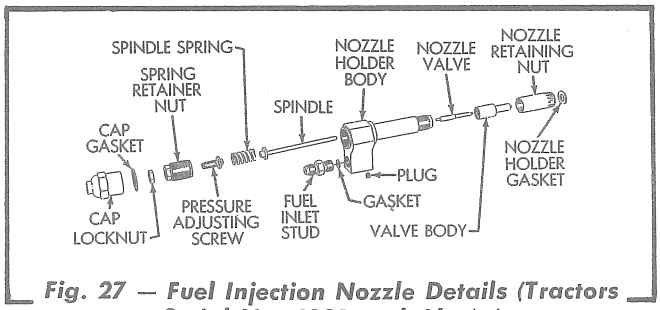

Fig. 27 — Fuel Injection Nozzle Details (Tractors Serial No. 4001 and Above)

f. The valve seat and the seat in the valve body are ground to slightly different angles to provide a line contact seat between the two parts. Practically all of the wear occurs in the seat in the valve body. The valve should never be lapped to the seat in the valve body.

(1) Using a magnifying glass, inspect the condition of the seat in the valve body. If the seat is damaged or worn in any way to prevent proper seating of the valve, the valve body and valve must be replaced. Examine the lapped bore in the valve body for signs of scoring. If scoring is apparent, the valve body and valve must be replaced.

The outer surfaces of the valve body may be cleaned with a brass wire brush. Do not scrape carbon from the surface around the orifice(s) in the tip of the valve body with any hard object as damage may result.

On hole type nozzles, used in tractors Serial No. 4001 and above, make certain that the 4 holes in the valve body tip are clean. These holes are .35 mm. in diameter and may be cleaned using a .013" diameter wire as shown in Fig. 23.

(2) Visually inspect the condition of the valve, preferably with the aid of a magnifying glass. The lapped surface (large O.D.) of the valve must be smooth and free from signs of scoring. Also, the valve must not show any signs of wear or damage at the seat location. If the valve is damaged in any way, the valve and valve body must be replaced. On the pintle type valve used in tractors prior to Serial No. 4001, particular attention must be paid to the pintle profile of the valve. This profile must not be damaged in any way or the resultant fuel spray pattern will be distorted.

g. Thoroughly rinse the valve and the valve body in clean diesel fuel or calibrating oil. The valve must fit freely in the valve body. To check this fit, lift the valve about one third of its length out of the body. The valve should slide down to its seat without aid when the assembly is held at a 45 degree angle.

If the fit of the valve in the valve body is unsatisfactory, the valve may be cleaned and polished with "Allis-Chalmers" 900G lapping compound and castor oil used on tissue paper. The valve may be held by its stem in a revolving chuck for this cleaning operation.

Hard or sharp tools, emery cloth, crocus cloth, jeweler's rouge, grinding compounds, or other abrasives should never be used in cleaning.

h. Thoroughly rinse the valve in clean diesel fuel before installing it in the valve body.

i. Examine the flat sealing surface of the valve body (surface which contacts the lower end of the holder body) and make certain the surface is clean and free of scratches. This surface may be lapped, if necessary, using "Allis-Chalmers" 900G lapping compound, castor oil, and a lapping block as shown in Fig. 28. After lapping, remove all traces of the lapping compound with clean diesel fuel.

j. Make certain that the bottom flat sealing surface of the nozzle holder body is clean and in good condition. Rinse the valve and the valve body in clean diesel fuel, then insert the valve into position in the valve body. Place the valve body and valve in position on the end of the nozzle holder body and center the valve body with the holder body. Lower the nozzle retaining nut into position over the valve body. Tighten the nut to a torque of 50 to 55 lbs. ft. NOTE: *It is important that the valve body be centered in the nozzle retaining nut. Use care while tightening the nozzle retaining nut so that the valve body remains centered in the nut.*

k. Adjust and test the fuel injection nozzle (refer to Paragraphs F and G above).

2. Disassembly, Cleaning, and Assembly of Fuel Injection Nozzle Holder

If the malfunction of the fuel injection nozzle was not corrected by the removal and cleaning of the nozzle valve and the valve body as in Step 1 above, disassemble and clean the injection nozzle holder as follows:

a. Remove the nozzle protection cap and gasket from the upper end of the nozzle. Loosen and remove the adjusting screw locknut.

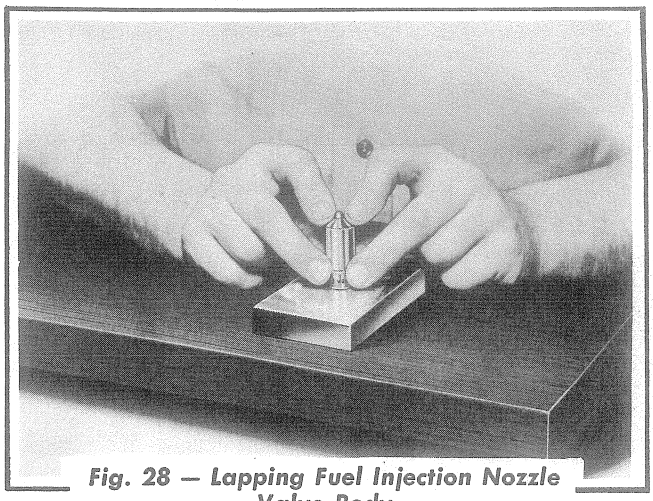

Fig. 28 — Lapping Fuel Injection Nozzle Valve Body

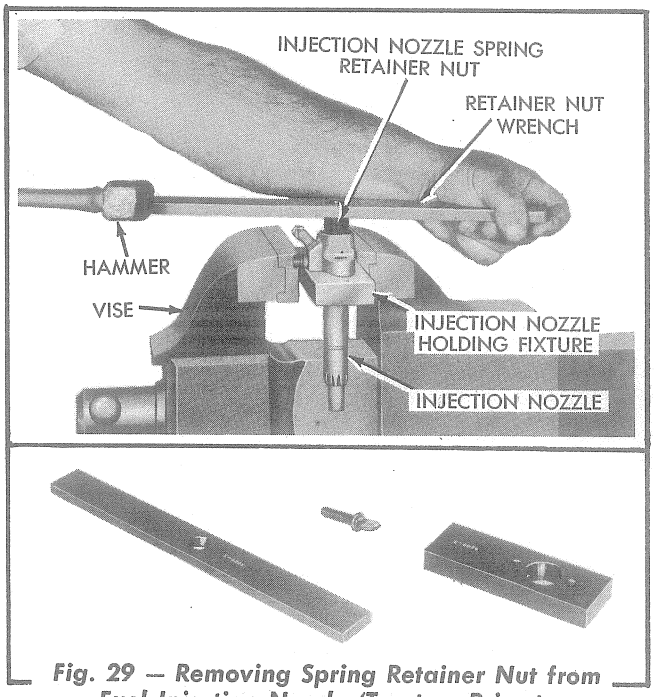

Fig. 29 — Removing Spring Retainer Nut from Fuel Injection Nozzle (Tractors Prior to Serial No. 4001)

b. On fuel injection nozzles used in tractors prior to Serial No. 4001, remove the spring retainer nut using an injection nozzle spring retainer nut wrench and an injection nozzle holding fixture similar to those shown in Fig. 29. On nozzles used in tractors Serial No. 4001 and above, the spring retainer nut may be removed by clamping the nozzle in a vise, and removing the nut using a suitable socket or box wrench. Remove the spindle spring and the spindle from the holder body.

c. Remove the nozzle retaining nut, then remove the valve body and valve (refer to Step 1 above).

d. Place all the parts in clean diesel fuel. Using filtered compressed air, blow out the fuel passages in the holder body.

e. Visually inspect the parts for damage or wear and replace the necessary parts. Examine the flat sealing surface of the holder body (surface which contacts the upper end of the valve body) and make certain the surface is clean and free from scratches. This surface should be lapped, if necessary, using "Allis-Chalmers" 900G lapping compound, castor oil, and a lapping block similar to the one shown in Fig. 28. When lapping, use care to keep the nozzle holder body square with the lapping block to assure contact with the entire area being resurfaced. After lapping, remove all traces of the lapping compound with fuel and dry with filtered compressed air.

   Examine the spindle spring. If the spring is scratched or pitted, it must be replaced. Also, the spring must be replaced if the ends have worn from contact with the spring seats. Always replace questionable springs.

f. Rinse the spindle in clean fuel and insert it into position in the holder body. Place the spindle spring in position on the spindle. NOTE: *If the nozzle being assembled has the early type pressure adjusting screw and upper spring seat (Fig. 26), place the spring seat in position on the spring.* Start the spring retainer nut (with pressure adjusting screw) into the holder body. Tighten the retainer nut securely (50 to 60 lbs. ft. torque).

g. Install the nozzle valve, valve body, and the nozzle retaining nut (refer to Step 1 above).

h. Install the adjusting screw lock nut and the nozzle protection cap (with gasket) but do not tighten at this time as the nozzle must be placed on a nozzle tester and adjusted for the specified "popping" pressure.

i. Adjust and test the fuel injection nozzle following the procedure in Paragraphs F and G above. After adjusting and testing, tighten the nozzle protection cap to a torque of 50 to 60 lbs. ft.

I. Installation of Fuel Injection Nozzles in Engine (Tractors Prior to Serial No. 4001)

1. Make certain that the old nozzle holder gaskets are removed from the nozzle recesses in the cylinder heads. Thoroughly clean each fuel injection nozzle recess in the cylinder heads before inserting the nozzles. Make certain that no particles of carbon are present which would cause a nozzle to be cocked, thereby, permitting "blow-by" from the cylinder. Hard or sharp tools should not be used for cleaning; a round piece of wood or brass properly shaped is very effective.

   NOTE: *Under no circumstances should an engine be operated with a leaky or "blowing-by" nozzle holder; this will cause a localization of heat which will distort the nozzle, resulting in serious damage.*

2. Always use a new nozzle holder gasket when installing a fuel injection nozzle. Place a new gasket in position on the end of each nozzle and carefully insert the nozzles into position in the cylinder heads.

3. Install lockwashers and hex-nuts to secure each fuel injection nozzle to the cylinder head; tighten the nuts evenly to a torque of 12 to 15 lbs. ft.

4. Connect the fuel injection lines and the fuel return manifold to the nozzles and tighten the nuts securely.

J. Installation of Fuel Injection Nozzles in Engine (Tractors Serial No. 4001 and Above)

1. Thoroughly clean the inside of the injection nozzle sleeves in the cylinder heads before inserting the nozzles. When cleaning the nozzle sleeves make certain that the old nozzle holder gaskets are removed from the sleeve as new gaskets must be used when installing the nozzles. Make certain that no small particles of carbon are present in the nozzle sleeve which would prevent the nozzle holder gasket from seating properly, thereby permitting "blow-by" from the cylinder.

   When the cylinder heads have been removed from the engine, it is advisable to use a carbon removing tool similar to the one shown in Fig. 30 to clean any carbon deposits from the fuel injection nozzle sleeves before installing the cylinder heads on the engine. A wire brush similar to the one shown in Fig. 31 may be used to clean the carbon from the fuel injection nozzle tip hole in the cylinder heads before the cylinder heads are installed on the engine. Under no circumstances should an engine be operated with a leaky or "blowing-by" nozzle holder; this will cause a localization of heat which will distort the nozzle, resulting in serious damage.

2. Place a new nozzle holder gasket in position on each nozzle and carefully insert the nozzles into position in the injection nozzle sleeves in the cylinder heads.

3. Refer to Fig. 18 and install the nozzle holder clamp, washer, and nut for each nozzle but do not tighten at this time. Install the fuel injection tubes, inserting the end of each tube into the injection line connector, then inserting the other end of each tube into position in the injection nozzle. Start the injection tube nuts but do not tighten at this time.

4. Tighten the nozzle holder clamp nuts to a torque of 25 to 30 lbs. ft. Tighten the injection tube nuts securely.

5. Install the rocker arm retaining spring clips and the fuel return manifolds as shown in

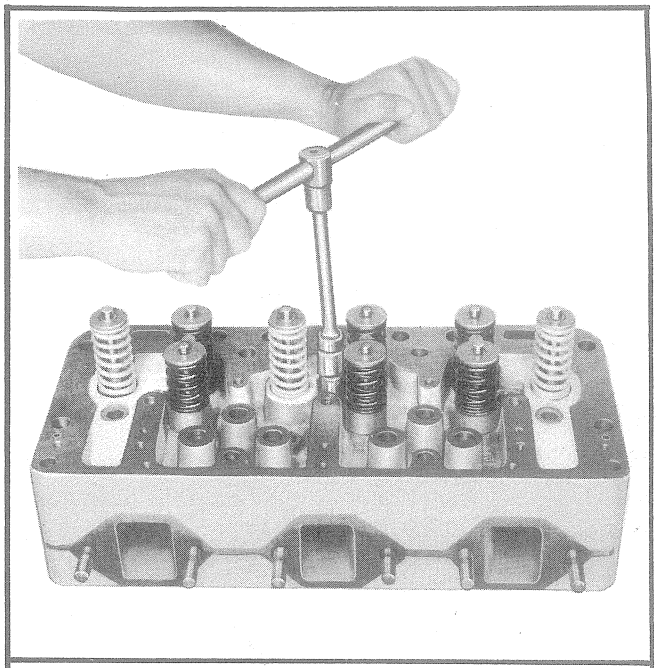

Fig. 30 — Cleaning Carbon from Fuel Injection Nozzle Sleeve (Tractors Serial No. 4001 and Above)

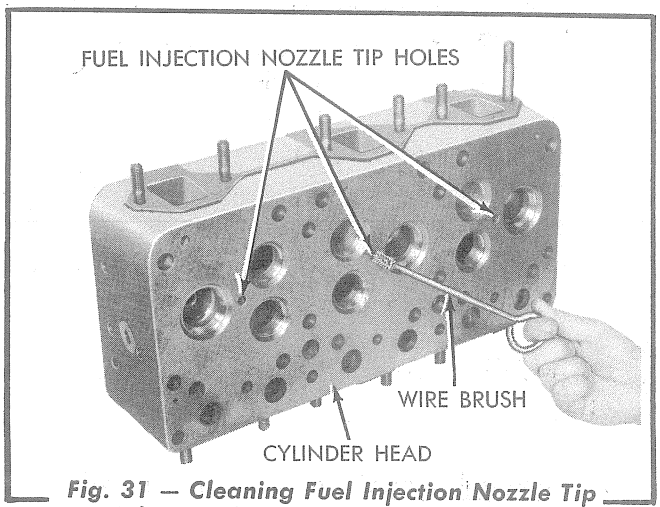

Fig. 31 — Cleaning Fuel Injection Nozzle Tip Hole in Cylinder Head (Tractors Serial (No. 4001 and Above)

Fig. 18. Start the engine, run at approximately ¼ throttle and observe the fuel injection tubes and the fuel return manifold connections for fuel leakage. Correct any leaks found.

6. Make certain that the rocker cover gaskets are in good condition and install the valve rocker covers. Install the rocker cover sealing washers and the rocker cover nuts. Install the engine hood.

6. FUEL INJECTION NOZZLE SLEEVES

A. Description

NOTE: *Fuel injection nozzle sleeves are used only in tractors Serial No. 4001 and above.* The bore in the cylinder head for each fuel injection nozzle extends directly through the cylinder head water jacket. To prevent the engine coolant from contacting the fuel injection nozzle, a stainless steel sleeve is pressed into the cylinder heads at each fuel injection nozzle bore. The sleeve forms a water tight receptacle for the fuel injection nozzle. The coolant in the cylinder head flows around the stainless steel sleeve and helps to cool the fuel injection nozzle.

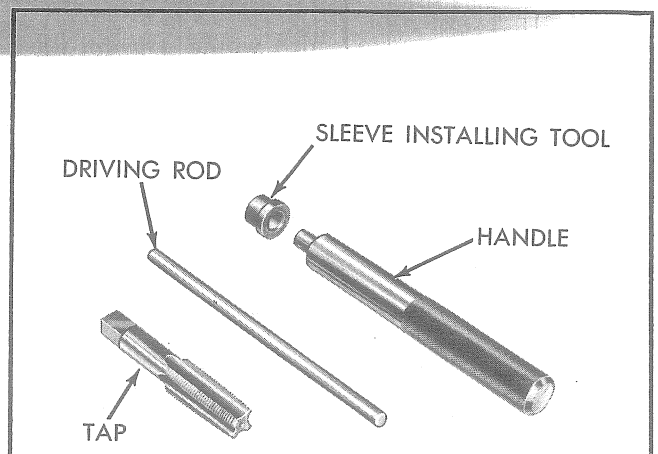

Fig. 32 — Fuel Injection Nozzle Sleeve Removing and Installing Tool Details (Tractors Serial No. 4001 and Above)

B. Removal of Fuel Injection Nozzle Sleeve

Whenever the cylinder heads are removed from the engine, the fuel injection nozzle sleeve should be thoroughly cleaned (refer to Fig. 30) and inspected. If the condition of the nozzle sleeve is such that replacement is necessary, the sleeve may be removed as follows:

1. Using tools similar to the ones shown in Fig. 32 screw the tap (⅞") down into the fuel injection nozzle sleeve as shown in Fig. 33.

2. Insert the driving rod through the nozzle tip hole in the bottom of the cylinder head, and using a hammer, drive the nozzle sleeve out of the cylinder head.

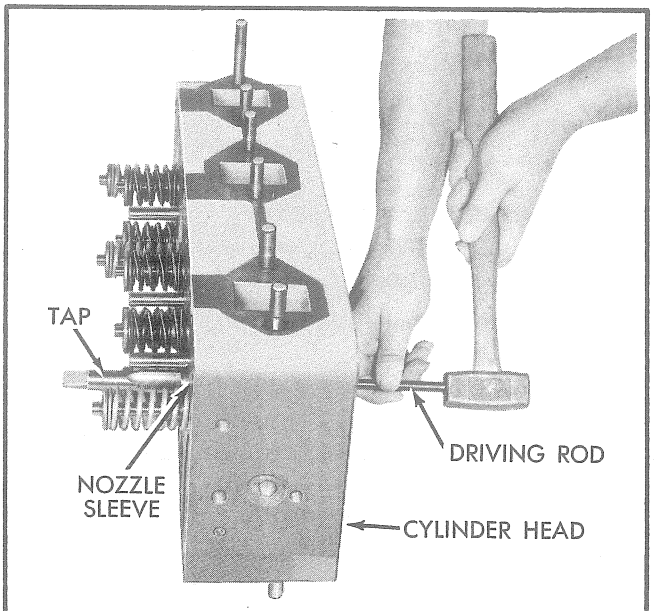

Fig. 33 — Removing Fuel Injection Nozzle Sleeve (Tractors Serial No. 4001 and Above)

C. Installation of Fuel Injection Nozzle Sleeve

1. Thoroughly clean the bore in the cylinder head for the fuel injection nozzle sleeve.

2. Install the nozzle sleeve in position in the cylinder head, with the end of the sleeve having the larger O.D. toward the top. Using tools similar to the ones shown in Figs. 32 and 34, drive the nozzle sleeve into position in the cylinder head until it bottoms solidly in the bore.

3. Install the cylinder heads on the engine (refer to Section VIII, Topic 2).

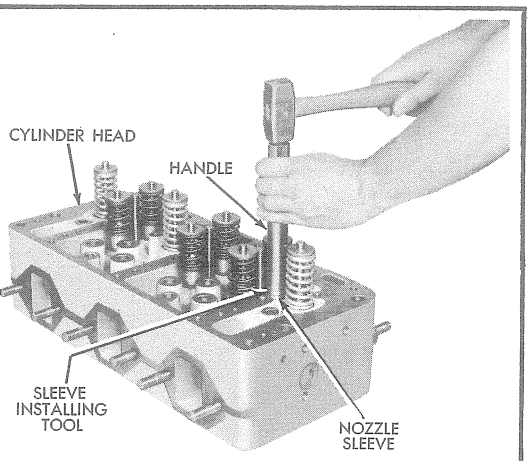

Fig. 34 — Installing Fuel Injection Nozzle Sleeve (Tractors Serial No. 4001 and Above)

7. FUEL INJECTION PUMP AND GOVERNOR

A. Description

All engines are equipped with an "American Bosch" (Model APE 6BB) multiple-plunger, constant stroke, cam actuated, heavy-duty fuel injection pump. On tractors prior to Serial No. 4001, the pump is equipped with 11 mm. plungers and is timed for port opening, 16° B.T.D.C. (end of fuel injection into cylinders). On tractors Serial No. 4001 and above, the pump is equipped with 10 mm. plungers and is timed for port closing (start of fuel injection into cylinders), 28° B.T.D.C. on tractors with a torque converter and 24° B.T.D.C. on tractors without a torque converter. The purpose of the fuel injection pump is to meter the fuel accurately and deliver it precisely at a definite moment in the engine cycle and under high pressure to the fuel injection nozzles.

The governor is of the mechanical-centrifugal type (Type "GVB") and is attached to the rear of the fuel injection pump. The purpose of the governor is to serve as a means for pre-setting and maintaining within close regulation any desired engine speed within the nominal idling and nominal maximum speed range, irrespective of engine load. The governor also controls the engine idling speed to prevent stalling and the maximum speed to prevent racing.

B. Operation of Fuel Injection Pump and Governor

1. Pumping

The fuel injection pump and governor are mounted on the left side of the engine. The camshaft of the fuel injection pump is driven at one-half engine speed by the accessory drive assembly of the engine, through an adjustable fuel injection pump drive coupling. The plungers of the fuel injection pump are lifted by the pump camshaft through the use of the tappet assemblies, located below the plungers and in contact with the pump camshaft. The plungers are lowered by plunger springs.

Fuel is supplied by the fuel transfer pump through the second stage fuel filter and into the fuel sump of the fuel injection pump surrounding the injection pump plungers. When a plunger is at the bottom of its stroke, the fuel flows through the plunger barrel ports, and fills that portion of the plunger barrel above the plunger. The plunger moving upwards closes the barrel ports, and as it continues its upward movement, the fuel now under pressure, opens the corresponding delivery valve assembly and flows through the fuel injection line to the corresponding fuel injection nozzle, where it is injected into the combustion chamber for that particular

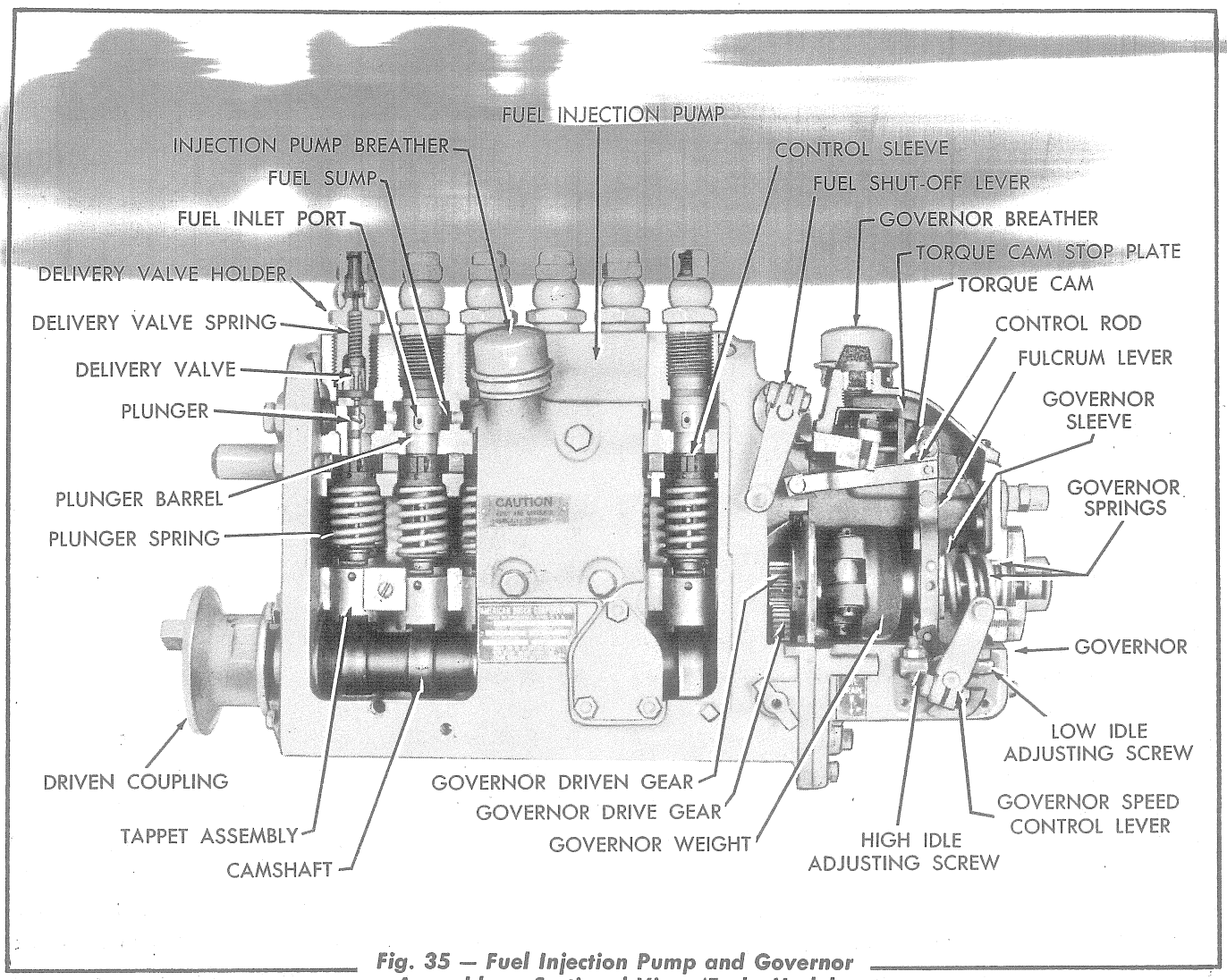

Fig. 35 — Fuel Injection Pump and Governor Assembly — Sectional View (Early Model Pump Shown — Later Models Similar)

cylinder. Delivery of fuel ceases when the helix or the upper edge of the annular groove in the plunger opens the by-pass port in the plunger barrel. The by-passing of fuel back into the fuel sump of the injection pump relieves the pressure and permits the delivery valve to close.

On tractors prior to Serial No. 4001, without a torque converter, the excess fuel delivered to the fuel sump of the fuel injection pump, passes through the fuel injection pump and is returned to the fuel tank through the fuel return line.

On tractors prior to Serial No. 4001, with a torque converter, the excess fuel delivered to the fuel sump of the fuel injection pump passes through the fuel injection pump-to-torque converter line to the torque converter, is circulated through the torque converter fluid heat exchanger, passes through the fuel return line filter, and is returned to the fuel tank through the fuel return line. On tractors Serial No. 4001 and above, the excess fuel delivered to the fuel sump of the fuel injection pump passes through a .068" to .072" restricted fitting in the upper rear of the injection pump and returns to the top of the fuel filter head and to the fuel tank through the fuel return line. The restricted fitting maintains a pressure of approximately 15 to 20 P.S.I. in the fuel sump of the injection pump.

2. Metering and Control

Control of the amount of fuel delivered by each plunger is accomplished by rotating the plunger in the plunger barrel; this in turn changes the position of the helix in the plunger in relation to the ports in the plunger barrel. A control sleeve, having a toothed segment, is installed over the plunger

barrel and the teeth of this sleeve are engaged with teeth in a control rack connected to the governor; movement of the control rack by the governor rotates the plunger in its barrel, which in turn controls the amount of fuel delivered by the plunger. The less the control rack is moved away from its stop position, the less the plunger is turned in its barrel, and the shorter the effective fuel delivery stroke of the plunger. The more the control rack is moved away from its stop, the more the plunger is turned in its barrel and the longer the effective fuel delivery stroke. When the control rack is moved to the stop position, the plunger is turned in its barrel so that the vertical groove in the plunger registers with the by-pass port and no fuel is delivered by the plunger.

The governor drive gear, located on the rear end of the fuel injection pump camshaft, is engaged with the driven gear mounted on the front end of the governor weight shaft. A friction clutch, built into the governor drive gear, is so designed that it causes the drive gear to slip on the hub momentarily whenever sudden speed changes of the pump camshaft occur. This clutch assures smooth operation of the governor weights and helps to minimize governor wear.

The governor weights are attached to and rotate with the governor weight shaft, thus providing governor control at all engine speeds. As the weights revolve, centrifugal force tends to throw them outward, moving the weights longitudinally along the shaft. This movement is opposed by the governor springs through a sliding sleeve. The higher the speed, the greater the centrifugal force and movement of the sleeve against the governor springs. If the speed is decreased, the centrifugal force of the weights lessens, and the governor springs force the sleeve forward toward the fuel injection pump. A control rod, connected to the fulcrum lever on the governor sleeve and engaged with the tooth segment of the control sleeve on each plunger barrel of the injection pump, transmits the movement of the governor sleeve to the control sleeve on each plunger barrel. Movement of the plunger sleeve by the control rack rotates the corresponding pump plunger in its barrel, which in turn controls the amount of fuel delivered by the plunger.

C. Service of Fuel Injection Pump and Governor

In most cases, malfunctioning of the fuel injection equipment is the direct result of dirty fuel. Dirt in the fuel causes rapid wear on the precision parts, particularly the plunger, control sleeve, delivery valves and seats, and the fuel injection nozzle valves and valve bodies. Therefore, extreme care should be used in the storage and handling of fuel to prevent the entrance of dirt, water, and abrasive particles. Any water or sediment should be drained from the fuel filters daily and the fuel filter elements must be changed after every 300 to 500 hours of operation, or when the fuel pressure drops below 30 pounds per square inch with the engine running at high idle.

On tractors prior to Serial No. 4001, the lubricating oil in the oil sump of the fuel injection pump must be drained after every 10 hours of operation and refilled with one quart of new engine crankcase lubricant. The level of the lubricating oil in the oil sump of the governor on tractors prior to Serial No. 4001 must be checked after every 10 hours of operation and new engine crankcase lubricant added as necessary to maintain the proper oil level. The oil must be drained from the governor after every 100 hours of operation and the governor refilled to the proper level with new engine crankcase lubricant.

The fuel injection pump and governor breathers should be removed, washed clean, saturated with clean oil, and reinstalled at each engine oil change (or more often if conditions warrant). There is a certain amount of fuel seepage between the lapped surfaces of the fuel injection pump plungers and the plunger barrels, which is necessary for lubrication between these parts. This seepage of fuel collects in the oil sump of the injection pump and an oil overflow vent tube (Fig. 5) is provided to maintain the proper oil level. Check the overflow vent tube and make certain it is not damaged or clogged. A slight discharge of fuel through this tube is normal during operation; if a steady stream of fuel is observed, worn pump plungers and barrels are indicated and the fuel injection pump should be removed and repaired or replaced.

Effective with tractor Serial No. 4001, the fuel injection pump and governor assembly are lubricated from the engine lubricating system. No lubrication service on this injection pump and governor assembly is required. The fuel injection pump and the governor breathers (governor breather only on tractors Serial No. 4001 and above) should be removed, washed clean, saturated with clean oil and reinstalled at each engine oil change (or more often if conditions warrant). NOTE: *Due to the small amount of oil in the lubricating oil sump of the fuel injection pump, it is not necessary to drain the sump when changing the engine crankcase lubricant.*

"Allis-Chalmers" Construction Machinery Dealers are equipped with Fuel Injection Pump Calibrating and Test Stands and the special tools required to test, adjust, and repair the fuel injection pump and governor assembly. Therefore, if at any time the fuel injection pump and governor assembly requires repairs or adjustment, the assembly should be removed and taken to your nearest "Allis-Chalmers" Construction Machinery Dealer. It is important that the Dealer be furnished with the tractor and engine Serial Number from which the injection pump and governor assembly was removed so that the pump may be properly calibrated and the correct replacement pump or pump parts may be furnished for the particular tractor being serviced.

D. Removal, Installation, and Timing of Fuel Injection Pump

1. Removal of Fuel Injection Pump

Before removing the fuel injection pump from the engine, make certain the timing mark on the fuel injection pump driven coupling (drive coupling flywheel in tractors Serial No. 4001 and above) and the corresponding timing mark on the fuel injection pump front end plate Figs. 40 and 42 are aligned. When these marks are aligned, the No. 1 piston is near the top on its compression stroke.

a. Make certain the engine shut-off knob is pulled back to the "STOP" position. Crank the engine with the starter until the timing marks Fig. 40 or 42 are nearly aligned.

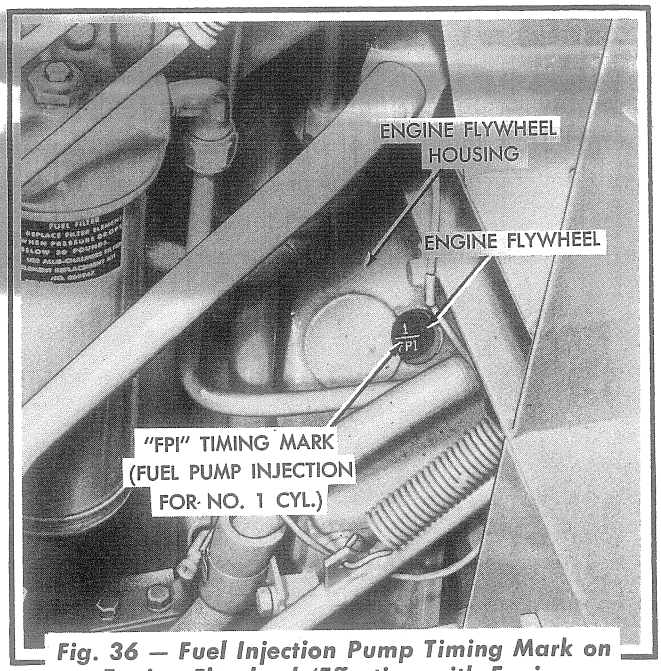

Fig. 36 — Fuel Injection Pump Timing Mark on Engine Flywheel (Effective with Engine Serial No. 67395)

b. Effective with engine Serial No. 67395 an "FPI" mark was stamped in the engine flywheel and a timing hole plug was provided in the flywheel housing. On engines Serial No. 67395 and above, remove the timing hole plug (Fig. 36) from the upper left side of the engine flywheel housing.

c. Remove the center floor plate. Move the transmission shift lever to its neutral position and pull the engine clutch operating lever to its engaged position. Using a bar, or similar tool, inserted in the drive shaft universal joint, turn the joint counterclockwise (viewed from rear) until the fuel injection pump timing marks (Figs. 40 and 42) are aligned. NOTE: *When the fuel injection pump timing marks are aligned, the "FPI" mark in the engine flywheel should be centered in the timing hole in the flywheel housing.*

d. Disconnect the engine shut-off front rod and the throttle control front rod from their corresponding control levers on the fuel injection pump and governor.

e. Close the fuel tank shut-off valve. Disconnect all fuel lines from the fuel injection pump.

f. Disconnect the fuel injection lines from the fuel injection pump outlets located at the top of the pump. Cover all the fuel openings to prevent the entrance of dirt.

g. Remove the capscrews and lockwashers attaching the fuel injection pump to the pump mounting bracket. Raise the injection pump slightly and move it toward the rear to free the drive coupling components, then remove the injection pump and governor, as a unit from the engine.

2. Installation and Timing of Fuel Injection Pump on Tractors Prior to Serial No. 4001

Effective with engine Serial No. 67395 an "FPI" timing mark is stamped in the engine flywheel (Fig. 36). With the timing mark centered in the timing hole in the flywheel housing and the No. 1 piston near the top on its compression stroke, the engine timing gear train is properly positioned for the installation of the fuel injection pump. On engines prior to Serial No. 67395 an "FPI" timing mark is not stamped in the engine flywheel and the .215" thickness timing gage (Fig. 39), included with the tractor tools, must be used to properly position the No. 1 piston for installation of the fuel injection pump. NOTE: *To assure accurate positioning of the No. 1 piston, it is recommended that a timing gage be used on all tractors prior to tractor Serial No. 4001.* The timing gage is to be inserted through the energy cell opening in the cylinder head and positioned between the top of the No. 1 piston and the bottom flat surface of the cylinder head, when the piston is near the top on its compression stroke. This can be determined by observing the valves for the No. 1 cylinder; with both valves closed (valve push rods at the bottom of their travel) the piston is nearing the top of its compression stroke. Insert the timing gage as follows:

a. Remove the two nuts and lockwashers securing the No. 1 cylinder energy cell clamp to the cylinder head.

b. Using tools similar to the ones shown in Fig. 37, pull the energy cell plug from the energy cell.

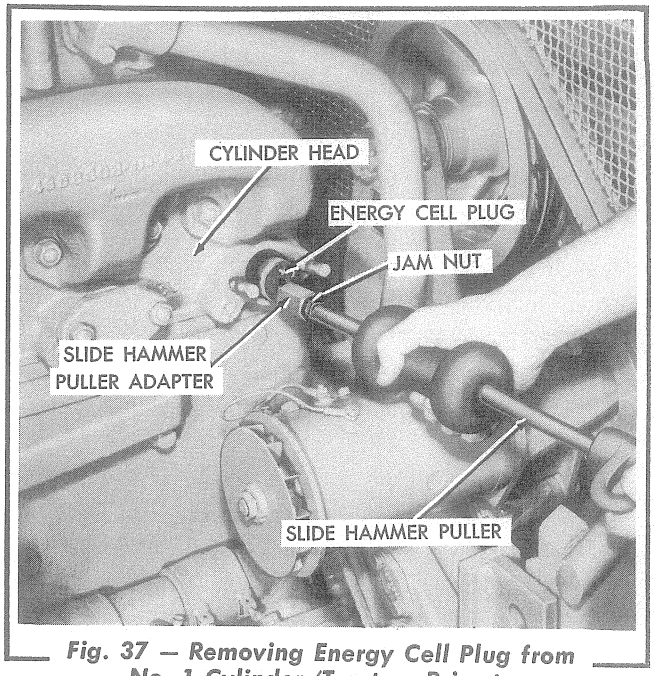

Fig. 37 — Removing Energy Cell Plug from No. 1 Cylinder (Tractors Prior to Serial No. 4001)

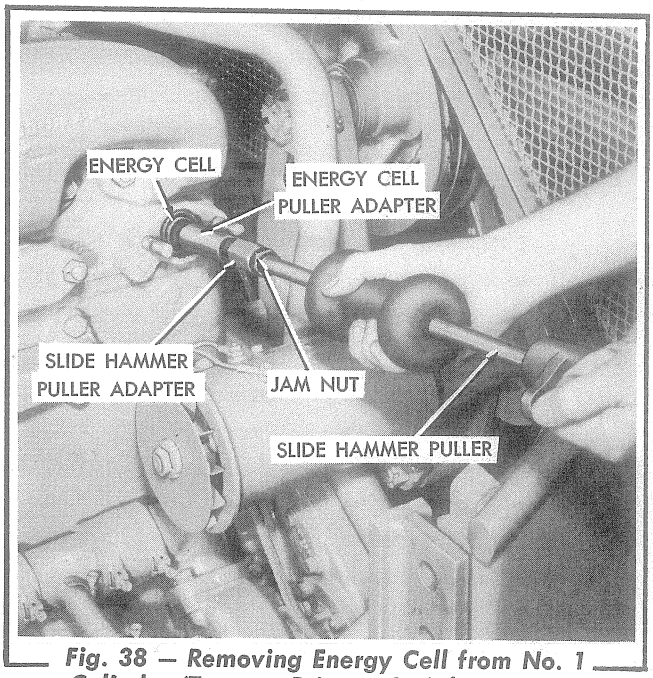

Fig. 38 — Removing Energy Cell from No. 1 Cylinder (Tractors Prior to Serial No. 4001)

c. Using tools similar to the ones shown in Fig. 38, pull the energy cell from the cylinder head.

d. With the No. 1 piston near the top on its compression stroke, insert the end of the timing gage (.215" thickness) into the energy cell opening as shown in Fig. 39, making certain that the gage is located below the flat surface of the cylinder head and above the piston.

e. With the center floor plate removed, the transmission shift lever in its neutral position, and the engine clutch engaged, slowly turn the drive shaft universal joint counterclockwise (viewed from the rear) with the use of a bar until the No. 1 piston contacts the timing gage. NOTE: *With the timing gage inserted as above, the "FPI" timing mark stamped in the engine flywheel on engines Serial No. 67395 and above should be located in the center, or very close to the center, of the timing hole in the flywheel housing.*

f. Try the fuel injection pump coupling disc (Fig. 41) on both the driven coupling and the drive coupling flange to see if the coupling disc fits smoothly on the flanges of the coupling members. Check the fit of the coupling disc with the driven coupling and the drive coupling flange; the clearance between the slots of the coupling disc and the driving lugs of the coupling must not exceed .007" to .008". If the clearance at these points is excessive, replace the coupling disc.

g. Loosen the two drive coupling flange attaching capscrews just enough so that the drive coupling flange may be turned slightly for alignment with the coupling disc when the injection pump is placed in position.

h. Turn the driven coupling of the fuel injection pump to align the timing mark on the driven coupling with the corresponding timing mark on the pump front end plate (Fig. 40).

i. Install the fuel injection pump and governor in position on the pump mounting bracket, inserting the driving lugs of the drive coupling flange into the slots of the coupling disc. The two zeros ("0"), one on the drive coupling flange and one on the driven coupling (Fig. 40), should be in alignment when the pump is installed. Install the capscrews to attach the fuel injection pump to the pump mounting bracket, but do not tighten the capscrews at this time.

j. The accessory drive lower shaft and the fuel injection pump camshaft must be carefully aligned. Use a straight edge as shown in Fig. 40 to check the alignment of the pump with the accessory drive. Move the

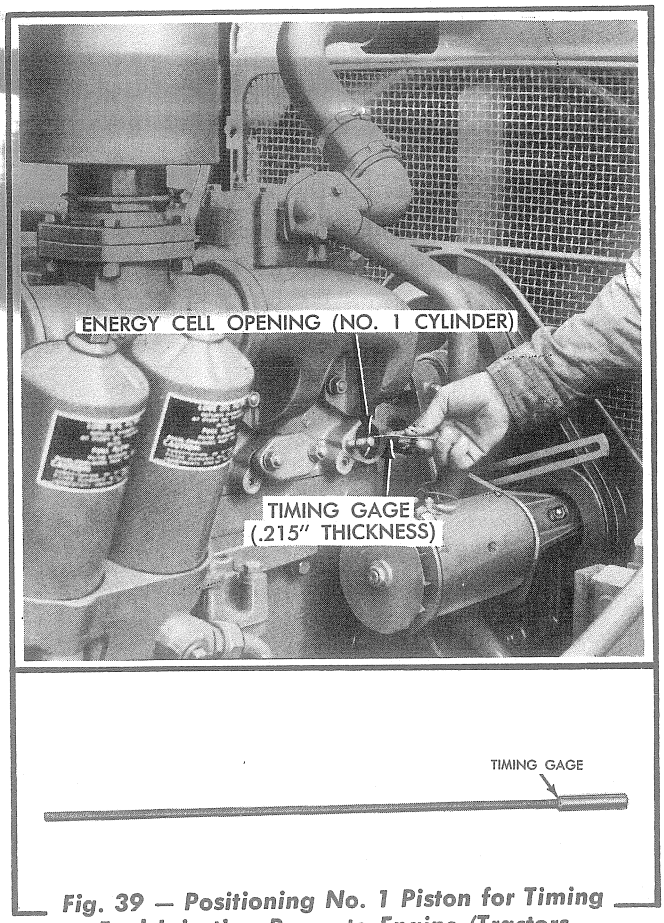

Fig. 39 — Positioning No. 1 Piston for Timing Fuel Injection Pump to Engine (Tractors Prior to Serial No. 4001)

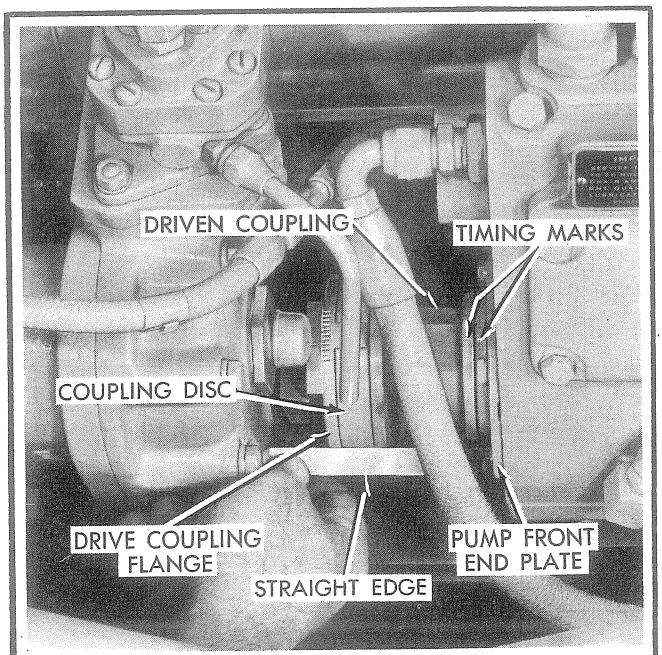

Fig. 40 — Checking Alignment of Fuel Injection Pump (Tractors Prior to Serial No. 4001)

pump as necessary to obtain the proper alignment.

k. A clearance of .004" should be provided between the coupling disc and the drive coupling flange, so that the coupling disc can move transversely to allow for slight misalignment of the pump with the accessory drive. Insert a .004" thickness feeler gage between the drive coupling flange and the coupling disc as shown in Fig. 41, then move the pump as necessary to obtain this clearance. IMPORTANT: *Make certain that this .004" clearance is obtained on both the inner and outer sides (opposite sides) of the coupling.*

l. Tighten the six pump attaching capscrews, then recheck the pump for alignment and end clearance.

m. Observe the timing mark on the pump front end plate and the corresponding timing mark on the driven coupling (Fig. 40) to see if they are properly aligned. If a slight misalignment is observed, turn the drive coupling flange as necessary to align these timing marks, then tighten the two drive coupling flange attaching capscrews.

n. Connect the fuel injection lines to the fuel injection pump outlets.

o. Connect the fuel line to the upper rear of the fuel injection pump. Connect the injection pump fuel supply line to the front of the fuel injection pump.

p. Connect the engine shut-off front rod and the throttle control front rod to their corresponding control levers of the fuel injection pump and governor. Make certain that the control linkage is properly adjusted so that the control levers move their full travel when the controls are actuated.

q. Remove the timing gage from the No. 1 cylinder. NOTE: *It may be necessary to crank the engine in the opposite direction (lowering the No. 1 piston) just enough to free the timing gage.* On tractors with a torque converter, the engine cannot be cranked in the opposite direction by turning the drive shaft universal joint. In this case, the timing gage may be freed by cranking the engine in the opposite direction by the use of the cooling fan. Install the No. 1 cylinder energy cell, energy cell plug, and energy cell clamp. Install the center floor plate.

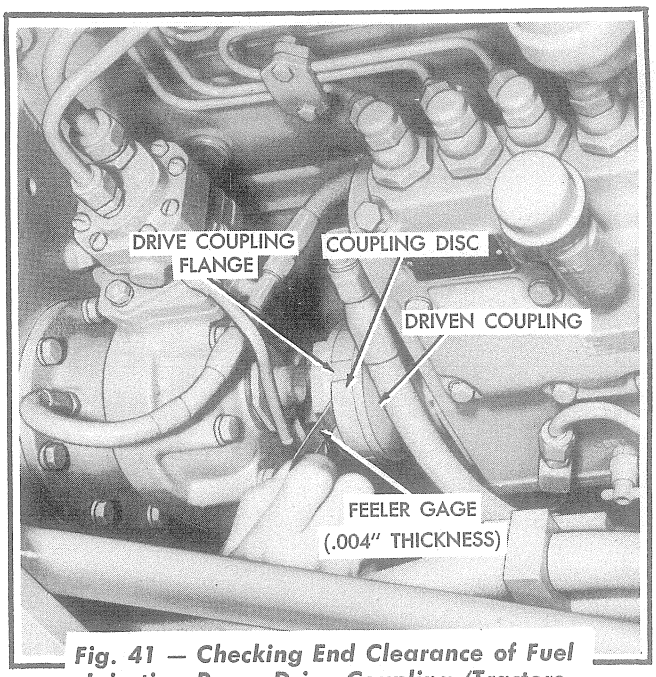

Fig. 41 — Checking End Clearance of Fuel Injection Pump Drive Coupling (Tractors Prior to Serial No. 4001)

r. On engines Serial No. 67395 and above, install the timing hole plug in position in the engine flywheel housing.

s. Remove the breathers (Fig. 35) from the fuel injection pump and governor. Fill the oil sump of the injection pump with 1 quart of new engine crankcase lubricant and install the breather. Fill the governor with ¼ pint of new engine crankcase lubricant and install the breather.

t. Open the fuel tank shut-off valve. Vent the fuel system (refer to Step 4 below).

3. Installation and Timing of Fuel Injection Pump on Tractors Serial No. 4001 and Above

Before installing the fuel injection pump, make certain that the "FPI" timing mark (Fig. 36), stamped in the engine flywheel is centered with the timing hole in the flywheel housing. Also, make certain that the No. 1 piston (piston nearest fan) is on its compression stroke when centering the "FPI" mark with the timing hole. This can be determined by observing the valves for the No. 1 cylinder; with the exhaust and the intake valves closed (valve push rods at the bottom of their travel), the piston is nearing the top on its compression stroke.

a. Remove the center floor plate. Move the transmission shift lever to its neutral position and pull the engine clutch operating lever to its engaged position. Using a bar, or similar tool, inserted in the drive shaft universal joint, turn the joint counterclockwise (viewed from rear) until the "FPI" timing mark stamped in the engine flywheel is centered with the timing hole in the flywheel housing.

b. Try the fuel injection pump coupling disc on both the drive coupling flange and the drive coupling flywheel to see if the coupling disc fits smoothly on the coupling members. Check the fit of the coupling disc with the drive coupling flywheel and the drive coupling flange; the clearance between the slots of the coupling disc and the driving lugs of the couplings must not exceed .007" to .008". If the clearance at these points is excessive, replace the coupling disc.

c. Loosen the two drive coupling flange attaching capscrews (Fig. 42), just enough so that the drive coupling flange may be turned slightly for alignment with the coupling disc when the pump is placed in position.

d. Install a new "O"-ring seal in position in each counterbore, for the oil inlet and the oil return passage, in the fuel injection pump mounting bracket. Make certain the pump mounting bracket and the bottom surface of the injection pump are clean. Make certain that the oil drain coupling, used under the governor housing is in good condition and install it in position in the pump mounting bracket.

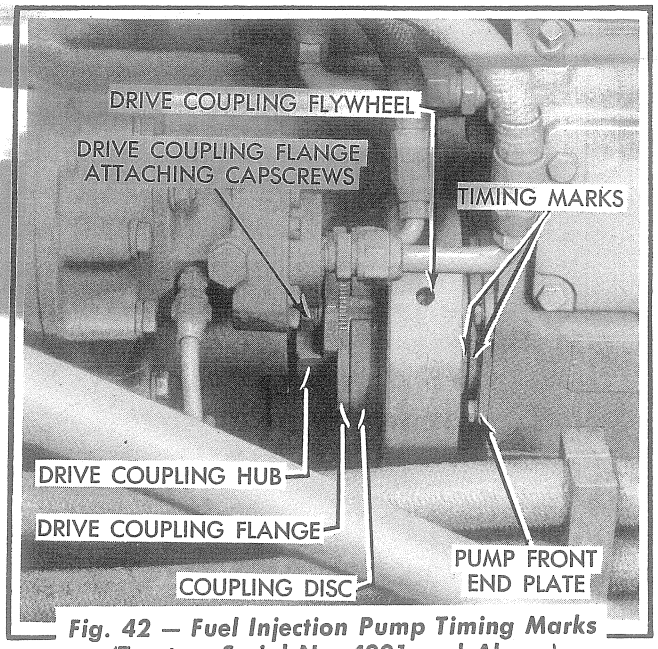

Fig. 42 — Fuel Injection Pump Timing Marks (Tractors Serial No. 4001 and Above)

e. Turn the drive coupling flywheel of the fuel injection pump to align the timing mark on the coupling flywheel with the corresponding timing mark on the pump front end plate.

f. Install the fuel injection pump and governor in position on the pump mounting bracket, inserting the driving lugs of the drive coupling flywheel into the slots of the coupling disc. Make certain that the oil drain coupling is properly installed between the bottom of the governor housing and the pump mounting bracket. Install the capscrews and lockwashers to attach the fuel injection pump to the pump mounting bracket, but do not tighten the capscrews at this time.

g. A clearance of .004" — .012" should be provided between the coupling disc and the drive coupling flange, so that the coupling disc can move transversely to allow for slight misalignment of the pump with the accessory drive. Insert a feeler gage between the drive coupling flange

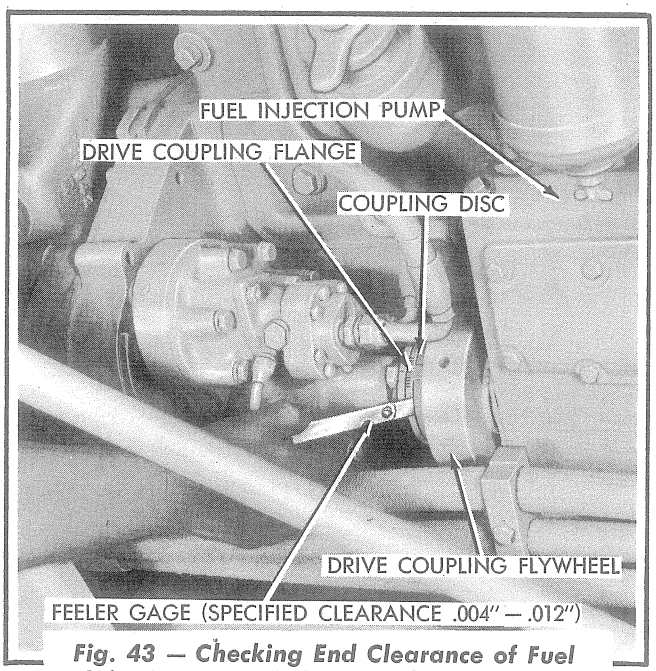

Fig. 43 — Checking End Clearance of Fuel Injection Pump Drive Coupling (Tractors Serial No. 4001 and Above)

and the coupling disc as shown in Fig. 43, then move the pump as necessary to obtain the specified clearance. IMPORTANT: *Make certain that the clearance is equal on both the inner and outer sides (opposite sides) of the coupling.* Also, make certain the outside diameters of the coupling disc and the drive coupling flange are flush.

h. Tighten the pump attaching capscrews, then recheck the pump for alignment and end clearance as in Step g above.

i. Observe the timing mark on the pump front end plate and the corresponding timing mark on the drive coupling flywheel (Fig. 42) to see if they are properly aligned. If a slight misalignment is observed, turn the drive coupling flange as necessary to align these timing marks, then tighten the two drive coupling flange attaching capscrews.

j. Connect the fuel injection lines to the fuel injection pump outlets and tighten the capscrews attaching the fuel injection line clamp plates.

k. Connect the fuel injection pump fuel return hose to the upper rear of the fuel injection pump.

l. Connect the fuel injection pump fuel supply hose to the front of the fuel injection pump.

m. Connect the engine shut-off front rod and the throttle control front rod to their corresponding control levers of the fuel injection pump and governor. Make certain that the control linkage is properly adjusted so that the control levers move their full travel when the controls are actuated.

n. Install the timing hole plug in position in the engine flywheel housing. Install the center floor plate.

o. Vent the fuel system as outlined in the following paragraphs.

4. Venting of Fuel System

a. Venting of low pressure fuel system:

(1) Remove the vent screw, located in the top of the first stage fuel filter retaining nut, and allow the filter to fill with fuel by gravity. When fuel flows (free of bubbles) from the opening for the vent screw, install and tighten the vent screw.

(2) Remove the vent screw located in the top of the second stage fuel filter retaining nut. Crank the engine with the starter until a full stream of fuel (free of bubbles) flows from the opening for the vent screw, then install and tighten the vent screw while continuing to crank the engine.

(3) Loosen the fuel line from the upper rear of the fuel injection pump. Crank the engine with the starter until a full stream of fuel (free of bubbles) flows from the rear of the pump, then tighten the line connection.

b. Venting of high pressure fuel system: The high pressure fuel system is usually self-venting due to the fact that any air trapped by the fuel injection pump is forced out

through the fuel injection nozzles and into the engine combustion chambers. However, if the fuel lines have been removed, the engine has run out of fuel, or the unit has not been operated for some time, venting of the high pressure system may be necessary to facilitate starting of the engine. Vent the high pressure fuel system as follows:

(1) On tractors prior to Serial No. 4001, loosen the fuel line nut attaching each fuel injection line to its corresponding fuel injection nozzle. On tractors Serial No. 4001 and above, loosen the nut attaching the upper end of each fuel injection line to its line connector in the rocker cover housing.

(2) Pull the throttle operating lever back to the high speed position and push the engine shut-off knob to the run position.

(3) Crank the engine with the starter until fuel flows from the ends of all the fuel injection lines, then tighten the fuel line nuts.

E. Governor Adjustment

1. General

The governor was adjusted at the factory to provide for the proper horsepower and engine speeds. The specified engine speeds are as follows:

2. Checking Engine Speed

The governor very seldom requires adjustment. If the engine speed is irregular, check the fuel system and all other engine adjustments before changing the governor setting.

NOTE: *If equipment on the tractor prevents the use of a tachometer at the front end of the engine crankshaft, the engine speed may be checked from the rear of the accessory drive upper shaft (Fig. 44).* The accessory drive upper shaft is driven at 1.5 times engine crankshaft speed. The table below gives the specified crankshaft and accessory drive upper shaft R.P.M. for low idle and high idle engine speeds.

Move the transmission shift lever to NEUTRAL and make certain the engine clutch operating lever is pushed forward to the disengaged position. Operate the engine until normal operating temperature (160° to 185° F.) is indicated by the engine temperature gage, then stop the engine. Move the throttle operating lever to its low and high speed positions and make certain the throttle control linkage moves the governor speed control lever through its full arc of travel.

If the accessory drive upper shaft is to be used for checking the engine speed, unscrew and remove the tachometer drive adapter cover. Wipe the oil from the rear end of the accessory drive upper shaft. Use a suitable tachometer (Fig. 44), refer to the table below, and check the engine speed as follows:

	LOW IDLE		HIGH IDLE		GOVERNED AT FULL LOAD	
	Crankshaft R.P.M.	Accessory Drive Upper Shaft R.P.M.	Crankshaft R.P.M.	Accessory Drive Upper Shaft R.P.M.	Crankshaft R.P.M.	Accessory Drive Upper Shaft R.P.M.
Tractors Prior to S/N 4001 (Without Torque Converter)	525 to 550	785 to 825	1715 (+ or — 25)	2570 (+ or — 35)	1600	2400
Tractors Prior to S/N 4001 (With Torque Converter)	525 to 550	785 to 825	1915 (+ or — 25)	2870 (+ or — 35)	1800	2700
Tractors S/N 4001 and Above (Without Torque Converter)	525 to 550	785 to 825	1685 (+ or — 25)	2525 (+ or — 35)	1600	2400
Tractors S/N 4001 and Above (With Torque Converter)	525 to 550	785 to 825	1925 (+ or — 25)	2885 (+ or — 35)	1800	2700

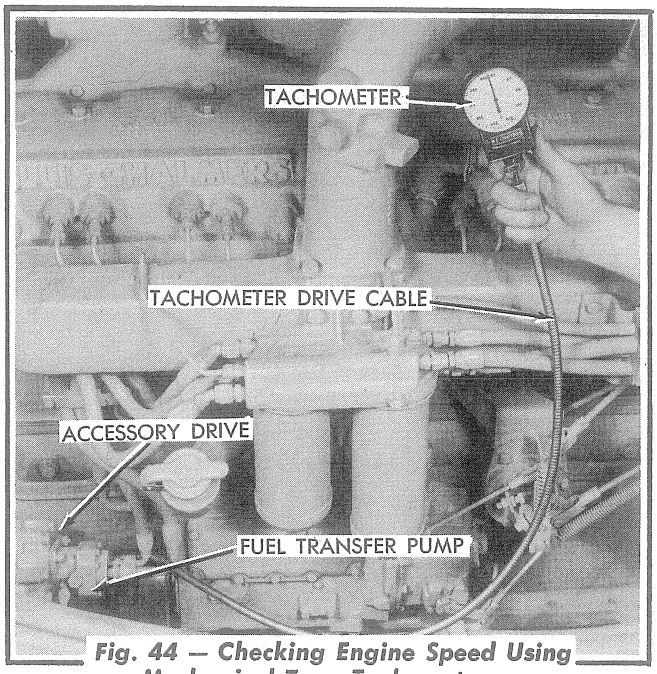

Fig. 44 — Checking Engine Speed Using Mechanical Type Tachometer on Accessory Drive Upper Shaft

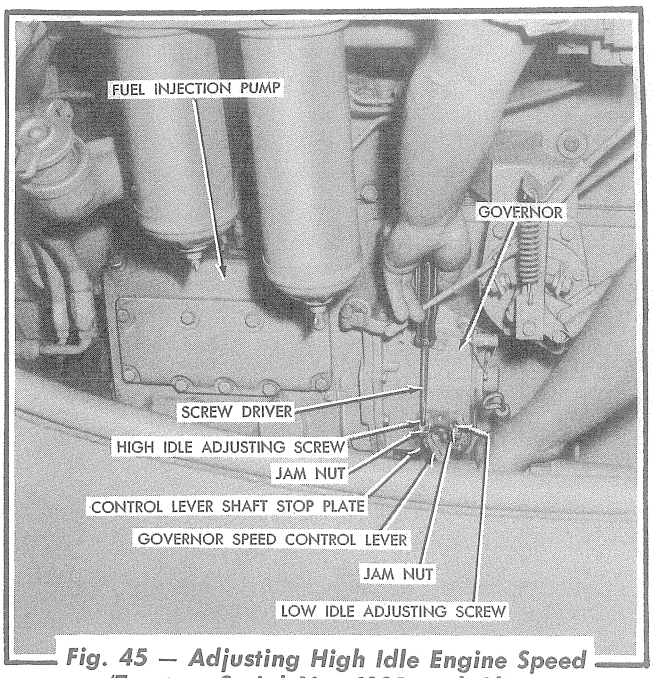

Fig. 45 — Adjusting High Idle Engine Speed (Tractors Serial No. 4001 and Above Shown — Earlier Tractors Similar)

a. Make certain the transmission shift lever is in NEUTRAL and the engine clutch is disengaged.

b. Start the engine and move the throttle operating lever all the way forward (low idle position). Using a tachometer, check the low idle engine speed. Pull the throttle operating lever all the way back (high speed position). Using a tachometer, check the high idle speed. If the engine speeds are not within the specified ranges, it will be necessary to adjust the governor.

3. Low Idle and High Idle Engine Speed Adjustments

a. Remove the speed adjusting screw access cover from the governor.

b. Disconnect the throttle control front rod from the governor speed control lever so that the lever may be moved by hand.

c. With the engine running, loosen the jam nut on the low idle adjusting screw. Hold the governor speed control lever so that the control lever shaft stop plate contacts the low idle adjusting screw. Turn the low idle adjusting screw IN as necessary to increase or OUT as necessary to decrease the low idle speed. When the specified low idle speed is obtained, hold the low idle adjusting screw and tighten the jam nut.

d. With the engine running, loosen the jam nut on the high idle adjusting screw. Hold the governor speed control lever so that the control lever shaft stop plate contacts the high idle adjusting screw. Turn the high idle adjusting screw OUT as necessary to increase or IN as necessary to decrease the high idle speed. When the high idle speed is within the specified range (refer to preceding table), hold the high idle adjusting screw and tighten the jam nut. Stop the engine.

e. Install the speed adjusting screw access cover in position on the governor.

f. Connect the throttle control front rod to the governor speed control lever.

8. ENGINE CONTROLS

A. Description

The throttle operating lever is used to regulate the speed of the engine. Throttle control rods and linkage connect the throttle operating lever with the speed control lever of the governor. The engine runs at full governed speed when the throttle operating lever is pulled all the way back and runs at idling speed when the throttle operating lever is pushed all the way forward.

A throttle assembly is provided in the throttle control linkage for the purpose of holding the throttle operating lever in any desired position between the low idle and high speed positions. The throttle assembly (Fig. 49) consists of a drum and shaft, friction band assembly, housing, and covers. The friction band, which is assembled around the drum, acts as a brake and holds the throttle operating lever in any desired position, therefore an infinite range of speed can be obtained between low idle and full governed speed. The throttle assembly is provided with an adjusting capscrew for adjusting the tightness of the band on the drum for ease of throttle operation.

On tractors Serial No. 4001 and above, a decelerator pedal (Fig. 48) located to the right of the right brake pedal, is provided on tractors with a torque converter, for use in conjunction with the throttle operating lever to regulate the engine speed. NOTE: *The decelerator is available for tractors without a torque converter, as special equipment.* With the engine operating at full speed (throttle operating lever all the way back), depressing the decelerator pedal with the foot slows the engine to the desired speed. Releasing of the decelerator pedal allows the engine speed to increase to the speed where the throttle operating lever is positioned. The pedal should be used for decelerating when shifting gears, or where minute control of the engine speed is required.

The engine shut-off knob is connected by linkage to the fuel shut-off lever of the fuel injection pump. When the shut-off knob is pushed all the way forward, the fuel shut-off lever is moved to the "RUN" position; pulling the knob all the way back moves the lever to the "STOP" position. Improper adjustment of the engine shut-off linkage may result in loss of engine speed or power, failure of the engine to start with the shut-off knob pushed in, or failure of the engine to stop when the shut-off knob is pulled back.

B. Adjustment of Engine Shut-Off Control Linkage on Tractors Prior to Serial No. 4001

If the engine shut-off controls fail to operate properly, first be sure the linkage and levers are properly lubricated and the condition is not due to binding in the linkage or to a broken spring.

Adjust the shut-off control linkage as follows:

1. Push the engine shut-off knob to the "RUN" position. Check the fuel shut-off lever of the fuel injection pump to see if the lever is moved to its extreme forward position (as far as it will go). If the shut-off lever is not moved to its extreme forward position, adjust the length of the engine shut-off intermediate rod as necessary to obtain full travel of the fuel shut-off lever.

2. Loosen the small stop clamp (Fig. 46), located on the engine shut-off rear rod, then pull the engine shut-off knob back as far as it will go. Push the shut-off knob forward $\frac{1}{16}$", then move the stop clamp rearward on the shut-off rear rod so that it contacts the rod guide boss (welded in cowl) and tighten the clamp securely. With the stop clamp in this position, the clamp will serve as a stop and will prevent imposing undue strain on the shaft for the fuel shut-off lever when the engine shut-off knob is pulled back to stop the engine.

C. Adjustment of Throttle Control Linkage on Tractors Prior to Serial No. 4001

If the throttle control fails to operate properly, first be sure the linkage is properly lubricated and the condition is not due to binding or to a broken spring. Adjust the throttle control linkage as follows:

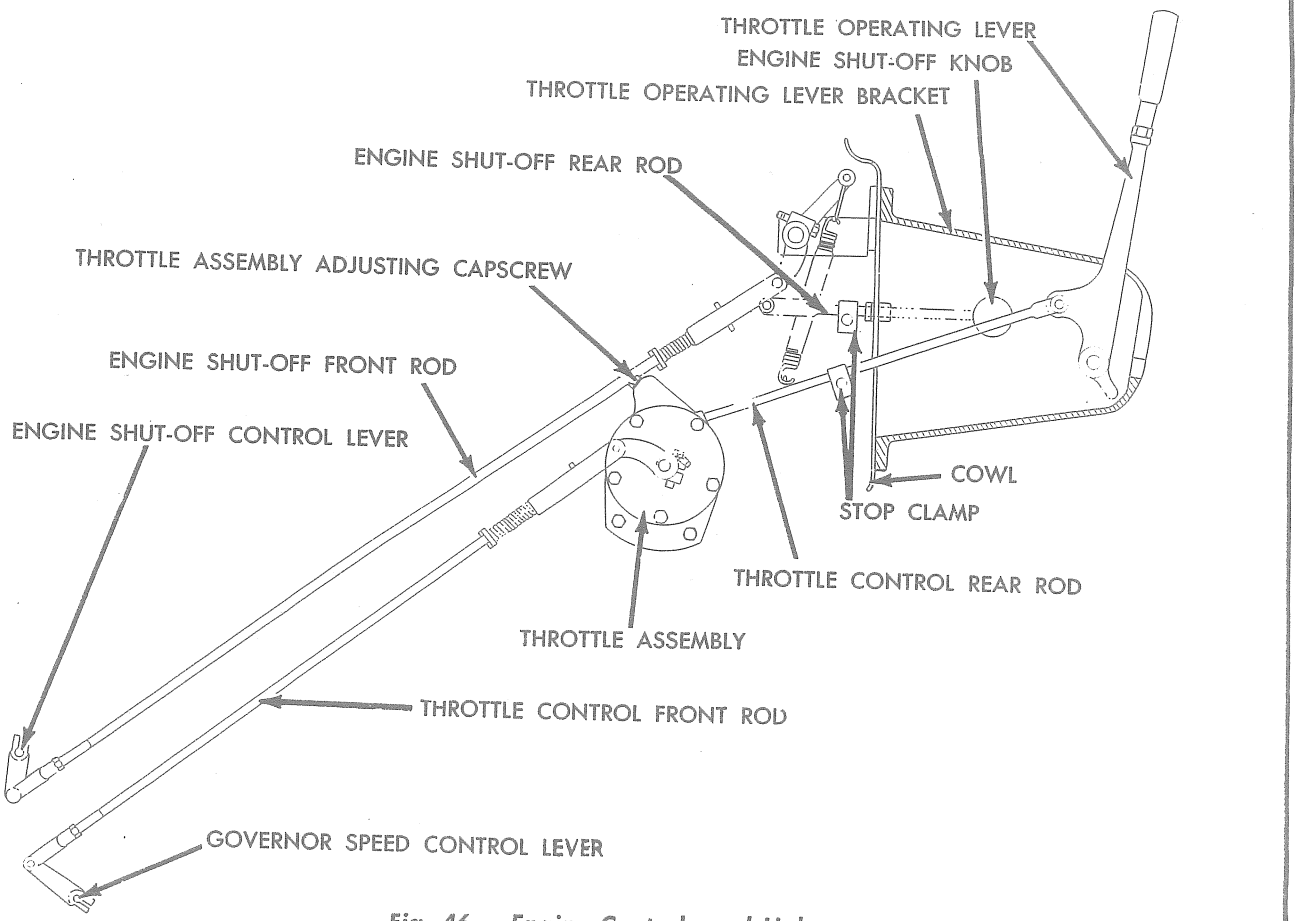

Fig. 46 — Engine Controls and Linkage (Tractors Prior to Serial No. 4001)

1. Move the throttle operating lever forward as far as possible (low idle position). Check the speed control lever of the governor to determine if the lever is in its extreme forward position (as far as it will go).

2. With the throttle operating lever moved all the way forward (low idle position), adjust the length of the throttle control intermediate rod so that the front side of the throttle operating lever just contacts its bracket.

3. Loosen the stop clamp (Fig. 46), located on the throttle control rear rod, then pull the throttle operating lever all the way back (high speed position), and make certain the throttle linkage moves the governor speed control lever rearward as far as it will go; shorten or lengthen the throttle control front rod as necessary by turning the control rod yoke. Push the throttle operating lever forward 1/16" from its high speed position, move the stop clamp rearward on the throttle control rear rod so that it contacts the cowl, and tighten the stop clamp bolt. With the stop clamp in this position, the clamp will serve as a stop and will prevent imposing undue strain on the governor speed control lever shaft when the throttle operating lever is moved to the high speed position.

4. A throttle assembly (Fig. 46), mounted on the front side of the cowl and containing a friction band, is provided in the throttle control linkage for the purpose of holding the throttle operating lever in any desired speed position between low idle and high speed position. If the throttle operating lever will not remain stationary when moved to the desired speed position, adjustment of the throttle assembly is necessary. Remove the cotter pin from the throttle assembly adjusting capscrew (Fig. 46) and turn the capscrew IN to increase or OUT

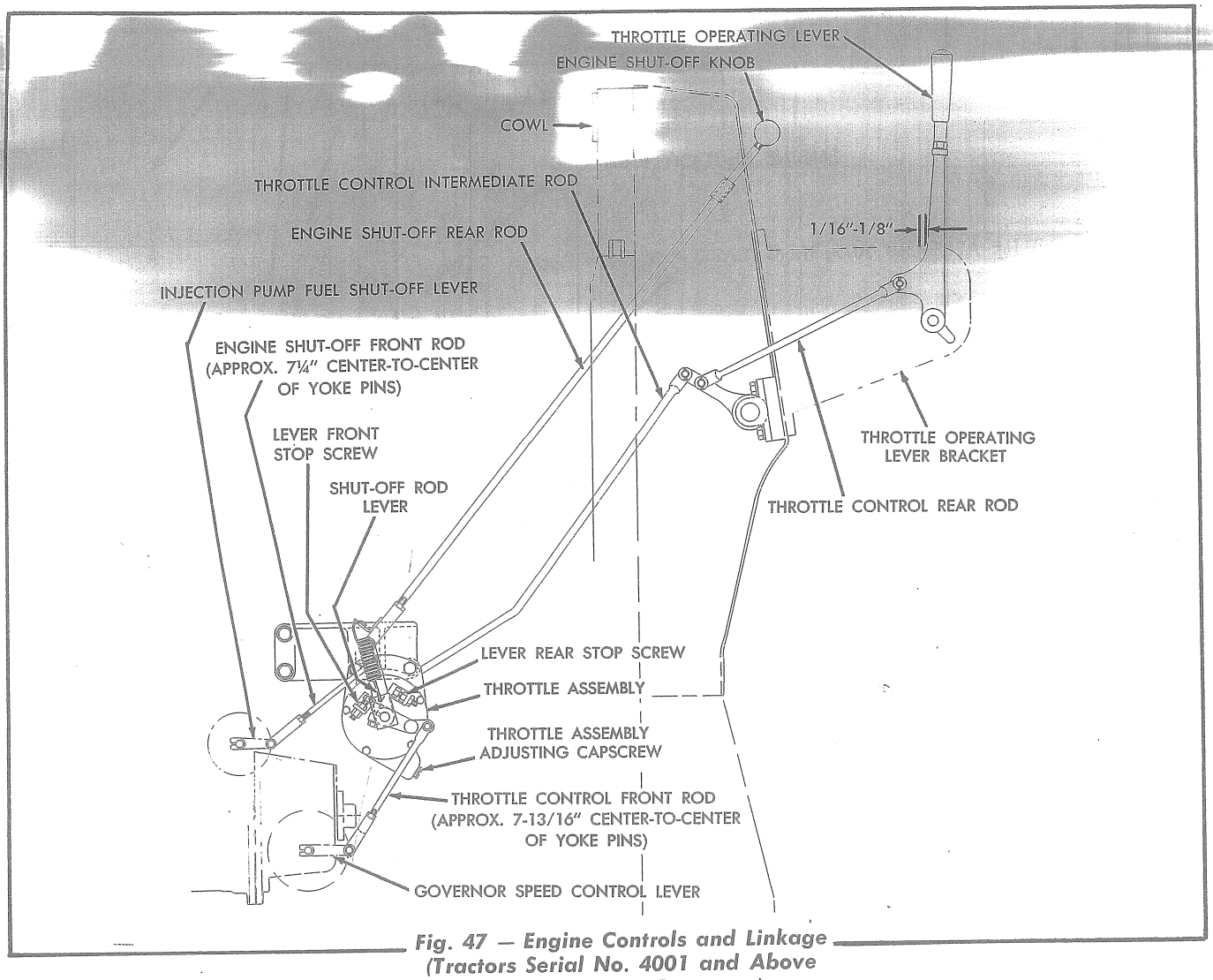

Fig. 47 — Engine Controls and Linkage (Tractors Serial No. 4001 and Above Without Torque Converter)

to decrease the friction band tension as necessary. Install the cotter pin in the adjusting screw.

D. Adjustment of Engine Shut-Off Control Linkage on Tractors Serial No. 4001 and Above

If the engine shut-off controls fail to operate properly, first be sure the linkage and levers are properly lubricated and the condition is not due to binding in the linkage or to a broken spring. Adjust the shut-off linkage as follows:

1. Remove the yoke pin connecting the engine shut-off front rod (Fig. 47 or 48) to the injection pump fuel shut-off lever. Pull the engine shut-off knob back as far as it will go. Check and make certain that the shut-off rod lever (Fig. 47 or 48) located on the shaft of the throttle assembly, is contacting the shut-off rod lever rear stop screw (Fig. 47 or 48).

2. Move the injection pump fuel shut-off lever up (toward rear) as far as it will go. Hold the lever in this position and adjust the length of the engine shut-off front rod as necessary so that the lower yoke pin can be inserted through the yoke and the fuel shut-off lever. Tighten the yoke lock nut on the engine shut-off front rod. Remove the yoke pin.

3. Push the engine shut-off knob forward as far as it will go. Move the injection pump fuel shut-off lever down (toward front) as far as it will go. Hold the lever in this posi-

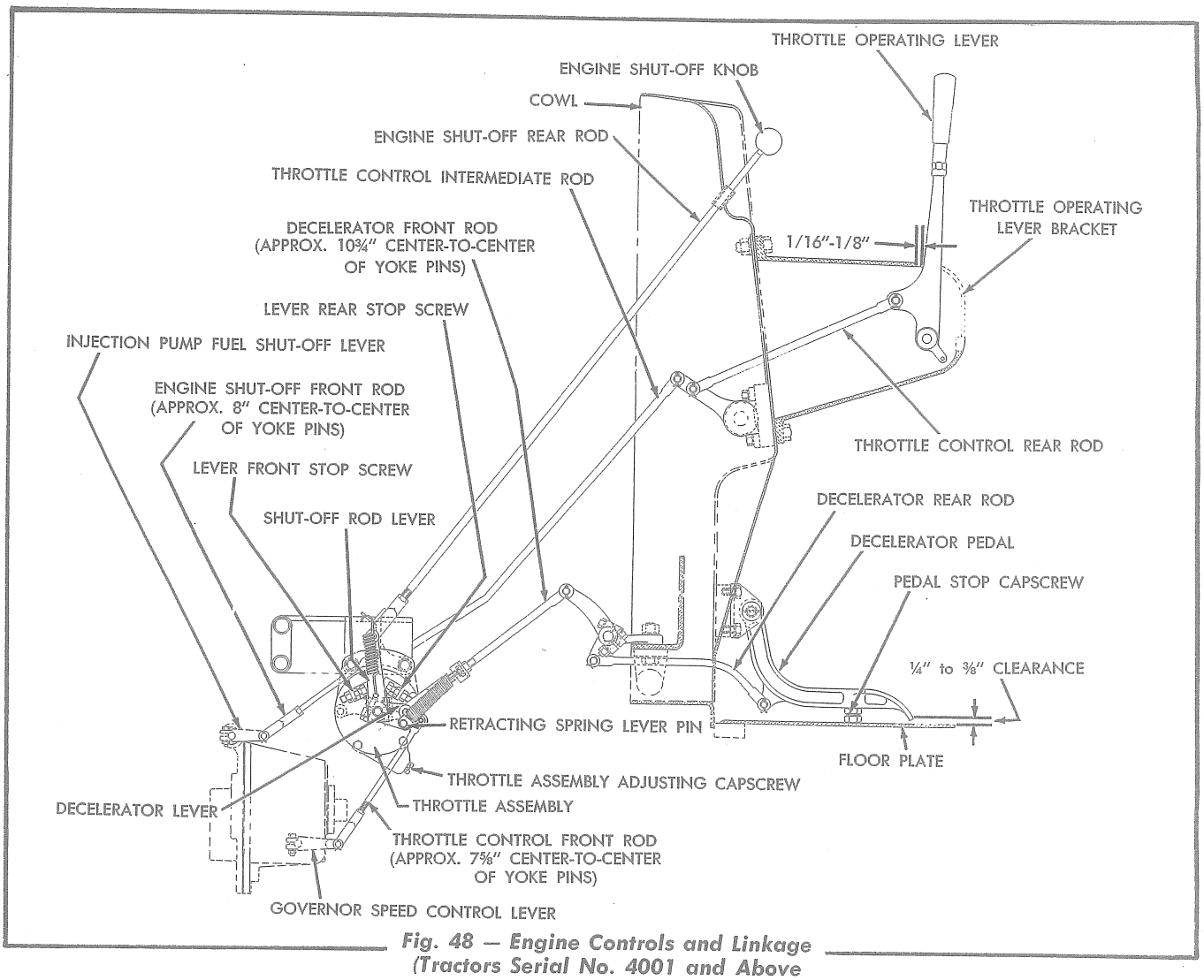

Fig. 48 — Engine Controls and Linkage (Tractors Serial No. 4001 and Above with Torque Converter)

tion and adjust the shut-off rod lever front stop screw (Fig. 47 or 48) as necessary so that the yoke pin can be inserted through the yoke and the fuel shut-off lever, with the shut-off rod lever contacting the front stop screw. Secure the yoke pin with a cotter pin and tighten the jam nut on the front stop screw.

E. Adjustment of Throttle Control Linkage on Tractors Serial No. 4001 and Above

If the throttle control fails to operate properly, first be sure the linkage is properly lubricated and the condition is not due to binding or to a broken spring. Adjust the throttle control linkage as follows:

1. Tractors Without a Torque Converter

a. Remove the yoke pin connecting the throttle control front rod (Fig. 47) to the governor speed control lever. Push the throttle operating lever forward as far as it will go (low idle position). Check and make certain that the throttle control rod lever located on the shaft of the throttle assembly, is contacting the throttle control rod lever front stop screw, located on the inner side (engine side) of the throttle assembly.

b. With the throttle control rod lever contacting the front stop screw of the throttle assembly, check the position of the throttle operating lever (hand lever). Adjust the throttle control intermediate rod as necessary so that there is 1/16" to 1/8" clearance between the front of the throttle operating lever and the lever bracket (as shown in

Fig. 47) when the throttle control rod lever is against the front stop screw of the throttle assembly.

c. Move the governor speed control lever up (toward rear) as far as it will go. Hold the lever in this position and adjust the length of the throttle control front rod as necessary so that the yoke pin can be inserted through the yoke and the governor speed control lever. Tighten the lock nut on the throttle control front rod. Secure the yoke pin with a cotter pin.

d. Loosen the jam nut on the rear stop screw located on the inner side (engine side) of the throttle assembly and turn the stop screw (rearward) into the bracket several turns. Pull the throttle operating lever back until the governor speed control lever is moved down (forward) as far as it will go. Turn the rear stop screw forward until the stop screw just contacts the throttle control rod lever. Hold the stop screw from turning and tighten the jam nut.

2. Tractors with a Torque Converter

a. Remove the yoke pin connecting the throttle control front rod (Fig. 48) to the governor speed control lever. Push the throttle operating lever forward as far as it will go (low idle position). Check and make certain that the throttle control rod lever located on the shaft of the throttle assembly, is contacting the throttle control rod lever front stop screw, located on the inner side (engine side) of the throttle assembly.

b. With the throttle control rod lever contacting the front stop screw of the throttle assembly, check the position of the throttle operating lever (hand lever). Adjust the throttle control intermediate rod as necessary so that there is 1/16" to 1/8" clearance between the front of the throttle operating lever and the lever bracket (as shown in Fig. 48) when the throttle control rod lever is against the front stop screw of the throttle assembly.

c. Move the governor speed control lever up (toward rear) as far as it will go. Hold the lever in this position and adjust the length of the throttle control front rod as necessary so that the lower yoke pin can be inserted through the yoke and the governor speed control lever. Tighten the lock nut on the throttle control front rod. Secure the yoke pin with a cotter pin.

d. Pull the throttle operating lever all the way back as far as it will go. Push the throttle operating lever forward until the inner end of the retracting spring lever pin (Fig. 48) just contacts the front of the decelerator lever, then adjust the throttle control rod lever rear stop screw (Fig. 48) so that it just contacts the throttle control lever. Tighten the jam nut on the rear stop screw.

e. After making the above checks and adjustments, check the decelerator linkage as follows:

(1) Move the throttle operating lever to its low idle position (all the way forward).

(2) Measure the clearance between the end of the decelerator pedal and the top of the floor plate; the clearance should be 1/4" to 3/8" (as shown in Fig. 48) when the pedal stop capscrew contacts the floor plate.

(3) If the clearance is not 1/4" to 3/8", adjust the length of the decelerator front rod as necessary to obtain the proper clearance, and adjust the pedal stop capscrew to contact the floor plate.

F. Adjustment of Throttle Assembly

The throttle assembly (Fig. 47 or 48), mounted on the left side of the engine, contains a friction band and is provided in the throttle linkage for the purpose of holding the throttle operating lever in any desired engine speed position between low idle and high speed position.

If the throttle operating lever will not remain sta-

tionary when moved to the desired speed position, adjustment of the throttle assembly is necessary. Remove the cotter pin from the throttle assembly adjusting capscrew (Fig. 47 or 48). Turn the capscrew IN to increase or OUT to decrease the friction band tension until a pull of 15 lbs. (+ or — 2 lbs.) is required to pull the throttle operating lever back. Install the cotter pin in the adjusting capscrew.

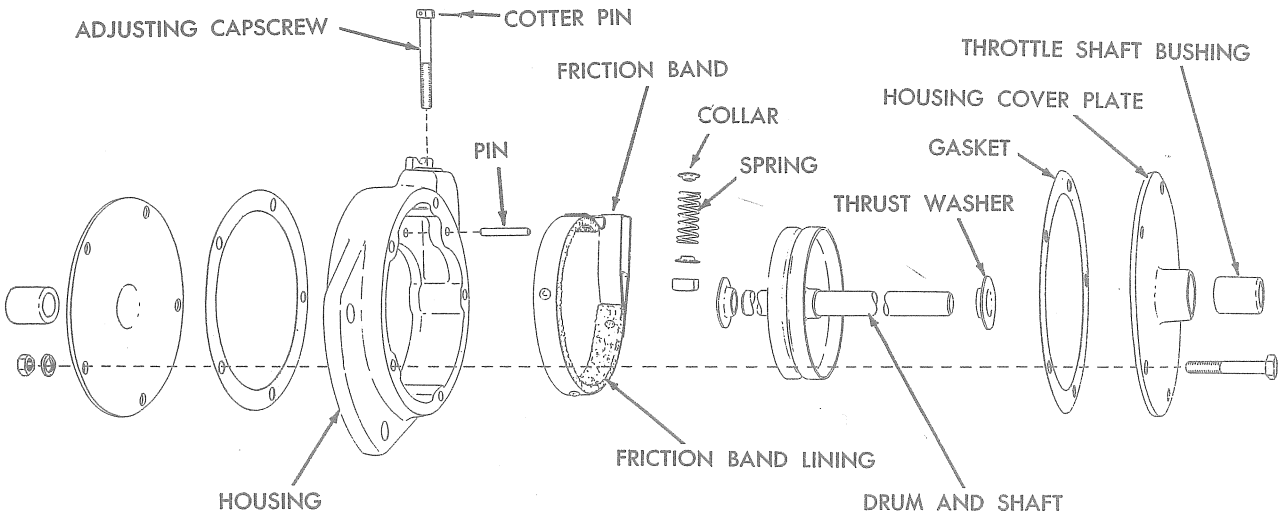

Fig. 49 — Throttle Assembly

SECTION III — ENGINE AIR INTAKE SYSTEM

Topic Title	Topic No.	Page No.
Description of System	1	60
Air Pre-Cleaner	2	60
Air Cleaner	3	61
Cold Weather Engine Primer	4	62
Engine Air Heater (Special Equipment)	5	64

1. DESCRIPTION OF SYSTEM

The engine air intake system includes the air pre-cleaner, air cleaner, air inlet tube, and the air inlet elbow. The purpose of the air pre-cleaner and the air cleaner is to remove dust and other foreign matter from the air used by the engine. The life of the engine depends largely upon the efficiency of the air pre-cleaner and the air cleaner. Rapid wear on cylinder sleeves, pistons, and rings will result if the air pre-cleaner and air cleaner are not kept in good condition and properly serviced.

In warm weather, sufficient heat is generated by compression of the air within the cylinders to ignite the fuel and start the engine within a very short cranking period. However, in cold weather the "drag" caused by cold oil between the pistons and cylinder walls and in the bearing, reduces the cranking speed of the engine. A large part of the heat generated by compression of the air is absorbed by the pistons and cylinder walls. This heat loss and the reduced cranking speed may reduce the temperature of the air in the cylinders to a point too low to ignite the fuel. A Cold Weather Engine Primer (Standard Equipment) or an Engine Air Heater (Special Equipment) is provided as an aid for starting the engine in cold weather.

2. AIR PRE-CLEANER

A. Description

Air for the engine enters through the air pre-cleaner mounted on top of the air cleaner pipe. The air pre-cleaner is designed to impart a rotary motion to the air; this causes the heavy particles of dust to be thrown to the outside of the pre-cleaner shell and deposited therein. A large percentage of the dust in the air drawn through the air pre-cleaner is thus removed before the air enters the air cleaner.

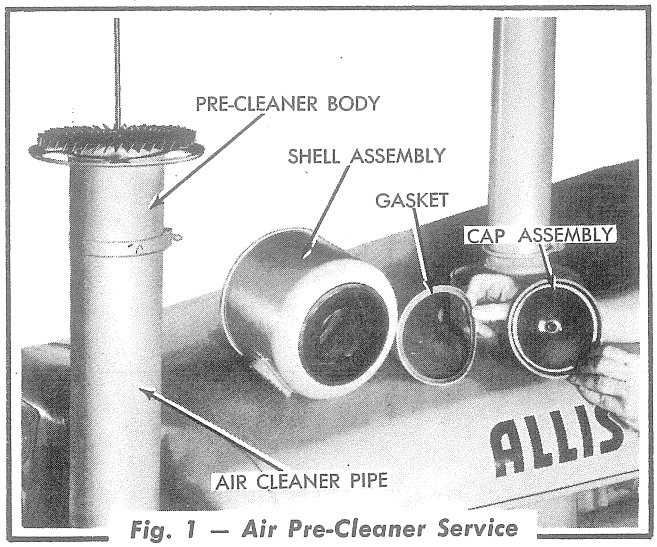

Fig. 1 — Air Pre-Cleaner Service

B. Air Pre-Cleaner Service

Empty the air pre-cleaner whenever the dust level reaches half-way up on the inspection glass located in the pre-cleaner shell assembly. Remove and clean as follows:

1. Unscrew the wing nut and remove the cap from the shell. Lift the shell from the pre-cleaner body.
2. Empty the dust from the shell and wipe the inside of the shell with a dry cloth. Make sure the fins in the pre-cleaner body are not bent, damaged, or clogged.
3. Wipe the dust off the cap and reassemble the pre-cleaner. Replace the cap gasket if it is not in good condition. Tighten the wing nut with the fingers; *DO NOT USE A WRENCH.*

3. AIR CLEANER

A. Description

After passing through the air pre-cleaner, the air enters the air cleaner through the pipe that extends down through the center of the air cleaner body. An oil cup filled to a specified level with engine oil is suspended on the lower end of the air cleaner body. As the air is drawn through the air cleaner, a portion of this oil is drawn up onto the rust-proof metallic filtering screens in the main body of the air cleaner. Dust still remaining in the air is collected by the filtering screens as the air passes through them. The oil, dripping back into the oil cup, carries this dust with it and deposits it in the cup. Thus, only clean air enters the engine air intake for delivery to the cylinders.

A damaged hose, loose hose clamp, damaged gasket, or leak of any kind that allows air to enter the engine cylinders without first passing through the air cleaner will defeat the purpose of the cleaner; therefore, extreme care should be taken to prevent leaks. Periodic inspection of the above parts and of the air cleaner body for dents, cracks, loosened solder connections, etc., should be made frequently. If any of the above mentioned conditions are found, they must be corrected immediately.

B. Service of Air Cleaner

The filtering oil in the air cleaner oil cup must be checked daily, or more often when operating under extremely dusty conditions, or in cold weather when operating in snow. Snow will be drawn in with the air and will melt in the air cleaner oil cup, raising the oil level. This mixture of oil and water will freeze into a mush-like mixture when the engine is stopped and air cleaner efficiency will be impaired when operation is resumed. Keep the oil cup filled to the specified level (stamped in the air baffle) with clean engine oil. CAUTION: *DO NOT OVERFILL.* Empty and wash the cup whenever the oil becomes discolored, indicating a quantity of dirt has collected, then refill the cup to the specified level with clean engine oil. Use the same viscosity oil as is used in the engine.

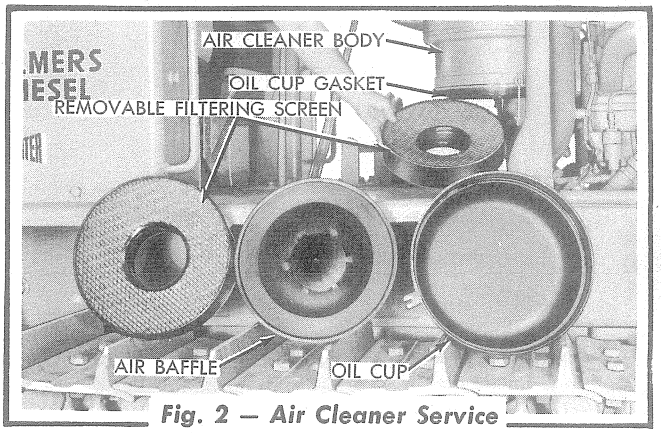

Fig. 2 — Air Cleaner Service

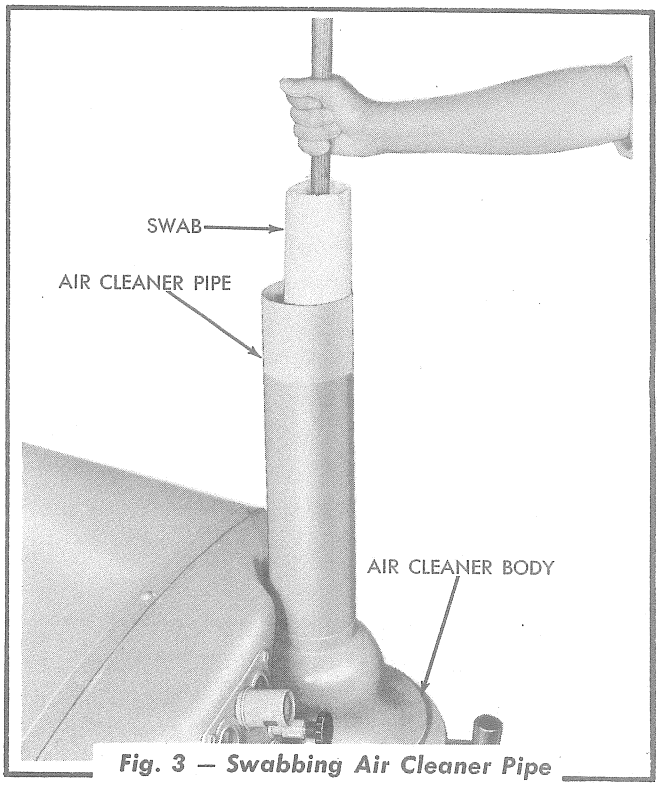

Fig. 3 — Swabbing Air Cleaner Pipe

NOTE: *SOME "DIESEL" ENGINE LUBRICATING OILS MAY FOAM WHEN USED IN THE AIR CLEANER. DO NOT USE AN OIL THAT FOAMS AS IT REDUCES AIR CLEANER EFFICIENCY AND IN SOME CASES ALLOWS THE OIL TO BE PULLED OVER INTO THE ENGINE, CAUSING SERIOUS DAMAGE.*

Service the air cleaner as follows:

1. Remove the oil cup from the bottom of the air cleaner body. Remove the air baffle from the oil cup, then empty the oil from the cup.

2. Thoroughly wash the oil cup and the air baffle with clean solvent or fuel. Remove the air pre-cleaner assembly from the top of the air cleaner pipe and swab out the inside of the air cleaner pipe that extends from the pre-cleaner to the oil cup. Install the air pre-cleaner assembly.

3. The removable filtering screens of the air cleaner should be removed periodically for cleaning. Remove the lower and upper filtering screens from the air cleaner body. Wash the filtering screens in clean solvent or fuel, dry with compressed air, and re-install in their respective positions (lower screen has baffle retaining spring).

4. Install the air baffle in position in the oil cup and fill the cup to the proper level (even with top of cone in center of air baffle) with clean engine oil. CAUTION: *DO NOT OVERFILL.*

5. Be sure that the oil cup gasket is in good condition, then install the oil cup in position on the bottom of the air cleaner body. Check the hose clamps on the front and rear hoses and make certain the clamps are tight and the hoses are not crimped, allowing air to enter the engine without passing through the air cleaner.

4. COLD WEATHER ENGINE PRIMER

A. Description

The cold weather engine primer consists of a cold weather starting fluid dispenser assembly, which holds and punctures a capsule containing ethyl ether starting fluid, a primer pump to force the starting fluid through a small nozzle and into the engine air inlet tube, a primer elbow assembly, and the necessary lines to complete the system. The dispenser is located on the cowl (below the instrument panel) and the primer pump is mounted in the instrument panel with the instruments, as shown in Fig. 4. The starting fluid is forced through the primer elbow assembly and into the engine air inlet tube, where it mixes with the intake air before it enters the cylinders. Since the starting fluid is highly combustible, it is easily ignited by the heat of the compressed air within the cylinders. The engine will start quickly at low ambient temperatures with the aid of the primer, even at a slow cranking speed. The starting fluid capsules, available in 7 c.c. and 17 c.c. sizes, can be obtained from "Allis-Chalmers" Dealers.

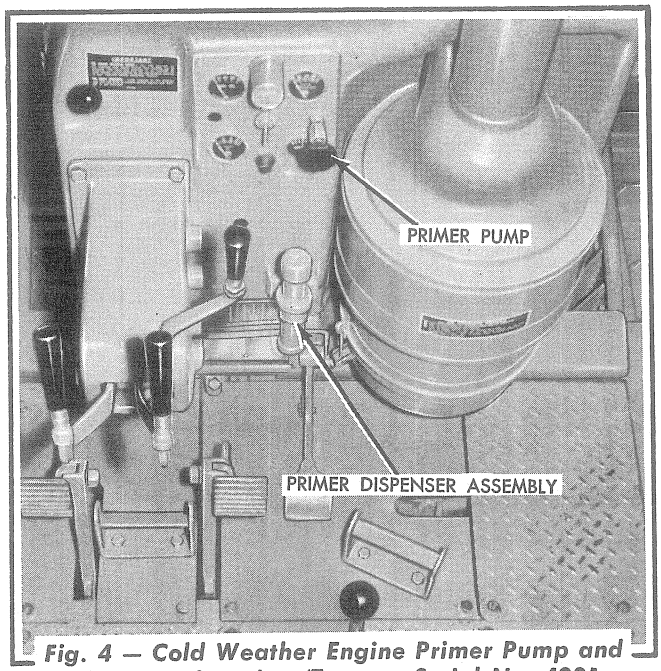

Fig. 4 — Cold Weather Engine Primer Pump and Dispenser Location (Tractors Serial No. 4001 and Above Shown — Tractors Prior to Serial No. 4001 Similar)

B. Engine Primer Trouble Shooting

If the engine is cranked, with the throttle operating lever pulled all the way back and with the engine shut-off knob all the way forward, and does not start after several strokes of the primer pump, it is advisable to stop cranking and inspect the primer system for the following possible causes of failure.

1. Clogged Primer Elbow Assembly

This condition will usually be indicated by excessive resistance on the primer pump. A partially clogged primer elbow assembly will prevent the delivery of sufficient starting fluid to the engine air intake system. To clean the primer elbow assembly, remove the elbow assembly from the air inlet tube and remove the small nozzle from the primer elbow assembly. Place the elbow and nozzle in alcohol to dissolve any gummy deposits. Open the hole

in the end of the nozzle, if clogged, and blow out with compressed air. CAUTION: *Do not enlarge the hole in the end of the nozzle.* If the nozzle is badly clogged, replace the primer elbow assembly. Install the elbow assembly in position in the air inlet tube and connect the fluid supply line.

2. Inoperative Primer Pump

Failure of the primer pump to function properly may be due to worn or damaged pump piston rings, a clogged fluid dispenser strainer, clogged fluid lines, or "frozen" or worn pump check valve balls. The piston rings on the pump piston are made of a special rubber composition and must be replaced by duplicate parts if worn or damaged.

To replace the primer pump piston rings, unscrew the piston locking nut from the pump barrel and withdraw the piston assembly from the barrel. Remove the piston rings from the grooves in the piston assembly and install new rings. Lubricate the rings and piston with light engine oil, install the piston assembly in the pump barrel, and tighten the piston locking nut.

3. Ball Check Valves

The two spring loaded ball check valves, located in the inlet and outlet ports of the primer pump, are provided to close the pump ports at the proper time. When the pump piston is pulled out (suction stroke, drawing starting fluid from dispenser), the ball check valve at the inlet port opens, allowing the fluid to be drawn from the dispenser. When the pump piston is pushed in (delivery stroke, supplying starting fluid to the primer elbow assembly), the ball check valve at the outlet port opens, allowing the pump to force the fluid to the primer elbow assembly.

Worn or "frozen" ball check valves, or broken springs, will prevent the primer pump from operating properly. When this occurs, remove the spring retainers, springs, and balls from the inlet and outlet ports of the pump. Inspect the balls, ball seats, and springs for wear or damage. Clean the pump barrel and all components thoroughly and reassemble, using new parts where necessary.

4. Clogged Fluid Dispenser Strainer

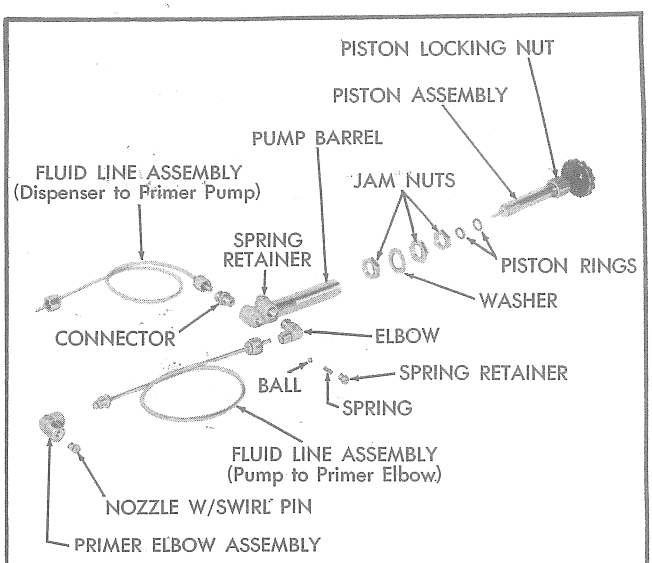

Fig. 5 — Primer Pump and Primer Elbow Details

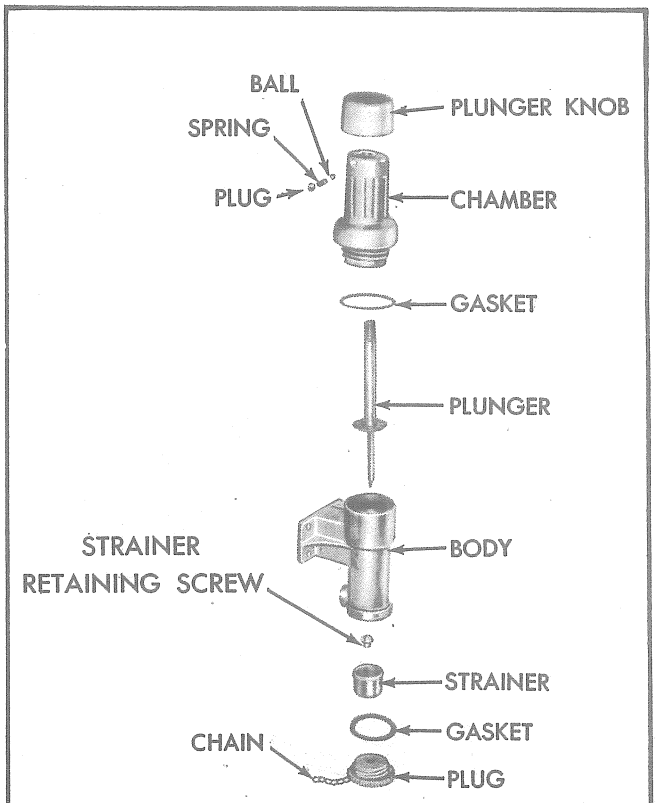

Fig. 6 — Starting Fluid Dispenser Details

A strainer is attached to the plug screwed into the bottom of the fluid dispenser body. If the starting fluid capsules are not removed soon after puncturing, the gelatine will melt and clog the strainer.

To clean the strainer, refer to Fig. 6, and unscrew the plug from the dispenser body and wash the strainer and plug in hot water. The strainer may be removed for replacement if necessary, by removing the screw attaching the strainer to the plug.

The fluid dispenser body may be washed without removing it from the cowl by removing the fluid dispenser chamber, the line connector and the plug.

Reassemble the dispenser assembly by a direct reversal of the disassembly procedure.

5. ENGINE AIR HEATER (SPECIAL EQUIPMENT)

A. Description

The engine air heater is essentially a small oil burner with electric ignition and is installed in a special engine air intake elbow which replaces the standard elbow. Fuel is supplied to the heater by a hand operated pump mounted in the instrument panel. On tractors prior to Serial No. 4001, the heater fuel supply pump draws fuel from the fuel pressure gage line. On tractors Serial No. 4001 and above, the heater fuel supply pump draws fuel from the top of the fuel filter head.

On the first type engine air heater, Figs. 7 and 10, the fuel supply pump forces the fuel through a small spray nozzle installed in the air heater body. On the second type engine air heater, Figs. 8 and 11, the fuel supply pump forces the fuel through a small spray nozzle installed in the engine air intake elbow.

Electrodes located in front of the spray nozzle ignite the fuel. The fuel thus ignited produces a flame which pre-heats the intake air to the engine. A push button type switch mounted in the instrument panel is provided to close the electric circuit to furnish electrical current to the coil which supplies high tension current to the electrodes.

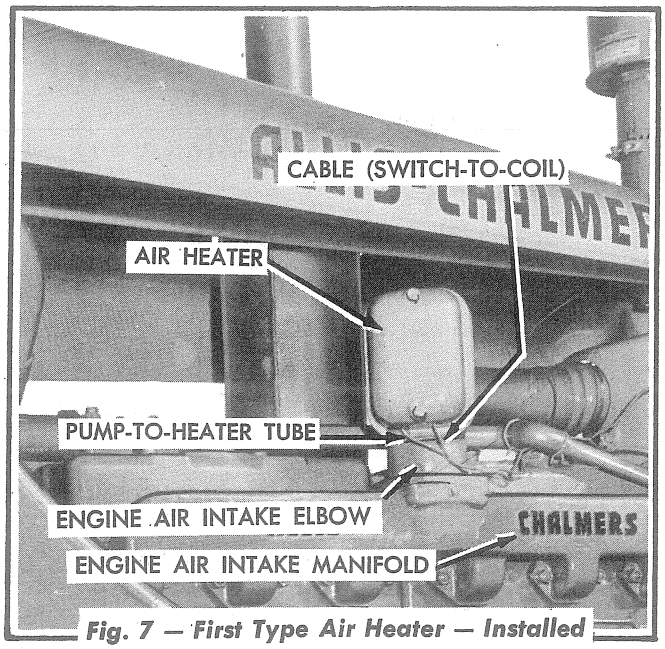

Fig. 7 — First Type Air Heater — Installed

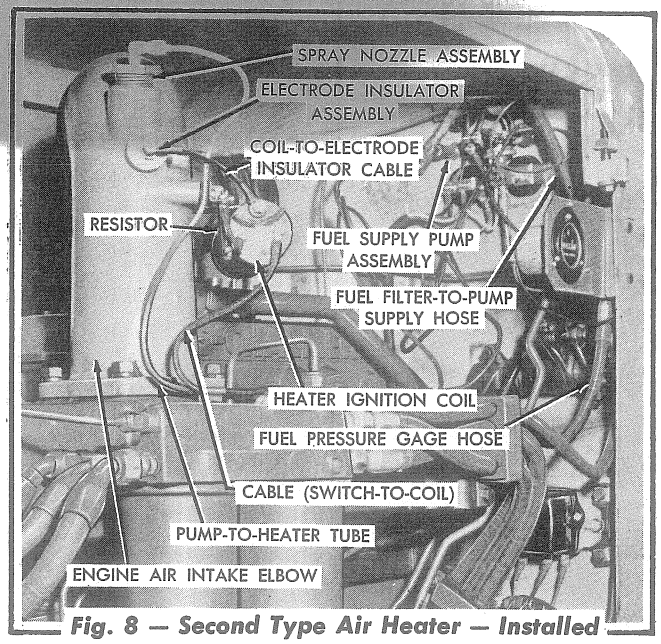

Fig. 8 — Second Type Air Heater — Installed

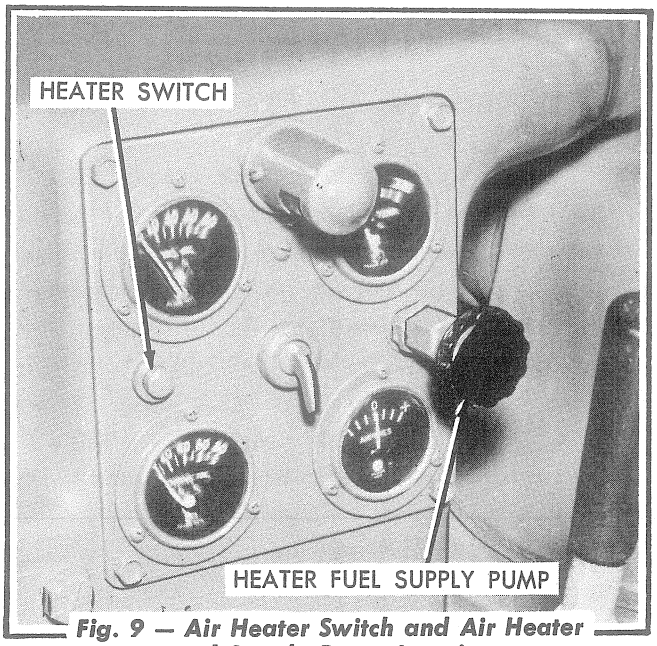

Fig. 9 — Air Heater Switch and Air Heater Fuel Supply Pump Location

B. Engine Air Heater Operation

In cold weather when it is necessary to use the engine air heater as an aid to start the engine, proceed as follows:

1. Disengage the engine clutch and move the transmission speed selection shift lever to its neutral position.

2. Push the engine shut-off knob all the way forward (run position).

3. Pull the throttle operating lever all the way back (high idle). Push in on the heater fuel supply pump knob and turn the knob to unlock the pump piston from the piston locking nut.

4. Crank the engine with the starter. While the starter is cranking the engine, press in on the air heater switch button and at the same time operate the air heater fuel supply pump with smooth even strokes.

   CAUTION: *Under no circumstances should starting fluid be used in engines equipped with an engine air heater.*

5. As soon as the engine starts, release the air heater switch button and immediately slow the engine to about ¼ throttle allowing the engine to warm up gradually. Push the air heater fuel supply pump knob all the way in and turn the knob to lock the piston.

   CAUTION: *Under no circumstances should starting fluid be used in engines equipped with an engine heater.*

C. Engine Air Heater Trouble Shooting

If the engine is cranked with the throttle operating lever pulled all the way back (high idle) and fails to start after several strokes of the air heater fuel supply pump (with heater switch button depressed), it is advisable to stop cranking and inspect for possible causes of failure. If an adequate cranking speed is obtained and the cylinders are receiving fuel (usually indicated by a light blue smoke from the exhaust), the trouble is probably due to improper function of the air heater.

The ignition system to the electrodes may be considered in working order if a "buzzing" sound is heard while pressing in on the air heater switch button. However, the same "buzzing" sound will be produced by a spark arcing across the insulator assembly instead of arcing at the electrodes as it should. To check the first type air heater (Fig. 10) remove the air heater cover. Loosen the air heater attaching capscrew, turn the clamp and remove the air heater assembly from the air intake elbow. Position the air heater assembly so that it is grounded and the electrodes and spray nozzle can be observed.

To check the second type air heater (Fig. 11), loosen the hose clamp attaching the front hose to the air intake elbow. Remove the capscrews attaching the air intake elbow to the air intake manifold and position the air intake elbow so that it is grounded and the electrodes and spray nozzle can be observed through the opening in the flanged end of the elbow.

Inspect the air heater for the following possible causes of failure:

1. Coil Points

Remove the cover from the end of the ignition coil (Fig. 12). Observe the coil points and the electrodes while pressing in on the heater switch button. The coil points should vibrate rapidly and continuous arcing should occur between the electrodes. If arcing does not occur between the electrodes, and the coil points do not operate properly, inspect the heater switch and wiring for loose connections. Inspect the coil points for dirt and carbon. Clean the coil points with a clean, fine-cut contact file. Never use sandpaper or emery cloth for cleaning the points as particles of emery or sand may be embedded and cause point burning. Reset the points after cleaning to provide .018" gap, with the vibrator arm held down against the coil body.

2. Electrodes

Check the gap between the electrodes; adjust for a 7/64" (+ or — 1/64") gap if necessary by bending the tip of the electrode screw. CAUTION: *Do not attempt to bend the tip of the electrode insulator assembly.* Scrape off any carbon that may have accumulated around the electrodes and if necessary remove the electrode insulator assembly for thorough cleaning.

3. Fuel Spray Nozzle Assembly

Check the air heater for a clogged fuel spray nozzle assembly. A clogged spray nozzle assembly will usually be indicated by excessive resistance on

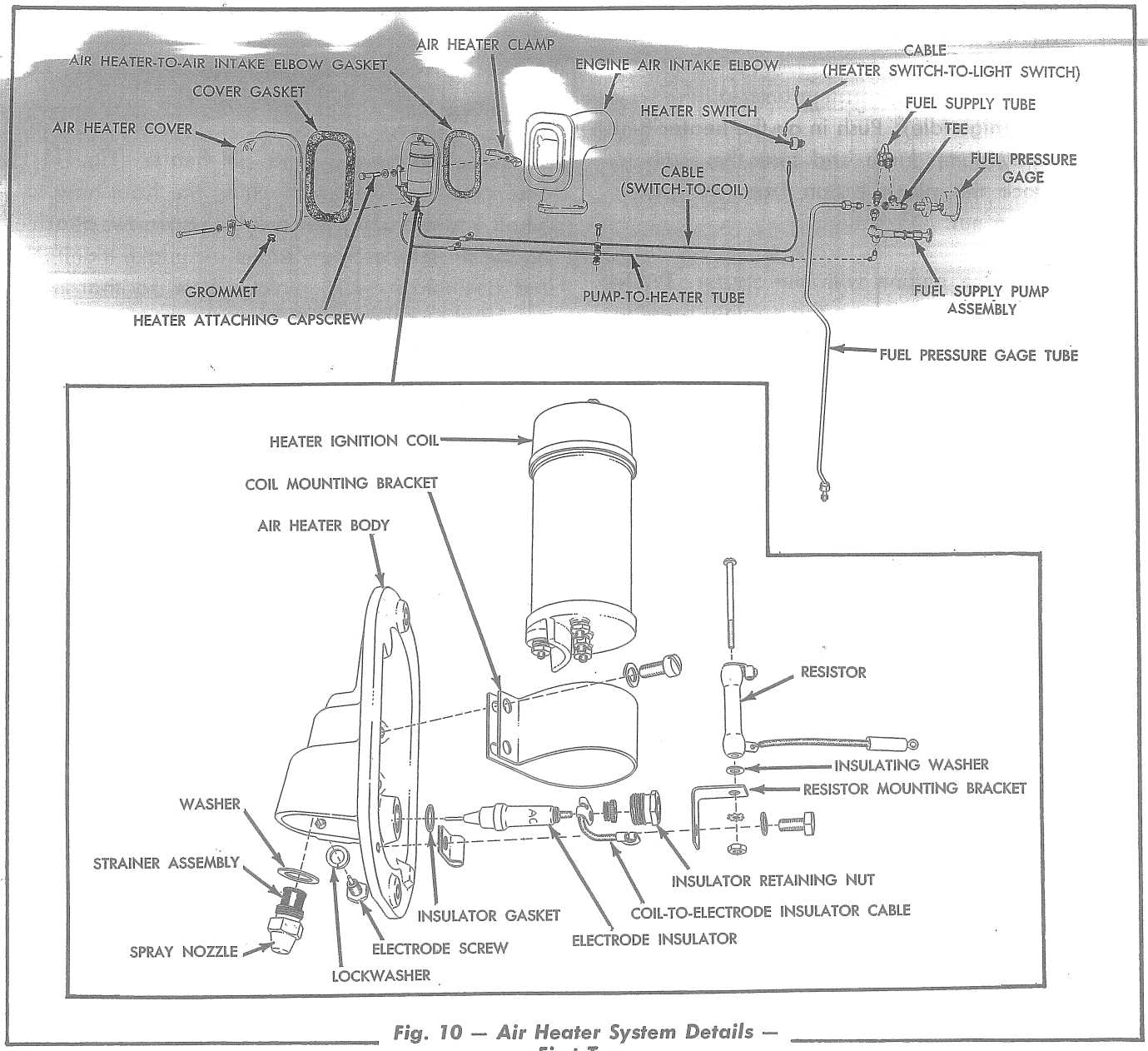

Fig. 10 — Air Heater System Details — First Type

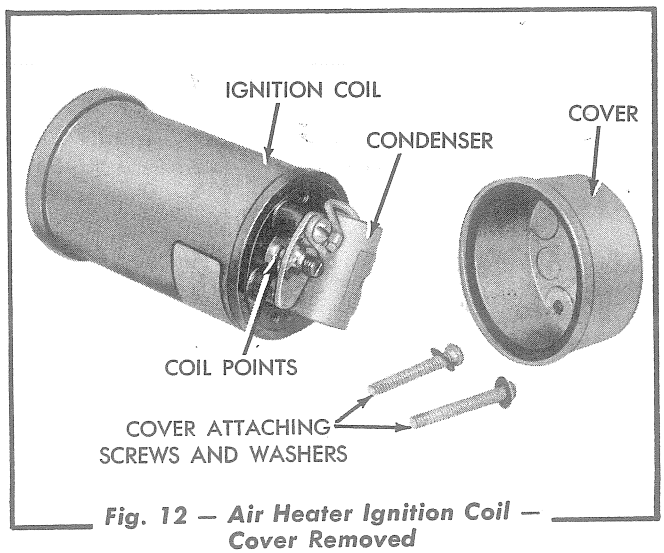

Fig. 12 — Air Heater Ignition Coil — Cover Removed

the heater fuel supply pump. A partially clogged spray nozzle will not properly "fog" the fuel for ignition and the nozzle must be removed and cleaned. Remove the spray nozzle. Thoroughly wash all parts in cleaning fluid and dry with compressed air. CAUTION: *Do not enlarge the hole by using a steel wire or a drill to clean the hole in the spray nozzle. After cleaning, reinstall the spray nozzle assembly.*

4. Air Heater Fuel Supply Pump

Failure of the air heater fuel supply pump to function properly may be due to worn or damaged pump piston rings, clogged fuel lines, or "frozen"

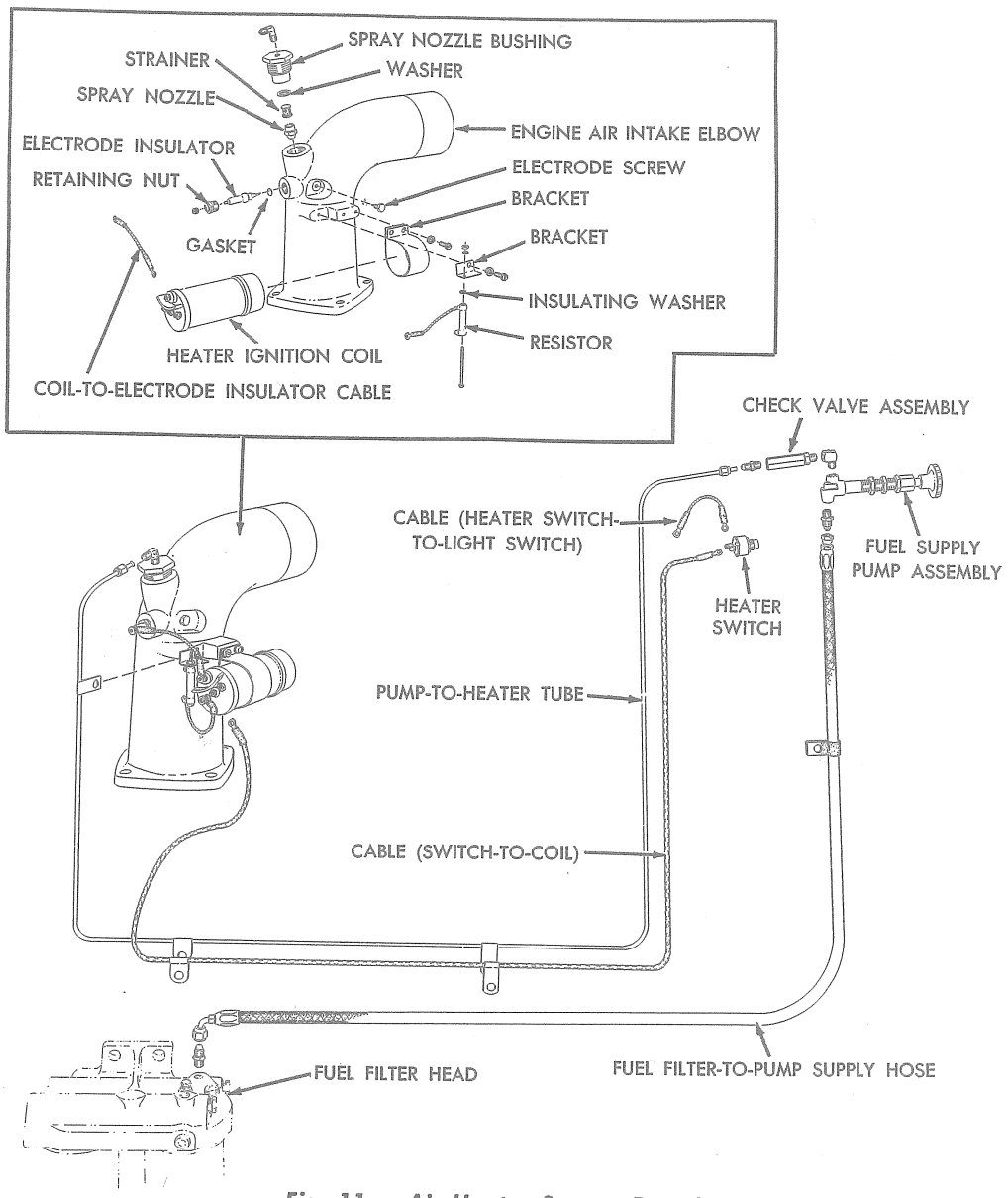

Fig. 11 — Air Heater System Details — Second Type

or worn pump check valve balls. The piston rings on the pump piston are made of a special rubber composition and must be replaced by duplicate parts if worn or damaged.

The air heater fuel supply pump is the same as the starting fluid pump used for the cold weather engine primer system. Refer to Topic 4, in this Section for pump repair instructions.