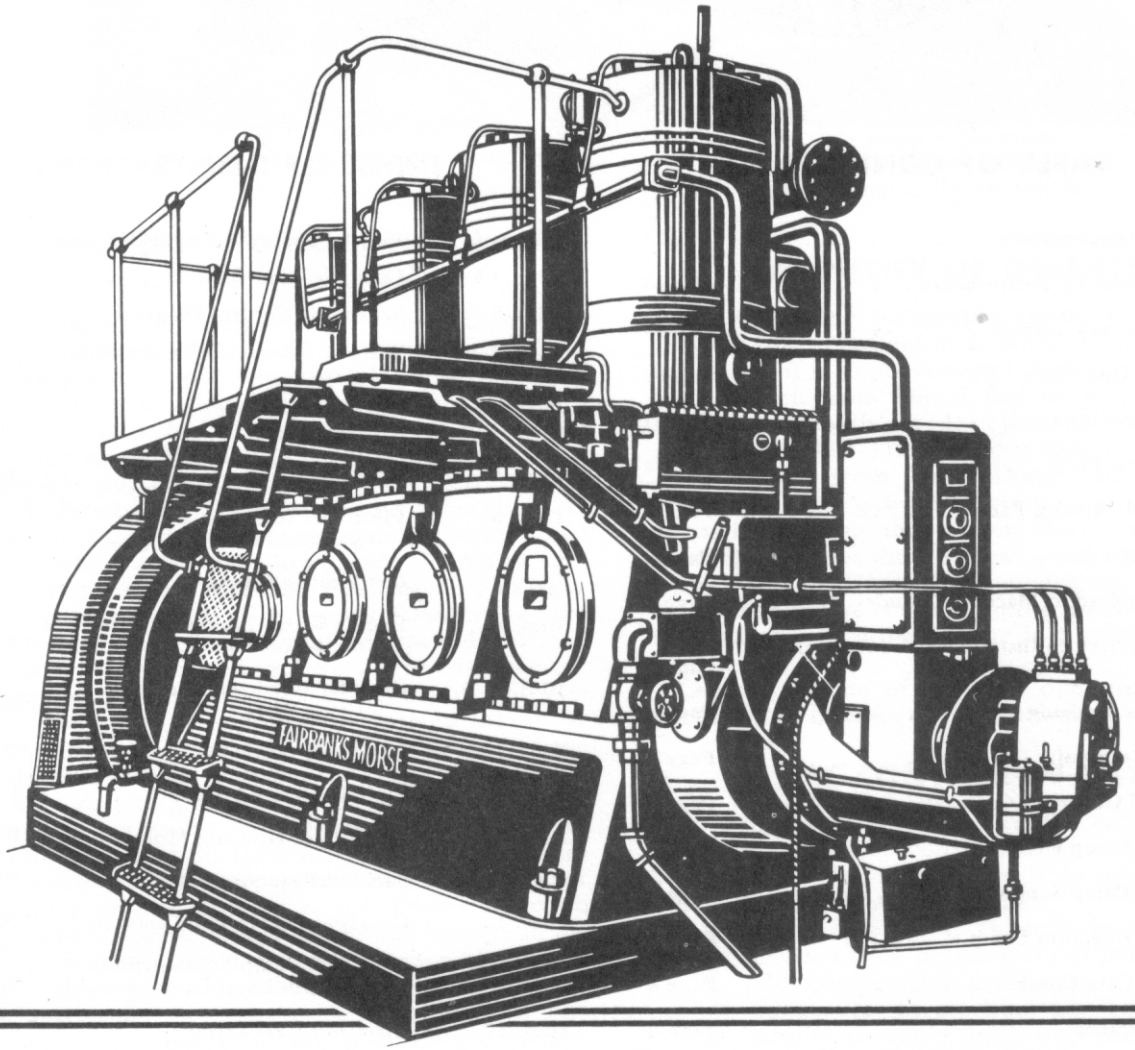
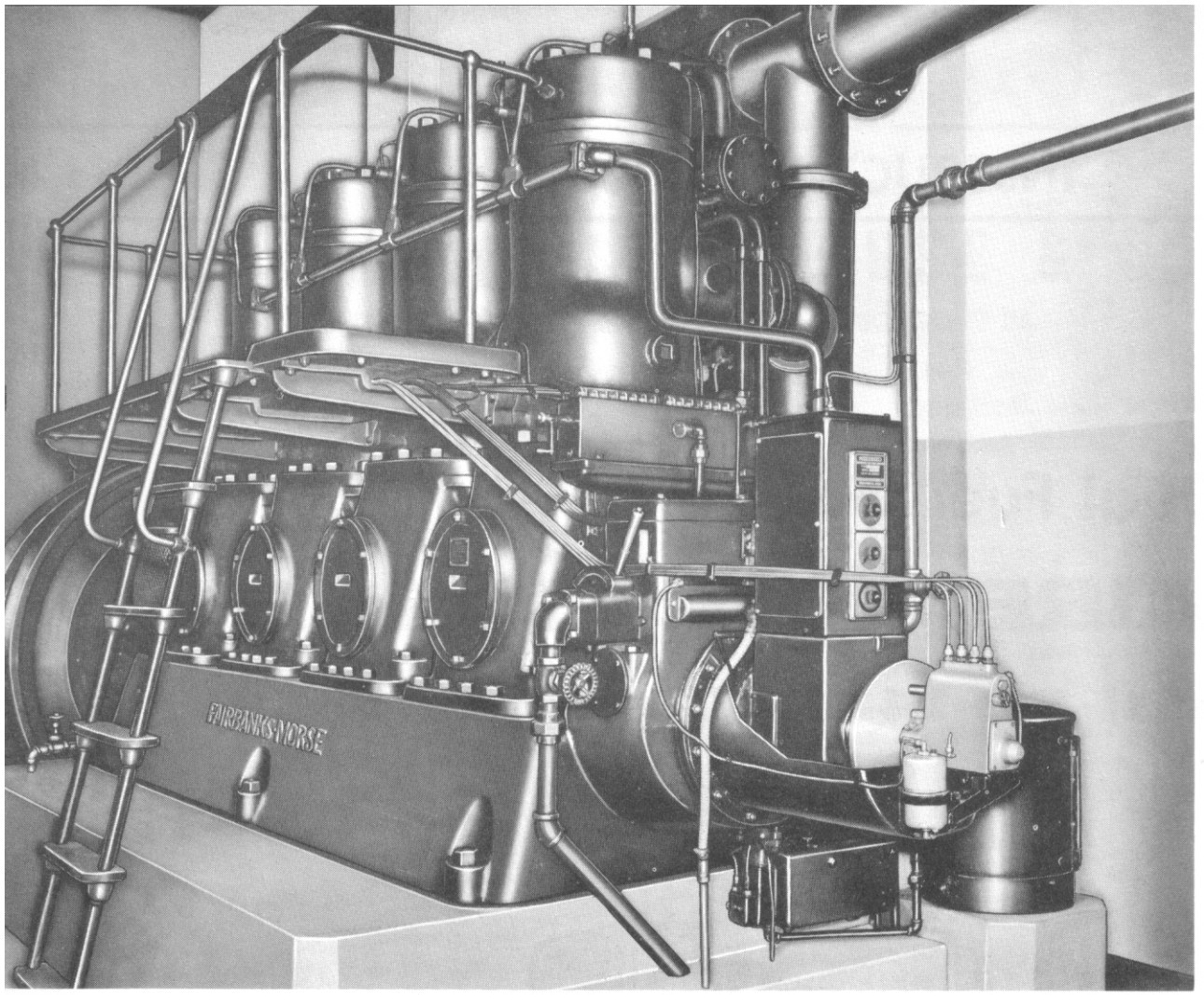
INSTRUCTIONS 3047-A

Dual Fuel Gas Conversion for

FAIRBANKS-MORSE

Model 32-14x17 Diesel Engines





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DUAL FUEL GAS CONVERSION
for FAIRBANKS-MORSE
MODEL 32 - 14 x 17 DIESEL ENGINES

CONVERSION REQUIREMENTS

The conversion may be applied only to those engines of the open head, full backflow type which are equipped with the Woodward Model IC governor. Conversion is, of course, applicable to earlier engines which have been changed to the above extent.

The first open head type engines built for production are:

	2 Cyl.	3 Cyl.	4 Cyl.	5 Cyl.	6 Cyl.
Eng. No.	780551	781324	781307	780205	780558

UNDERGROUND EXHAUST SYSTEMS ARE NOT TO BE USED, due to their potential explosion hazards when operating on gas. Individual exhaust pipes must be replaced as outlined on Page 2.

RESULTANT OPERATING PERFORMANCE

If the engine is in good mechanical condition, it will operate either as an oil Diesel or natural gas engine after conversion parts have been applied and existing parts reworked according to outlined procedure. As a gas engine, it will deliver the engine nameplate rating with 70 F. intake air. As a full Diesel engine, it attains the nameplate rating with 90 F. intake air.

DUAL FUEL ENGINE CONTROLS
(Illustration 1A, 1B and 2)

The controls are designed to assure reliable and safe operation as a full Diesel or when operated on gas with pilot fuel oil. A natural gas supply pressure of 25 psi. is required and No. 2 Diesel fuel is recommended for pilot fuel. The operation of the engine when running on Diesel fuel remains unchanged.

When running on gas fuel, the gas vent valves (Illus. 1-B) are closed and the main gas supply valve (Illus. 2) is opened. The pilot fuel supply pump creates a fuel pressure which acts on the lower side of a diaphragm in the automatic gas shut-off valve assembly causing this valve to open. This allows gas to flow through the overspeed shut-off valve if the engine speed is normal. This valve will be closed in the event of overspeed.

A gas connection to the Diesel fuel cut-off assembly (upper left, Illus. 2) supplies pressure to the upper side of the large diaphragm in this assembly. If the gas supply pressure is sufficient (approximately 22 psi), this diaphragm moves the Diesel fuel cut-off linkage and causes the main Diesel fuel pump suction valves to be raised from their seats thus stopping main Diesel fuel injection. If the gas pressure is too low for satisfactory engine operation, the Diesel injection pumps will continue to operate and the linkage in the upper part of the Diesel fuel cut-off assembly is held in a position which keeps the gas throttle valve in the closed position.

If speed, gas pressure and fuel pressure are normal, gas is supplied to the throttle valve and the valve is under governor control. The governor sets the position of the throttle valve, by moving the governor terminal shaft and connecting linkage, to permit sufficient gas to flow to the gas header to carry the load demanded of the engine. As the engine load is increased, the pressure in the gas header is increased.

The gas admission valve, located in the cylinder head, is a spring loaded check valve as shown in Illus. 10. During the low pressure portion of the cycle in the engine cylinder, while the exhaust and air ports are open and during a small portion of the compression stroke, the pressure in the cylinder is lower than that of the gas in the header. This difference in pressure forces the gas admission valve open and allows gas to flow into the cylinder. The gas mixes with the turbulent air in the cylinder during the compression stroke and the gas-air mixture is ignited by a small quantity of Diesel fuel supplied by the pilot fuel injection pump when the piston reaches top dead center.

It should be noted that the controls incorporate devices to shut off the gas supply to the engine in the event of (1) engine overspeed, (2) failure of pilot fuel supply system which would cause loss of ignition, and (3) low gas supply pressure. If either the pilot fuel or gas pressures drop below required values, the engine will automatically switch from gas to Diesel operation.

SIMPLICITY OF OPERATION

The foregoing paragraphs describe the automatic transfer from one fuel to another. If manual transfer is desired, it is easily accomplished.

To switch from Diesel fuel to gas, the operator merely closes both gas bleed lines and opens the main gas supply valve. The engine is then running on gas.

To transfer from gas to Diesel fuel, the operator closes the main gas valve part way, at the same time partially opening the header bleed valve. He then completely closes the main gas valve, opens the lower bleed valve, and completely opens the header bleed valve. The engine is then running on Diesel fuel. This method of switchover results in a minimum of load fluctuation.

During periods of overload operation, it may be necessary to operate on Diesel fuel.

PRE-CONVERSION DATA

It is important to make a careful record of engine performance before conversion procedure is started to determine that the engine is in good condition. The following data is essential:

A. Firing pressures, exhaust temperatures and exhaust back pressure at full load.
B. Hot compression pressures.
C. Exhaust temperature at 75% load.
D. Ability to carry 10% overload for a short period.

E. Piston rings should be carefully examined to make sure they are in good condition and are not stuck.

F. The main bearing and crankshaft must be in good condition and with proper bearing clearance.

NECESSARY NEW PARTS

All standard parts required to make the conversion from Diesel fuel to dual fuel are supplied by Fairbanks, Morse & Co. in a conversion kit. However, such items as the exhaust manifold and piping, gas pressure regulator and gas piping to the engine are not included in the kit.

The individual exhaust pipes must be replaced by a manifold as shown in Illus. 3. Exhaust pots, if retained, should be sealed off at floor level and provided with a top outlet. After the converted engine has been started, it may be necessary to fill the pots with sand, then cap them with cement at the most advantageous level. Optimum level may be determined by the use of water. See Illus. 4.

The overspeed governor trip lever link and trip lever pin must be replaced with new parts furnished in the conversion kit.

Because the governor case housing requires considerable machining, it must be returned to Fairbanks, Morse & Co., in exchange for the housing shown in Illus. 5. This housing requires a longer governor fuel control shaft to provide the take-off for the gas throttle valve linkage.

Eight longer studs are needed to mount the pilot fuel pump support.

Pilot injection tubes are required. The pilot injection tubes are of the same length for one engine. The 2 and 3 cylinder engines are equipped with one length of tubing. The 4, 5, and 6 Cylinder engines are equipped with two lengths connected by fittings. See Illus. 6. Placing the tubes requires the temporary removal of the platform to permit drilling and tapping for the fastening clamps.

Refer to Illus. 7 for placing of the gas header. Necessary drilling and tapping is done on the job.

The present "C" type injection nozzle must be replaced with the water cooled "CWD" type fuel injection nozzle. See Instruction 2769H. The CWD nozzle is equipped with a pilot fuel inlet fitting which admits the metered fuel for gas operation. During Diesel operation, both the main injection pumps and the pilot pumps supply the fuel requirements of the engine.

The nozzle would have negligible cooling during gas operation if there was no outside cooling. It is necessary to equip the engine with the injection nozzle cooling piping as shown in Illus. 8.

REWORKING OF EXISTING PARTS

Certain parts of the engine are used with slight modification as described below.

CYLINDER HEAD

The indicator tube well must be remachined as per cylinder head, Illus. 9, for accommodation of the gas valve assembly, Illus. 10. Flange interference of the water overflow pipe should be ground off as shown in Illus. 11. This will give clearance for the nozzle cooling fitting. Tools for remachining of the cylinder head must be ordered from Fairbanks, Morse & Co. and may be returned for credit.

PROCEDURE REQUIRED TO MACHINE CYLINDER HEAD YKA3W1 IN THE FIELD

1. Remove the Indicator Adapter Tube Gland 5566 using removing tool CHB1080A1, 5/8 x 4 3/4 capscrew and 5/8 washer. Remove Indicator Adapter Tube 5565A.
2. Align Jig C-TD3405A with the present indicator Adapter Tube hole, (the jig must center over the hole) use spacers C-TD3407A over the injection nozzle studs and clamp jig in place.
3. Install Bushing C-TD3406D with 1.7195 hole for 1 23/32 drill in jig.
4. Use 1 23/32 core drill and drill through top land only. Insert 2 four ft. long pipes in Cyl. head stud holes to hold drill.
5. Remove bushing C-TD3406D from jig and install bushing C-TD3406C with 1.751 hole for 1.750 reamer.
6. Use 1.750 shell reamer with shell reamer arbor and ream through top land only.
7. Using 27/64 drill and jig, drill two gas valve stud holes.
8. Remove jig and tap with 1/2–13 standard tap one inch deep and finish tapping using 1/2–13 bottom tap. Do not install gas valve stud at this time.
9. Install bushing C-TD3438D with 1.001 inch hole for one inch core drill in top land hole.
10. Using one inch core drill, drill through lower land into combustion chamber.
11. Remove bushing C-TD3438D and install bushing C-TD3438C with 1.1885 inch hole in top land hole.
12. Using 1 3/16 core drill, drill down till point of drill is 5 3/8 from top of bushing with bushing down tight against cylinder head surface.
13. Remove bushing C-TD3438C and install bushing C-TD3438B with 1.3448 inch hole in top land.
14. Using 1 11/32 Core drill, drill down until point of drill is 5 5/16 from top of bushing with bushing down tight against cylinder head surface.
15. Remove bushing C-TD3438B and install bushing C-TD3438A with 1.376 hole in top land hole.
16. Using 1 3/8 core drill, drill down until point of drill is 5 5/16 from top of bushing with bushing down tight against cylinder head surface.
17. Remove bushing C-TD3438B and install bushing C-TD3437A with 1.257 hole, after installing 1 3/8 dia. 90 degree counterbore.
18. Using 1 3/8 dia. 90 degree counterbore, one inch pilot, holder and extension, counterbore gas valve gasket surface 5.000 + .000 — .010 deep from top of cylinder head surface.
19. Remove bushing and drive gas valve studs using 1/2 stud driver.

TOOLS REQUIRED
To Machine Cylinder Head

No. Req.	Description
1	C-TD3405A Jig
2	C-TD3407A Jig Spacers
1	C-TD3406C Drill Bushing (1.751 hole) for 1.750 reamer
1	C-TD3406D Drill Bushing (1.7195 hole for 1 23/32 core drill
1	C-TD3438D Drill Bushing (1.001 hole) for 1" core drill
1	C-TD3438C Drill Bushing (1.1885 hole) ıor 1 3/16 core drill
1	C-TD3438B Drill Bushing (1.3448 hole) for 1 11/32 core drill
1	C-TD3438A Drill Bushing (1.376 hole) for 1.375 reamer
1	C-TD3437A Drill Bushing (1.257 hole) for tool holder
1	1 23/32 High speed #5 taper shank for groove core drill for top land drilling. (Machine shank tor No. 4 M.T.)
1	1" High speed #3 taper shank four groove core drill
1	1 3/16 High speed #4 taper shank four groove core drill
1	1 11/32 High speed #4 taper shank four groove core drill
1	1 3/8 High speed #4 taper shank four groove core drill
1	1 3/4 High speed spiral flute shell reamer
1	#8 Shell reamer arbor #4 taper shank
1	90 degree angle countersink—Gairing Tool Co., C-14 2 3/8 dia., pilot type, Type C

No. Req.	Description
1	Tool holder—Gairing Tool Co., C-14, Type C, 7/16 pilot nut #4 Morse taper shank
1	1 3/4 dia. pilot—Gairing Tool Co., for C-14 tool holder, 7/16 pilot shank
1	1 3/8 dia., 90 degree counterbore—Gairing Tool Co., C-13
1	Tool holder—Gairing Tool Co., C-13, Type C 5/16 pilot nut #3 Morse taper shank. (The taper shank must be machined for a number two Morse taper.)
1	1" dia. pilot—with two inch long pilot instead of standard length, 5/16 shank, for C-13 tool holder. Gairing Tool Co.
1	#2 Morse taper inside and outside. 7 3/4 inch long extension socket style 100-W #23105—Scully Jones, Chicago.
1	#3 Morse taper outside and #2 Morse taper inside extension sockets style 100-W #23106.—Scully Jones, Chicago.
1	#4 inside, #3 outside Morse taper extension socket, style 100-W #23112—Scully Jones, Chicago.
1	27/64 High speed straight shank drill
1	1/2–13 standard plug GLI tap
1	1/2–13 bottom GLI tap
1	Cylinder Head Packing Gland Wrench CHB1080A1
1	5/8–11 x 4 3/4 11FM7A Capscrew—Use with gland wrench
1	5/8 11FM1B Washer

TOOLS REQUIRED
To Install Dual Conversion Parts

No. Req.	Description
1	5/16 Drill
1	3/8–16 Standard plug GHI tap
1	3/8–16 Bottom tap
1	7/16 Drill
1	1/4 Pipe Tap
1	9/32 Drill for overspeed trip lever
1	23/64 High speed straight shank drill for Governor Housing dowels
1	3/8 Hand reamer straight flutes—for Governor Housing dowels

No. Req.	Description
1	#38 High speed straight shank drill for Governor Drive Gear ball bearing retaining stud dowel
1	#25 High speed straight shank drill for pilot tube clamps
1	#10–24 standard plug GHI tap for pilot tube clamps
1	13/64 High speed straight shank drill for filter bracket
1	1/4–20 standard plug GH1 tap for filter bracket
1	21/64" High speed straight shank drill for pilot pump drive housing dowel
1	#6 Taper pin reamer for pilot pump drive housing dowel

PUMP CASE HOUSING

The pump case housing must be drilled and tapped for the fuel control mounting bracket capscrews. See Illus. 12.

FUEL OIL RESERVOIR

The fuel oil reservoir must be drilled and tapped for the fuel control bracket capscrews. See Illus. 13.

OVERSPEED GOVERNOR CAMSHAFT

The valve lifting prongs of this part must be reworked to give the required operating clearance. See Illus. 14. The center section of this shaft must be ground and drilled for assembly of the Diesel cut-off yoke. New parts are furnished to replace the overspeed governor trip lever link and trip lever pin.

PILOT FUEL PUMP DRIVE

Before mounting the drive assembly Illus. 15, it is necessary to replace the governor drive couplings, shaft and gears. The drive assembly is then bolted to the governor case housing. The alignment should be held to give a backlash of from .003″ to .005″ with the support bracket and ball bearing in place. See Illus. 16.

PILOT FUEL PUMP SUPPORT

To mount this support, the six ½″ studs in the lower base and the lower ½″ studs in the pump case housing should be removed. Eight longer studs for bolting on the pump support should be driven in.

PILOT FUEL INJECTION PUMP

The pilot fuel injection pump is a constant stroke, plunger type, self contained unit. This unit should be mounted in perfect alignment with the pump drive take-off to assure satisfactory operation.

GOVERNOR CASE COVER

To facilitate assembly and inspection of the governor, a slotted opening and tapped holes must be added as shown in Illus. 17.

ENGINE ADJUSTMENT

A number of adjustments are required after the completion of the change-over for satisfactory operation.

The exhaust temperature should be balanced within 30° F. between the cylinders at full load, gas operation.

The pilot fuel pump should be timed as shown in the following table to provide injection timing of 13° BTDC.

ENGINE	PILOT PUMP PORT CLOSURE
2 cylinder	26.6° Before Top Center, #1 Piston
3 cylinder	27.8° Before Top Center, #1 Piston
4 cylinder	29.5° Before Top Center, #1 Piston
5 cylinder	30.1° Before Top Center, #1 Piston
6 cylinder	32.3° Before Top Center, #1 Piston

The pump body has two port closure lines. The one on the "R" side of the vertical line is for reverse rotation engines. The one on the "L" side of the vertical line is for standard rotation engines. Standard engine rotation is clockwise facing the governor end. Standard pilot pump rotation is clockwise facing the drive end of the pilot pump.

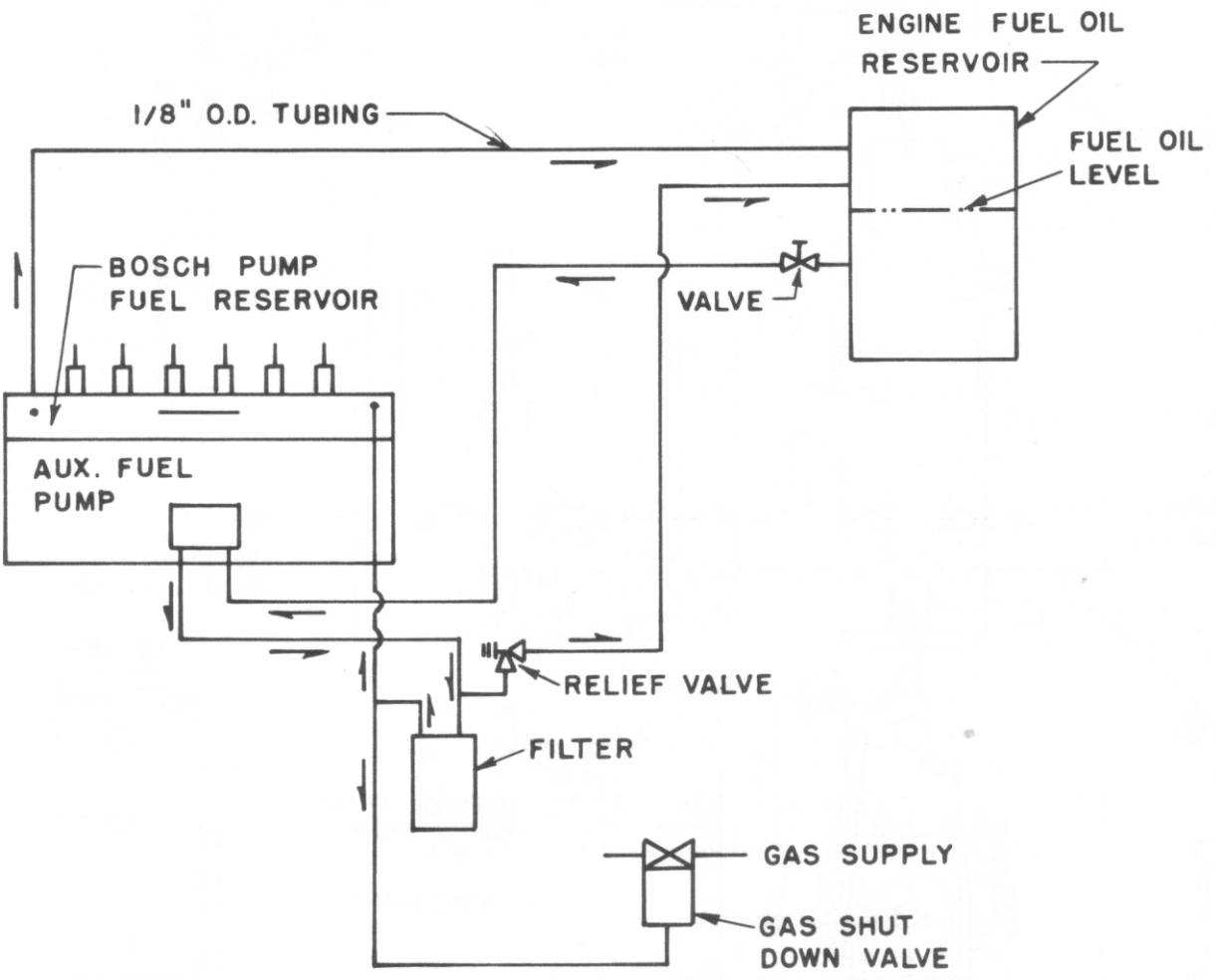
Minor timing changes can be made to improve fuel rate and load carrying ability.

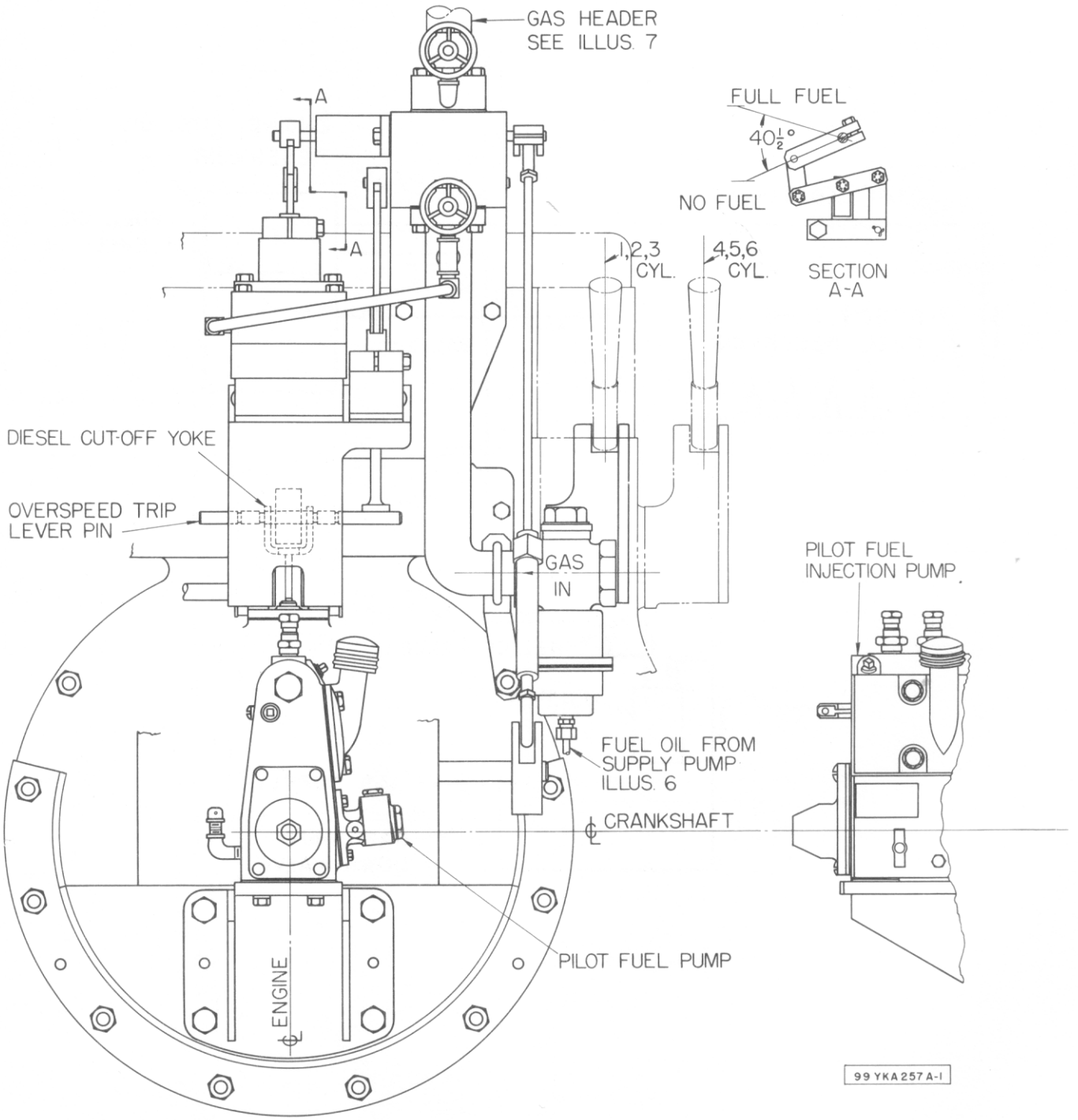
Compression pressure may have to be lowered to approximately 400 psi. to increase load carrying ability.

The lubricator cylinder feed setting should be made according to the needs of the specific engine.

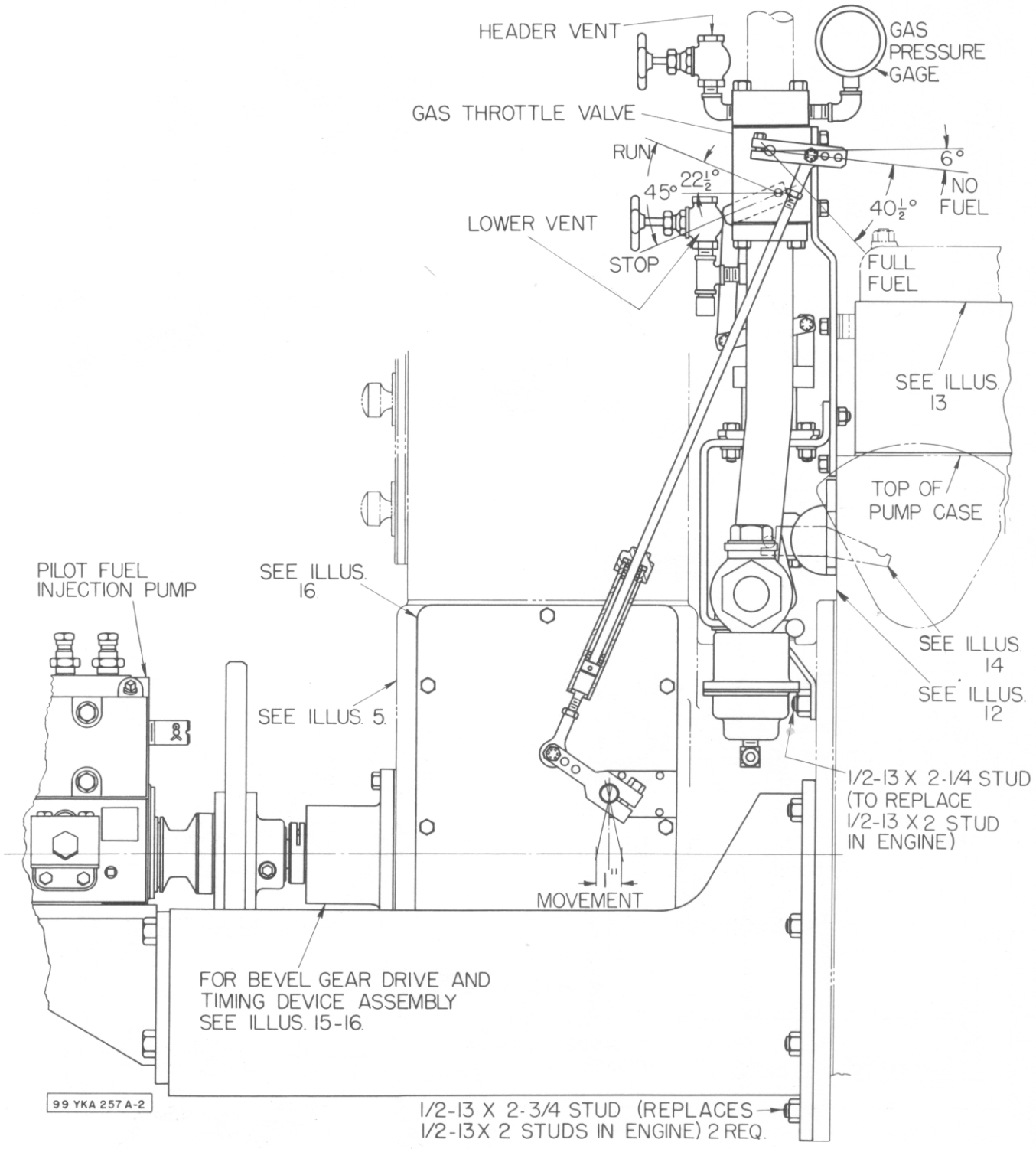
Gas pressure to the engine automatic gas control valve should be adjusted to 25 psi.

Pilot Injection Pump Fuel Oil System

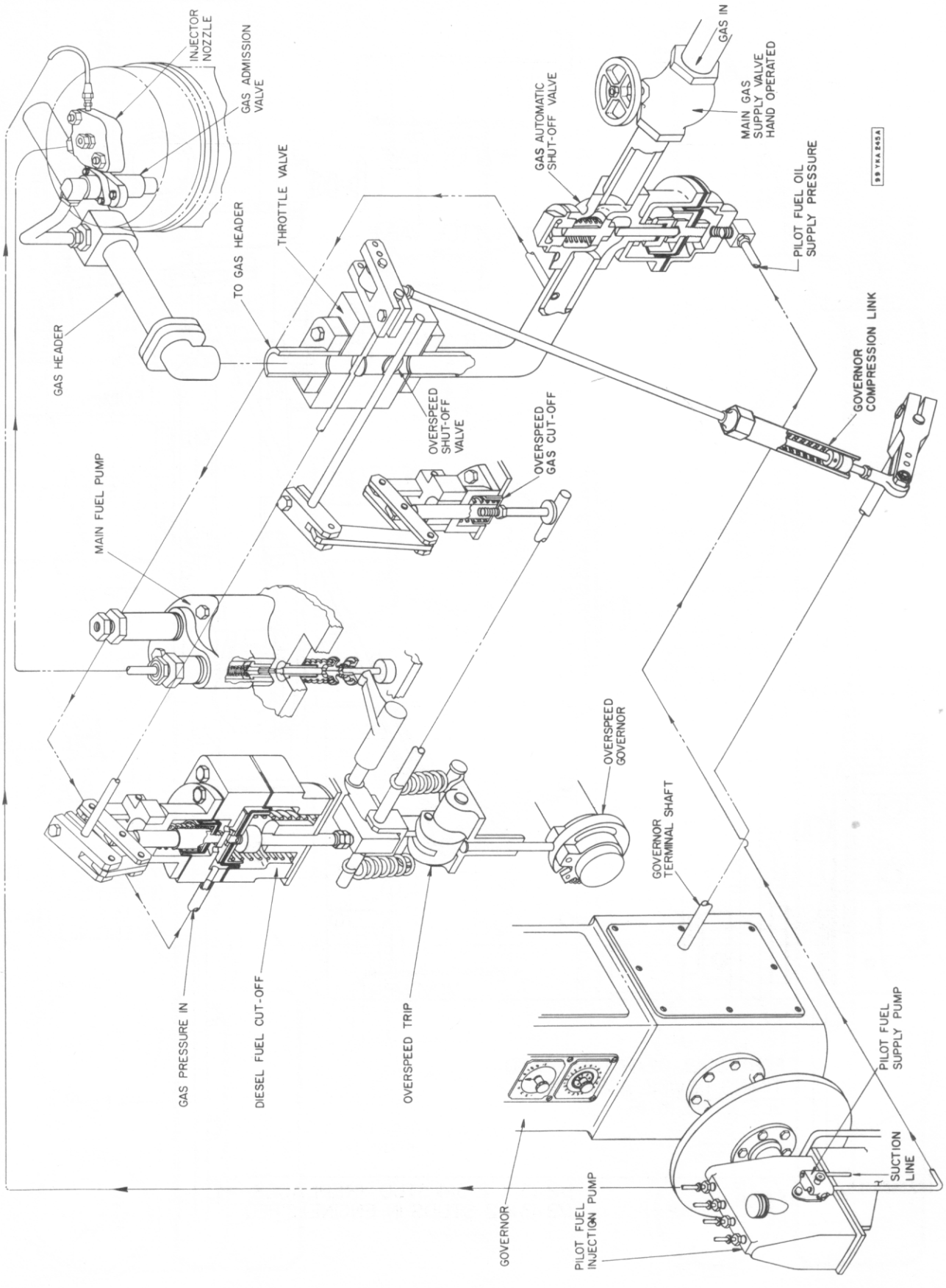




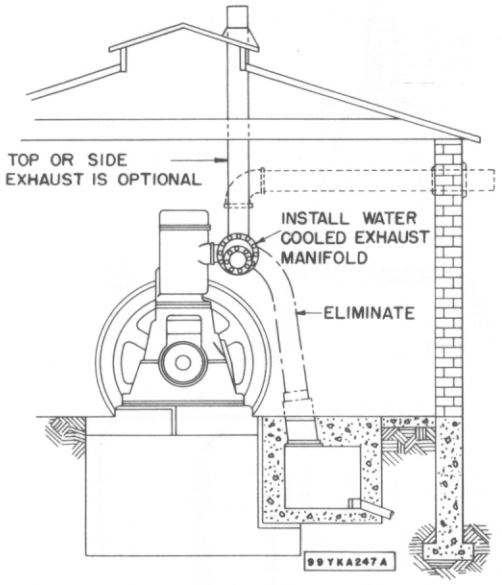
Illus. 1A Dual Fuel Controls



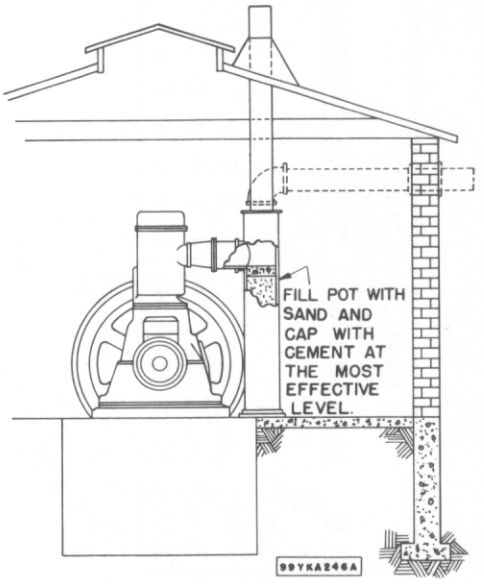
Illus. 1B Dual Fuel Controls



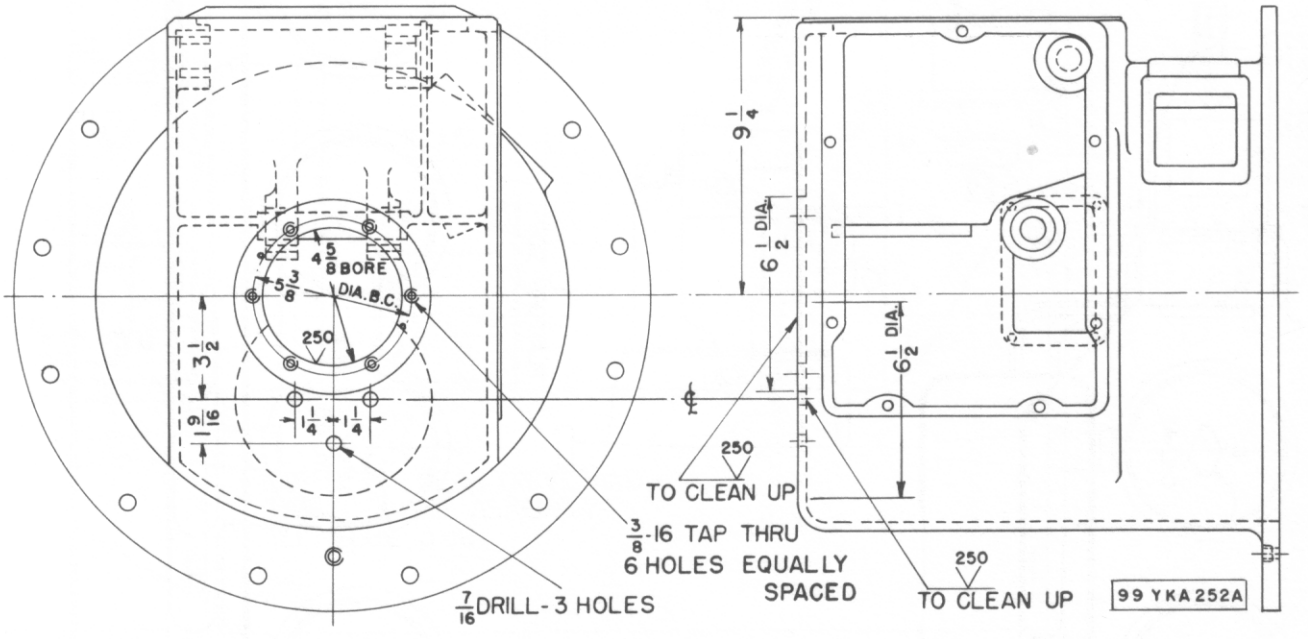
Illus. 2 Schematic Control Diagram



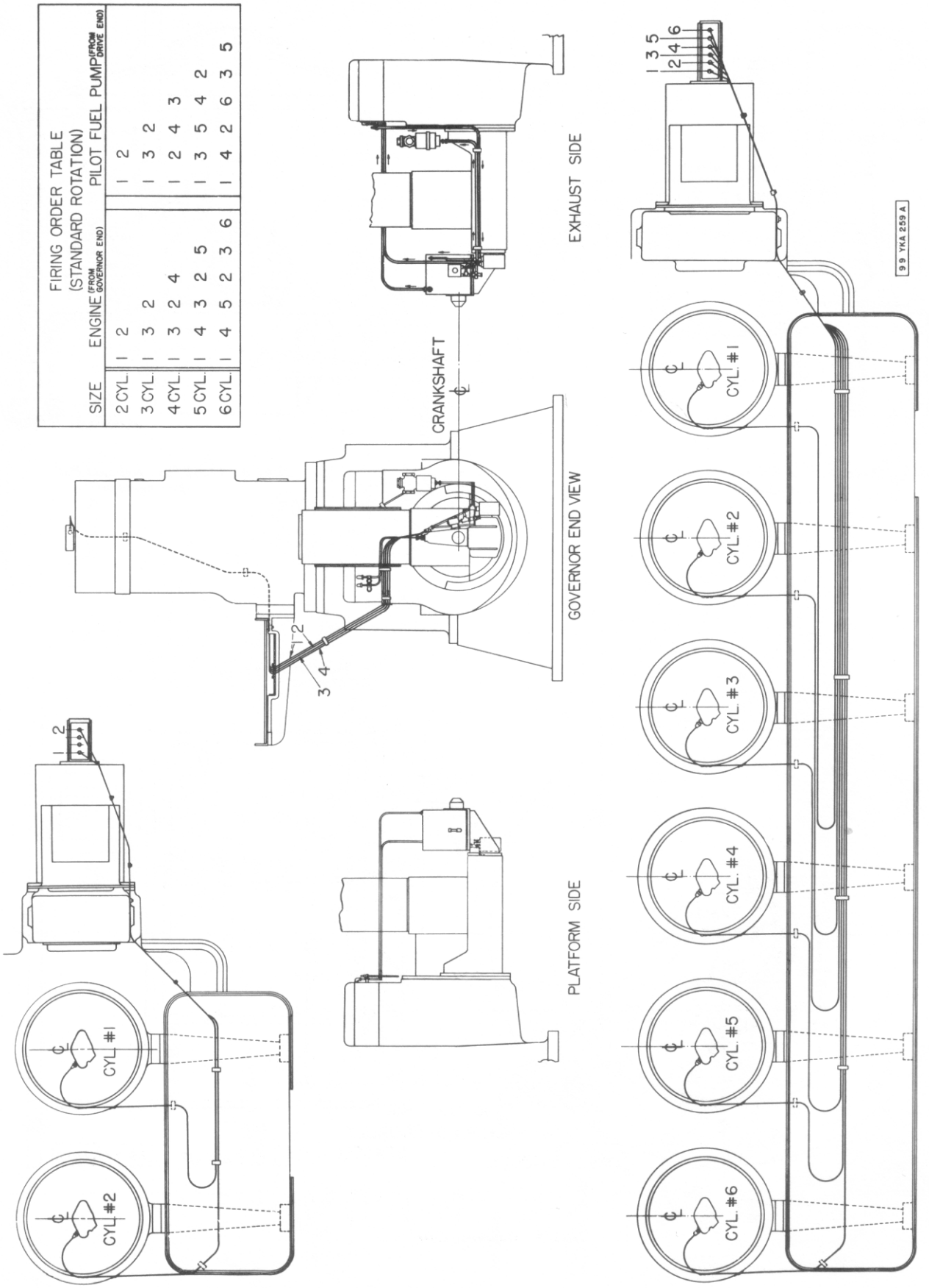
Illus. 3 Water Cooled Exhaust Manifold Arrangement



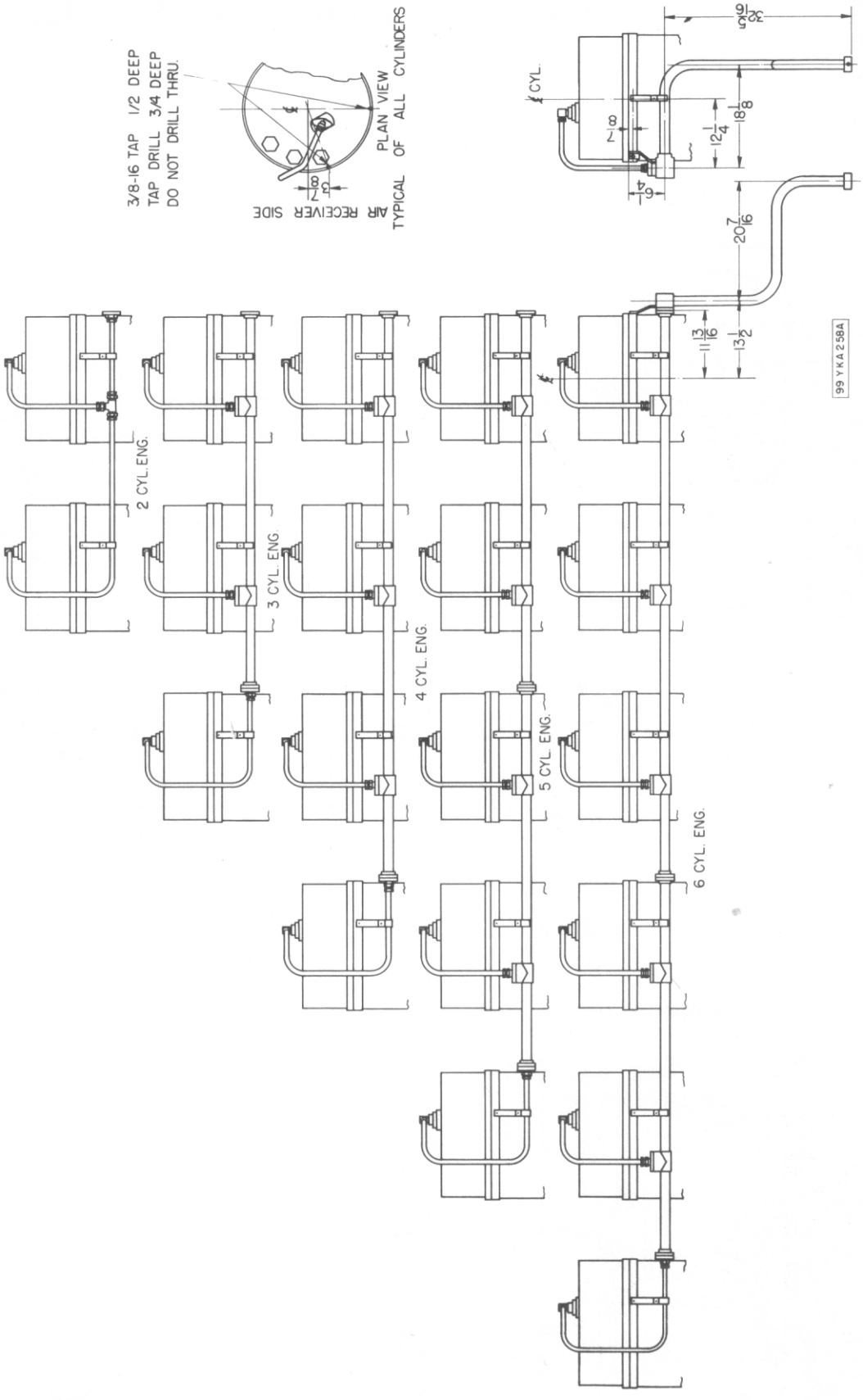
Illus. 4 Dual Fuel Exhaust Pot Arrangement



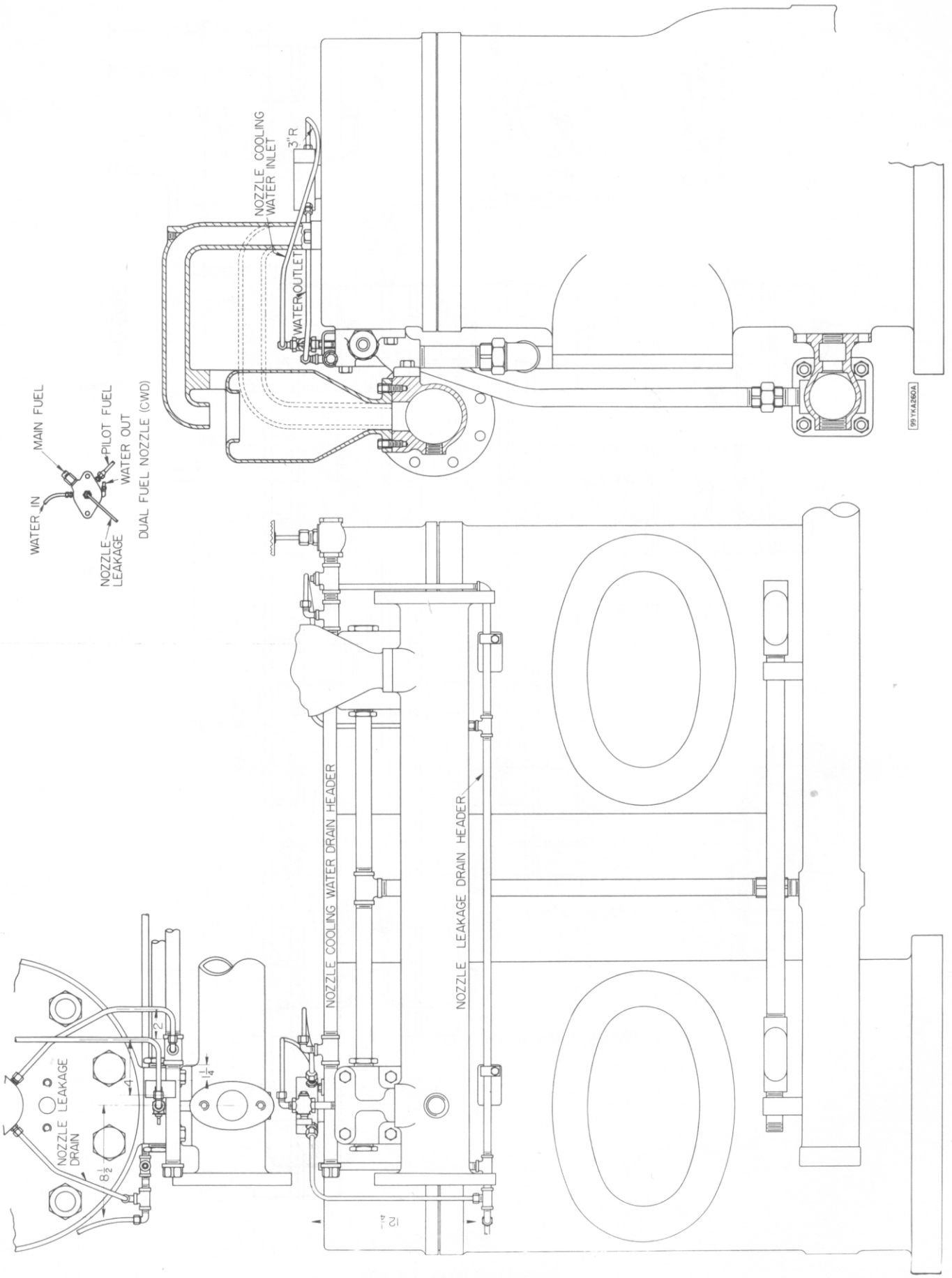
Illus. 5 Governor Case



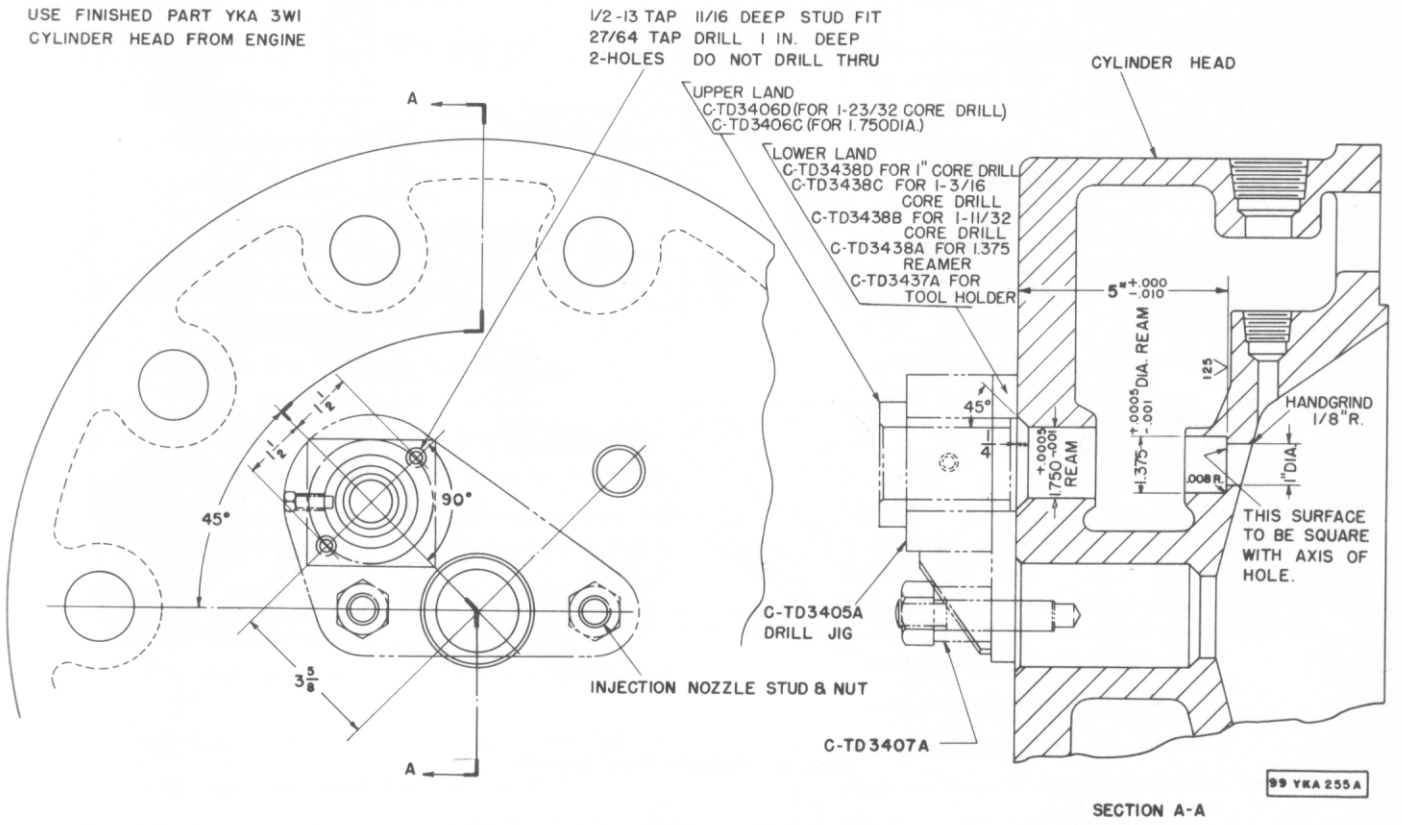
Illus. 6 Pilot Fuel Injection Tubing Arrangement



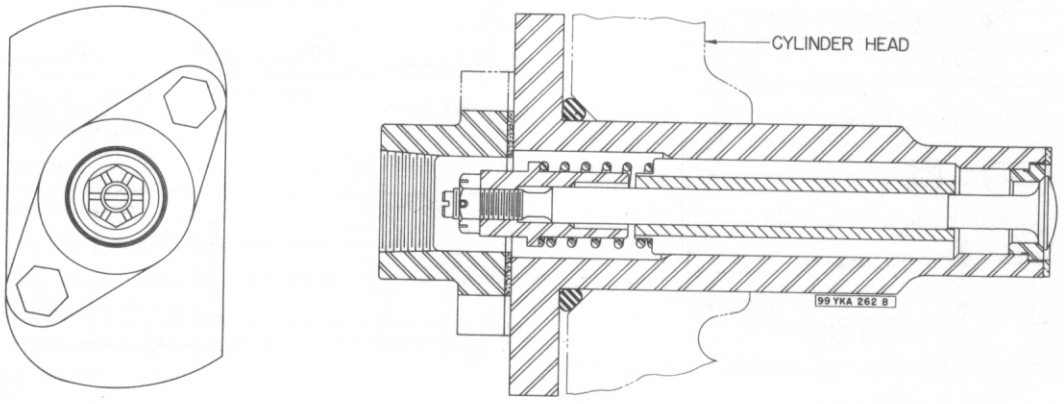
Illus. 7 Gas Header Piping



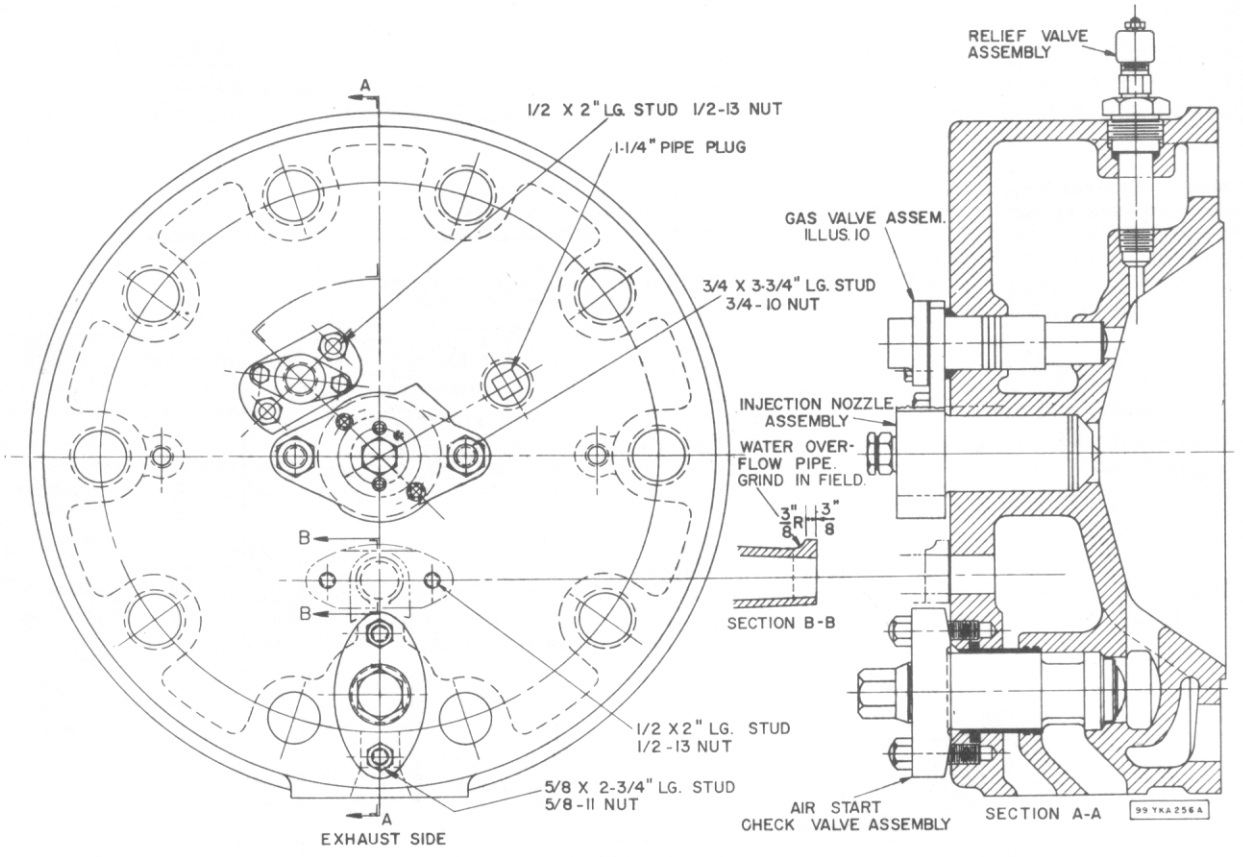
Illus. 8 Engine Water Piping for Injection Nozzle Cooling



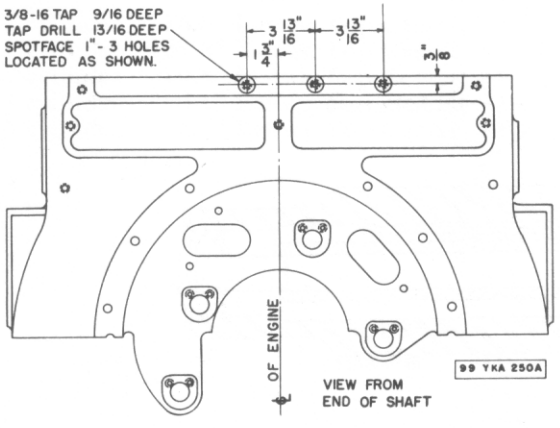
Illus. 9 Cylinder Head Modified for Gas Valve



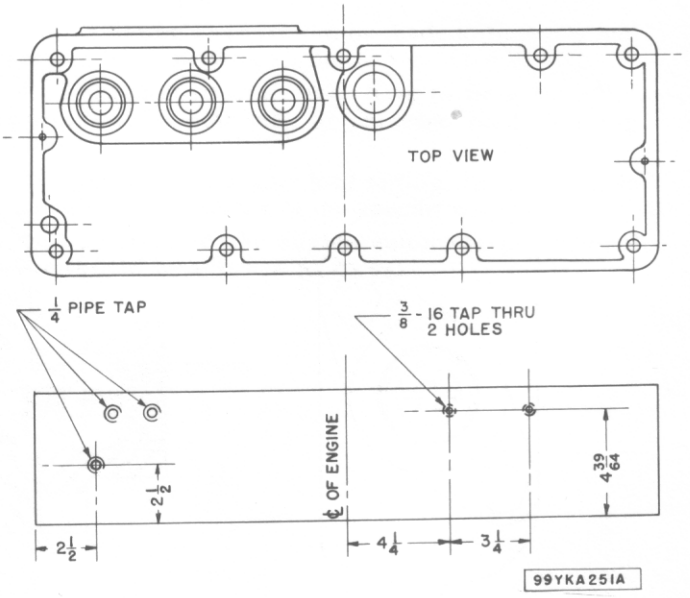
Illus. 10 Gas Valve Assembly



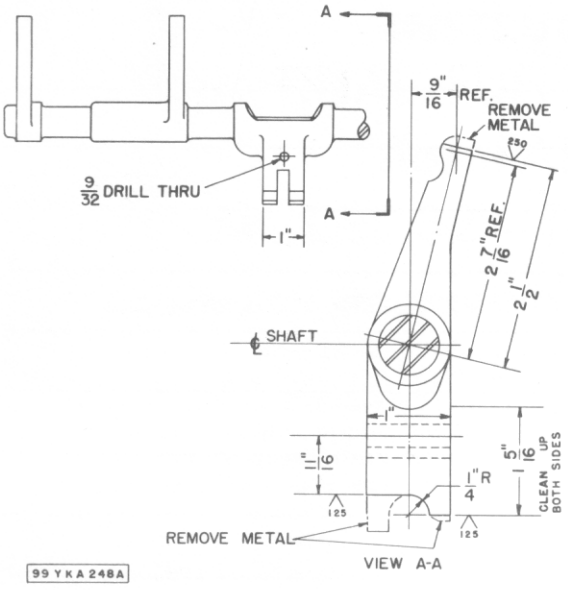
Illus. 11 Cylinder Head Assembly



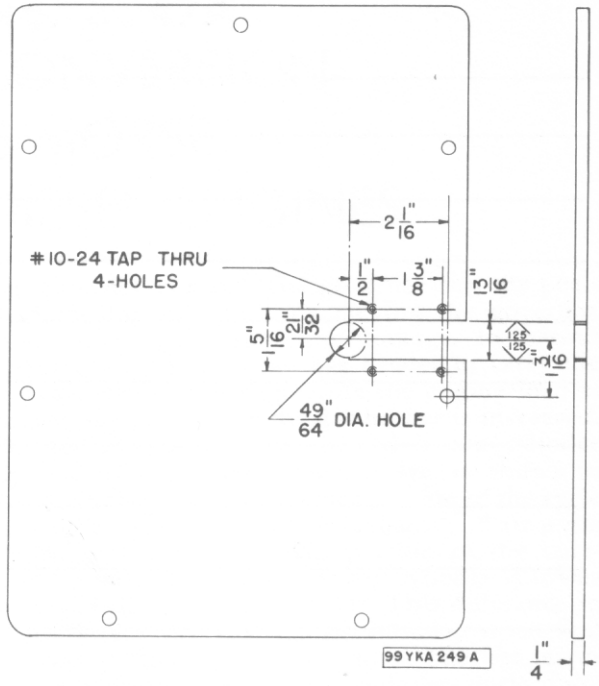
Illus. 12 Pump Case Housing Modification



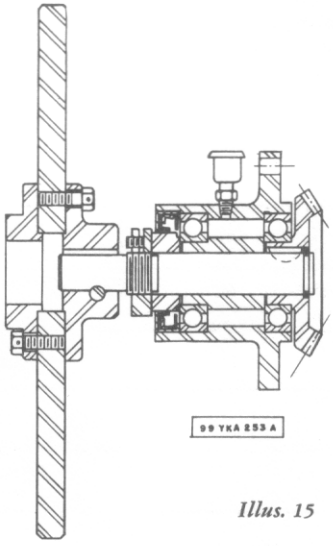
Illus. 13 Fuel Oil Reservoir Modification



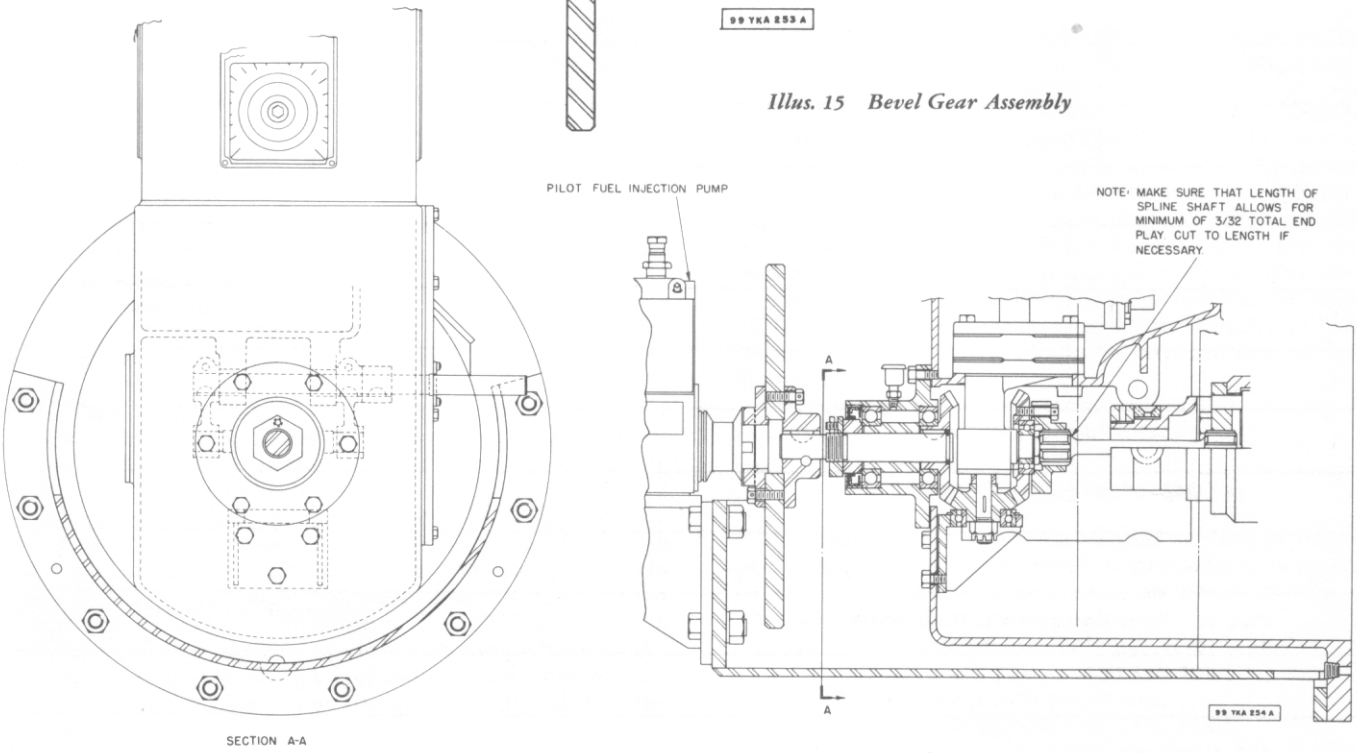
Illus. 14 Overspeed Governor Camshaft



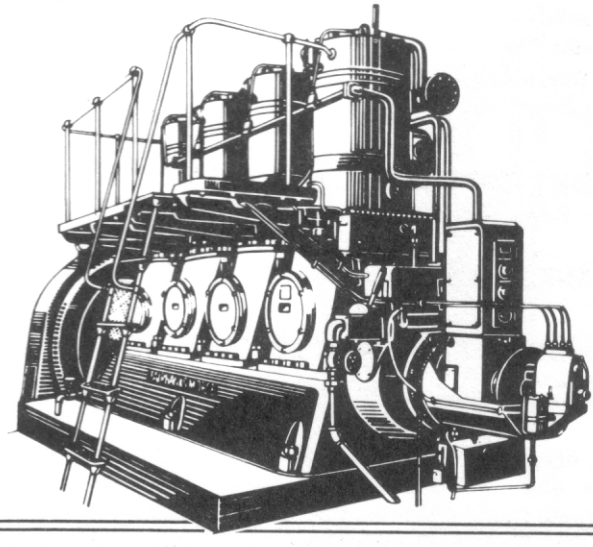
Illus. 17 Governor Case Cover



Illus. 15 Bevel Gear Assembly



Illus. 16 Pilot Fuel Pump Drive Arrangement



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