MIL-STD-1401
1 August 1966

MILITARY STANDARD

ENGINE, GASOLINE, AIR-COOLED, 20 BHP, 4 CYCLE, MILITARY DESIGN, MODEL 4A084

INSTALLATION PROCEDURES

FSC 2805

CONTENTS

TABLES

FIGURES

FIGURES (Cont'd)

1. SCOPE

1.1 Coverage. This standard covers the recommended installation procedures for the model 4A084, 20 hp Military design engine.

1.2 Objective. The objective of this standard is to insure compatibility of the engine and the end item of equipment.

2. REFERENCED DOCUMENTS

2.1 Governmental. The issues of the following documents in effect on the date of invitation for bids form a part of this standard to the extent specified herein.

SPECIFICATIONS

MIL-B-11040	- Belt, V; Engine Accessory Drive.
MIL-E-62014(MO)	- Engines, Gasoline, Air-Cooled, Industrial Type, 4 Cycle, 10 and 20 Net Continuous Horsepower.

(Copies of specifications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. DEFINITIONS

3.1 Definitions. For the purpose of this standard, the following definitions shall apply.

3.1.1 The Military design engine, model 4A084. A horizontally-opposed, 4-cylinder, air-cooled, overhead-valve, 84 cubic-inch-displacement, gasoline engine having a rating of 20 net continuous horsepower at 3,600 rpm (see figures 1, 2, 3, and 4) conforming to MIL-E-62014(MO).

3.1.2 Maximum net corrected brake horsepower. The maximum net corrected brake horsepower rating is the maximum observed horsepower available from the engine at wide-open-throttle (WOT) conditions at all engine speeds within the operating range with all accessories (including fan air cleaner and exhaust system - see 5.6.5) corrected to standard atmospheric conditions.

3.1.3 Intermittent net brake horsepower. The intermittent net brake horsepower rating is 90 percent of the maximum net corrected brake horsepower.

3.1.4 Continuous net brake horsepower. The continuous net brake horsepower rating is 20 observed horsepower at 3,600 rpm.

4. GENERAL REQUIREMENTS

4.1 Safety. When installed in the end item, rotating, reciprocating and high-temperature parts so located as to become a hazard to operating personnel and equipment shall be insulated or guarded. Exhaust mufflers and piping shall be located to minimize hazard to operating personnel.

4.2 Use conditions. The installation shall withstand shock load requirements as specified in the end-item specification. The installation shall be such that the engine will not be required to operate in a tilted position of more than 15 degrees from the horizontal in any plane at any time.

4.3 Design simplicity. The design of the end item shall be such that complete removal of the engine from the driven component or the driven component from the engine can be accomplished without the use of special tools.

5. DETAIL REQUIREMENTS

5.1 Power requirements. The maximum horsepower required to drive the end-item equipment and power transmission system under the environmental extremes specified for the end item shall not exceed the net continuous horsepower rating of the engine unless intermittent operation is indicated in the end-item specification, at which time the intermittent power requirement shall not be exceeded.

5.2 Operational requirements. The end item design and location of hoods and other external components shall not cause the engine to exceed the operational temperature limits specified in table I under all operating conditions and environmental extremes specified in the end-item specifications.

Table I. Operational Temperature Limits.

	Location	Maximum temperature, ° F.
Ambient air	In vicinity of engine	120
Cylinder head	Under spark plug	475 (500)*
Lubricating oil	In oil sump	265 (300)*
Cooling air**	At cooling air outlet	225
Carburetor inlet air**	Air cleaner inlet	150

* During first 10 hours of engine operation.

** Not applicable for arctic conditions.

5.3 Maintainability. The engine installation shall permit maximum accessibility for replacement, adjustment, and repair to all parts of the engine with minimum disturbance to adjacent parts of the end item and without the use of special tools (see figure 5).

5.3.1 Cooling and starting system. Clearance shall be provided for:

(a) Winding the starter rope on the pulley with a gloved hand (arctic type glove).
(b) Operation of the manual throttle control.
(c) Operation of the manual choke control.
(d) Removal of top sheetmetal cover.
(e) Operation of the oil pan air control baffle in its extreme positions.
(f) Access to electrical harness outlet (ten pin connector).
(g) Access to electric starter.
(h) Removal and replacement of voltage regulator.

5.3.2 Fuel system. Clearance shall be provided for:

(a) Carburetor adjustments.
(b) Servicing of the fuel filter.
(c) Connecting an auxiliary fuel line.

5.3.3 Induction system. Clearance shall be provided for:

(a) Servicing the air cleaner.
(b) Operation of the air cleaner winterization selector lever.
(c) Observation of the air cleaner restriction indicator.

5.3.4 Lubricating system. Clearance shall be provided for:

(a) Removal and insertion of the oil gage rod and for adding oil with or without a removable spout or funnel (see figure 5).
(b) Removal and replacement of the oil drain plug and the drainage of oil. The oil shall drain completely and shall not flow over any part of the end item. An extension to the crankcase drain system is permissible.
(c) Servicing the oil filter.

5.3.5 Governor system. Clearance shall be provided for governor speed and linkage adjustments.

5.3.6 Ignition system. Clearance shall be provided for:

(a) Removal and replacement of magneto, spark plugs, high-tension cables, breaker points, and capacitors, and for adjustment of the breaker points.
(b) Viewing the ignition timing mark in the window on the fan flywheel housing.
(c) Adjustment of the magneto for ignition timing.

5.4 Engine mounting requirements. The mounting brackets supplied with the engine shall be used (figures 6 and 7). The mounting brackets or engine mounting pads or flanges shall not deflect or deform when the engine is operated under any condition specified herein.

5.4.1 Vibration isolation. Suitable vibration isolators shall be used when shock mounting is specified in the end-item specification and shall be equally spaced about the center of gravity of the entire unit. The isolators shall be of such material and construction to prevent transmission of vibration or stresses to unisolated components. Figure 8 shows the spacing.

5.4.2 Design requirements for direct mounting of end-item. The maximum static moment that the fan housing mounting to the engine crankcase can absorb without excessive deformation is 450 lb. ft. and shall not be exceeded. This moment is not to be confused with the maximum allowable moment of 1000 lb. ft. used in the drop test calculations. Cantilever mounting of end-items to the engine is prohibited unless specifically detailed on Military design drawings. The maximum allowable shear and end moment loads that may be applied to the engine bearings by such items as belt pulleys, generator rotors, and pump rotors attached directly to the crankshaft are determined by referring to figures 9, 10, and 11.

5.4.3 Method for calculating maximum allowable spring force. The following design charts shall be used to insure that the final spring force will not apply a "G" magnification factor to the weight of the unit that will cause a moment exceeding 1000 lb. ft., figures 12, 13 and 14.

5.4.4 Procedure. The following procedure shall be followed in selecting the four vibration mounts to withstand the 18 inch free fall shock load requirements for a beam mounted unit, figure 8.

(a) Determine weight of the driven equipment e.g., 240 lbs.
(b) Select a vibration isolator, e.g., spring constant 750 lb/inch (obtain information from manufacturer).

(c) Calculate the static deflection by the following equation.

$$\delta_o = \frac{W_{eng} + W_{equip}}{4\ k}$$

Where

δ_o = static deflection - (inches)

k = spring constant = 750 lb/inch

W_{eng} = weight of engine = 205 lbs.

W_{equip} = weight of equipment = 240 lbs.

Static deflection δ_o = .1483 inches.

(d) From design chart (Figure 12) determine maximum spring force

F_s = 1847 lbs.

(e) If the spring force F_s is desired for a free fall of 24 inches then read the ratio F_s'/F_s = 1.145 from the extra plot in figure 12
Therefore

F_s = 1847 x 1.145 = 2115 lbs/spring

(f) The general form of the equation for determining the limiting value of the spring force F_s is as follows:

$$F_s = \frac{M}{4}\left(1 + \frac{W_e}{W_{eq}}\right)\left(\frac{C + D}{C(D-L) + D \cdot F \cdot W_e/W_{eq}}\right) \quad \text{lbs/spring}$$

C, D, L, H define the locations of force reactions R_1 and R_2 and inertial forces F_{equip}, and F_{eng}, see figure 8.

W_e = Weight of engine = 205 lbs.

W_{eq} = Weight of equipment, lbs.

M = Allowable moment on the engine end-item supporting pads = 12 x 1000 = 12,000 lbs-inches. For calculating maximum permissible spring for drop tests only.

C = Location of engine mount-force reaction R_1 with respect to plane 0.31 inch inward and parallel to face of mounting pad. - Ins.
D = Location of equipment mount-force reaction R_2 with respect to plane defined for C - Ins.
H = Location of engine C.G. with respect to R_1 - Ins.
L = Location of equipment C.G. with respect to plane defined for C - Ins.

Substitution of numerical values reduces the equation to

$$F_s = 3000\left(1 + \frac{205}{W_{eq}}\right)\left(\frac{C + D}{C(D-L) + D\cdot H\cdot 205/W_{eq}}\right) \text{ lbs/spring}$$

Determination of permissable spring force using the general equation.
Example

Equipment C.G. to mounting face, distance = 7.94 inches

L = 7.94 + .31 = 8.25 inches

Equipment leg to mounting face, distance = 10.69 inches

D = 10.69 + .31 = 11.00 inches

H = -1/0 inches (Engine leg, R_1, is placed on left side of engine C.G. see figure 8.)

Engine C.G. location with respect to mounting pad face = (10.384 + 1.812 (Air Inlet)) = 12.196 inches.

C = 12.196 - .31 - 1.0 = 10.886 inches
W_{eq} = 240 lbs.

$$F_s = 3000\left(1 + \frac{205}{240}\right)\left(\frac{10.886 + 11.00}{10.886(2.75) + 11(-1.0)205/240}\right)$$

= + 5926 lbs/spring

Note: Only numerical value of F_s is required, minus sign if it occurs can be ignored; Consider F_s = 5926 lbs/ spring.

Determination of maximum permissable spring force can be simplified by placing the rigid engine support R_1 in same vertical plane with the engine inertia force or C.G., i.e. make H = 0. This reduces the equation for the maximum spring force to:

$$F_s = 252.5 \left(1 + \frac{205}{W_{eq}}\right) \gamma, \text{ where}$$

C = 12.196 - .31 = 11.886 inches

γ = (11.886 + D) / (D-L) γ is plotted in figure 13

for various values of D and L, and F_s is plotted in figure 14 for various values of γ and W_{equip}.

Example: Determining F_s by use of figures 13 and 14 where engine support is assumed to be in line with vertical center of gravity plane.

H = 0

D = 11 inches

L = 8.25 inches

W_{eq} = 240 lbs.

γ = +8.32 (Figure 13)

F_s = 3895 lbs./spring (Figure 14)

Note: That the maximum spring force of 1847 lbs is less than the maximum permissable force of 3895 lbs. Therefore the four shock mounts are suitable if the natural frequency and total deflection of the mounts are within the design specifications.

(g) Determine natural frequency and total deflection, figure 15.

For Static deflection	o = .1483 inches
Natural Frequency	F = 487 CPM
The total deflection	= 2.46 inches

F shall not be greater than 70 percent of the engine governed speed.

5.4.5 Maximum axial thrust. The maximum axial thrust that can be safely applied to the flywheel end of the crankshaft without damage to the crankcase is 1200 lbs.

5.5 Power transmission requirements. The driven unit shall be connected to the engine drive shaft by one of the following methods and torsional vibration determinations shall be made as specified in paragraph 5.5.5.

5.5.1 Rigid coupling. When a rigid coupling is used, the driven equipment shaft shall be in accordance with figure 16 for engine installation, plus the overhung moment shall not exceed the limits specified in figures 9 and 10. Material used in coupling is not specified but it is recommended that a good quality steel (minimum yield strength 100,000 PSI) be used to withstand cyclic stresses.

5.5.2 Flexible coupling. When a flexible coupling is used between the engine and end item the coupling shall provide the correct torsional flexibility and a sufficient degree of dampening to insure that the maximum vibration torque does not exceed 1394 lb.-in.

5.5.2.1 Shaft alignment. The misalignment of the engine shaft and driven equipment shaft shall not exceed that shown in figure 17.

5.5.2.2 Coupling installation. The coupling flange shall be fastened to the engine flywheel by a piloted four bolt connection. See figure 16.

5.5.3 Belt drive. The V-belts used shall conform to MIL-B-11040.

5.5.3.1 Pulley alignment. The alignment of the pulleys shall insure optimum belt life and power transmission. The belt load transmitted through the power take off shall not exceed the limits as specified in figure 9.

5.5.3.2 Pulley installation. The pulley shall be fastened on the engine flywheel by a piloted four bolt connection similar to figure 16.

5.5.4 Gear drive. When an independent reduction gear drive is used it shall be coupled to the engine through a suitable flexible coupling, paragraph 5.5.2.

5.5.5 Method for calculating torsional vibration stresses. Safe torsional vibration natural frequencies for the engine are above 12,000 vibrations per minute (VPM). Natural frequencies below 12,000 VPM can cause shaft breakage and equipment failure. The procedure in 5.5.5.1 shall be used to match the polar moment of inertia of the end-item rotating mass and the coupling adapter shaft stiffness to the engine. If the design of the end item dictates that the natural frequency be below 12,000 VPM, a complete torsional analysis is mandatory.

5.5.5.1 Procedure for directly connected end item.

(a) Determine rotating inertia of end item from paragraph 10.4 of appendix.
(b) Determine stiffness of shafting between flywheel and inertia mass see Figure 19. Use minimum shaft diameter in the span and the length of span from flywheel to attached inertia mass. Minimum diameter section should be at least 10 percent of length of span.
(c) Determine system torsional natural frequency from figure 18, using inertia mass and shaft stiffness value determined above. Remember natural frequencies below 12,000 VPM can be dangerous to the equipment.
(d) Example:

End item inertia

WR^2 = 182 lb. in^2

$$\text{Inertia} = \frac{WR^2}{386.4} = .471 \text{ lb. in. sec}^2 \text{ mass units}$$

Shaft length from flywheel to inertia mass = 12 in.
Minimum shaft diameter = 1.00 in.
Stiffness = $.99 \times 10^5$ in. lb./radian (figure 19)
System natural frequency = 5200 VPM

This frequency is in the high torsional stress zone and can not be used. Increasing the shaft minimum diameter to 1.500 inches will increase stiffness to 5.0×10^5 in. lb./rad. and result in a safe natural frequency of 12,000 VPM.

5.5.5.2 Procedure for flexible coupling connected load. Since the coupling stiffness will vary the natural frequency and in turn the critical speeds for any particular application, the charts for a rigid coupling can not be used. A complete torsional analysis shall be made utilizing the selected coupling stiffness. The maximum vibration torque shall not exceed 1394 lb-in.

5.6 Miscellaneous design requirements.

5.6.1 Alteration. The engine shall not be altered in any manner by the end-item manufacturer for assembly or installation purposes.

5.6.2 Fuel tank. The capacity of the fuel tank for the end item may be determined from Table III. The location of the fuel tank and maximum allowable length of fuel supply line shall not exceed the limits specified in figure 20.

5.6.3 Fuel lines. Fuel lines shall be installed so that they will not be subjected to fatigue or chafing from vibration or be under strain due to sharp radii or other causes, shall contain no loops, dips or rises which will cause vapor locks or water freeze point, and shall be protected against excessive transfer of heat from other engine components. Clips, braces, or brackets shall be used to fasten all piping to the engine.

5.6.4 Cooling air outlet. Adequate clearance or baffling shall be provided to prevent recirculation of cooling air, figures 5 and 21.

5.6.5 Exhaust system. The back pressure of the exhaust system, including the muffler, shall be measured 2 inches behind the manifold outlet in the exhaust pipe or muffler inlet pipe applied to the engine and shall not exceed 20 inches of water at WOT and maximum governed speed of the end item

5.6.6 Air cleaner inlet. The air cleaner inlet shall be free from obstruction.

5.6.7 End item wiring diagram. Figure 28 shows a recommended end-item wiring diagram for engine control.

Custodians:

Army - MO(ERDL)
Navy - YD
Air Force - 82

Review activities:

Army - MO
Navy - YD, MC
Air Force - 82
DSA - CS

User activities:

Army - MI, EL
Navy - None
Air Force - None

Preparing activity:

Army - MO(ERDL)

Project No. 2805-0057

10. APPENDIX

10.1 General description of engine. The model 4A084 Military Design engine is a horizontal-opposed-4-cylinder, overhead valve, air-cooled, spark ignition, 4-cycle, gasoline engine. Performance characteristics of the engine are shown in figure 4. Figure 1 and 2 are photographs of the Model 4A084 Military Design engine illustrating the major components on the drive and accessory ends, respectively. The installation drawings in figure 3 illustrate the overall dimensions of the engine, the location of the major components, and the detailed dimensions of the engine mounting flanges, equipment mounting flange and power take-off flange.

10.2 Engine specifications. The engine specifications are presented in table II. In addition the following paragraphs describe certain features and components in more detail.

10.2.1 Fuel pump. The fuel pump is a single acting diaphragm-type pump rated for a static pressure range between 1.5 psi minimum to 5.00 psi maximum, measured at a point 16 inches above fuel pump outlet with pump cam action at 1800 rpm. The flow pressure head is between 1.75 psi and 3.00 psi with a normal head pressure of 2 psi. The rated capacity of the pump at 3600 rpm engine speed is 5 gallons per hour.

10.2.2 Exhaust system. The engine exhaust system is comprised of single exhaust manifold outlets on each side of the engine. The exhaust outlet is a two-hole SAE flange by which the muffler may be attached, figure 22. Care should be exercised not to overstress the exhaust manifold by hanging unsupported weight on the end of the exhaust flange creating a large over-hung moment.

10.2.3 Cooling system. A single cooling-heating system is provided to insure satisfactory operation over the specified temperature range from minus 25° F. to plus 120° F. Cooling air is provided by a centrifugal fan integral with the die cast aluminum flywheel. The cooling air of the pressure system is passed over the top portion of the cylinder barrel and is discharged across the bottom of the engine oil pan as well as below the cylinders and cylinder heads. The system is designed to maintain safe engine temperatures over the entire load range. At rated speed, the air-flow is 1900 cubic feet/minute, figure 21.

10.2.4 Starting system. The standard engine is equipped with a starter rope, and a 24 volt electric starting system. The torque effort to turn the engine (without end-item) at various temperatures is shown in figure 23. Figure 29 shows the wiring diagram for the electric starter.

10.2.5 Manual throttle control. This engine is equipped with a manual throttle control for operation below the governed engine speed. The governed engine speed is set for 3600 rpm by the manufacturer. If a remote throttle control is required, a simple cable control can be attached, figure 24.

10.2.6 Manual choke. The engine is equipped with a manual choke cable.

10.2.7 Electric choke. The engine is equipped with a 24 volt solenoid actuated choke which is fully closed when the starter is energized. This electrical choking system also incorporates a bimetal switch to prevent chocking when the engine is started after the engine has attained operating temperatures.

10.2.8 Tachometer. The engine is equipped with a mechanical SAE (heavy-drive) tachometer drive, figure 26.

10.2.9 High oil temperature control. The standard engine is not equipped with a high oil temperature control. In the event one is required the engine is equipped with two oil drain plugs and one can be removed to permit installation of a high oil temperature control, figure 27.

10.2.10 Low oil level pressure cut off switch. The engine is equipped with a low oil pressure cut off switch. This switch is provided with two terminals. In one terminal the contacts are normally open and in the other terminal the contacts are normally closed. For the majority of end-item applications the normally closed contacts can be used to ground out the ignition when the engine oil pressure drops below 16 to 18 psi. A method to override this switch for starting must be provided by the end-item system design.

10.2.11 Battery charging. The engine is equipped with a permanent magnet alternator enclosed behind the rope starting pulley with voltage regulation controlled by a solid state regulator mounted as shown in figure 1. This system regulates on 28.5 $\pm$ .5 volts DC and will not exceed 30 volts DC without a battery in the system.

10.2.12 Electrical wiring. Figure 25 is a schmatic wiring diagram of the engine system.

Table II

Engine Specifications

Model 4A084

A.	Engine	
	Number of Cylinders	4
	Bore, Inches	3.00
	Stroke, inches	3.00
	Total Displacement, cubic inches	84.80
	Rated Horsepower at 3600 rpm	20.0
	Maximum Horsepower at 3600 rpm	33.3
	Maximum Torque at 2000 rpm, lb,ft	60.3
	Compression Ratio	6.8:1
	Speed Range, rpm (for continuous operation)	2000 - 4000
B.	Fuel System	
	Fuel, Pump	diaphragm
	Fuel Filter	MIL-STD
C.	Lubrication System	
	Lubrication System	force feed
	Oil Sump Capacity (without filter) pints	8.0
	Oil Consumption, at Rated Load and Speed, lb/bhp-hr.	.005 average for 1500 hrs. of operation

D. Ignition	
Timing	28° BTDC
Ignition System	magneto
Spark Plug	18 mm
E. Governor Characteristics	
Speed Regulation percent	3
Rated Load Speed, rpm	3600
No Load Speed, rpm	3708 maximum
Engine Speed Stability (at constant value of load) percent	± 1/2 of 1
Maximum Speed Surging Characteristics Rated Load to No Load, seconds	6
No Load to Rated Load, seconds	4
Maximum Speed Change during surging period, percent	5
Speed Regulation, Rated Load to No Load (Overspeed), rpm	288 maximum
Speed Regulation, No Load to Rated Load (Droop), rpm	216 maximum
F. Engine and Accessories	
Air Cleaner	dry type, cleanable element
Cranking System	rope and electric
Main Bearings	copper-lead on steel backing
Crankshaft rotation, viewed from drive end	counterclockwise

Dry Weight, pounds	205
Life between major overhaul or rebuild hours	1500

G. Over-All Dimensions

Height, Inches	21.94
Length, inches	24.25
Width, inches	27.81

H. Environmental Extremes

Engine Operation (Self Sustaining)	+120° to-25°F.
Engine Storage	+160 to-80° F.
Engine Starting Capability without preheat	+120 to -25° F.
Humidity Extreme, percent Relative Humidity	85 at 85° F.
Tilt Operation, degrees in any Plane (maximum)	15
Maximum elevation for rated power, feet	5000 ft.

10.3 Fuel consumption. The fuel consumption characteristics (at 3600 rpm) of the 20 BHP Military design engine are presented in table III.

Table III Fuel Consumption

Horsepower (3600 rpm)	5.0	10.0	15.0	20.0	25.0	30.0	35.0.
Average Fuel Consumption, gal/hour	1.47	2.03	2.45	2.6	3.17	3.7	4.2

10.4 Moment of inertia of end-item. Determine the polar moment of inertia of a balanced pivoted mass which is not easily removable or to handle, such as the rotor of an electric motor, as follows:

(a) Support the rotating mass in a horizontal plane on anti-friction bearings or on knife edges.

(b) Attach a known weight, W, to the mass at a distance, L, from the axis of rotation. (When the mass is not accessible and the shaft rotates with it, attach the weight to the shaft with a light rigid rod of length L).

(c) Set the system in oscillation at amplitudes of 10 degrees or less and measure the period T.

(d) Determine the moment of inertia using the following formula:

$$J = WL\left[\left(\frac{T}{2\pi}\right)^2 - \frac{L}{G}\right]$$

Where

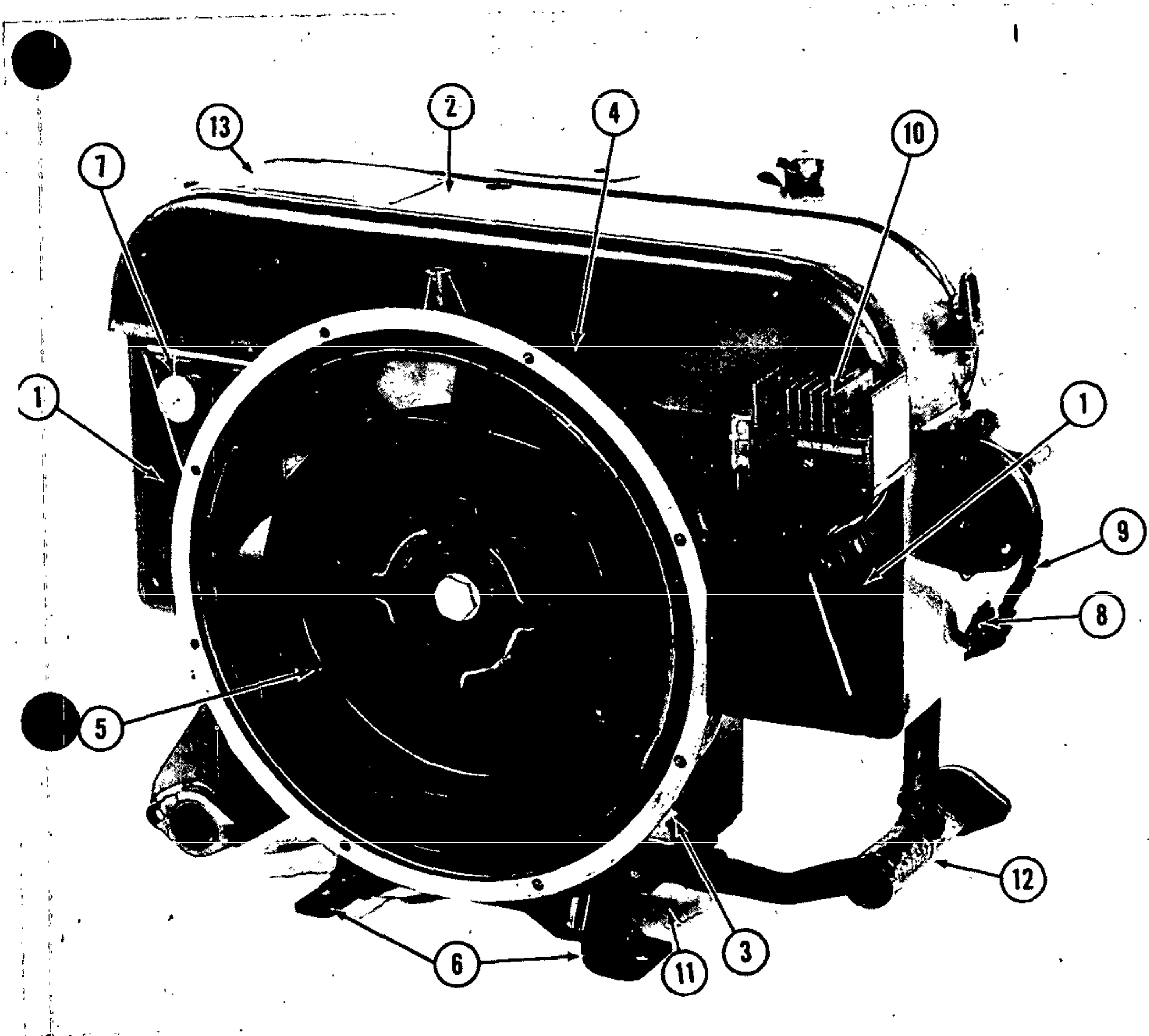
J = moment of inertia, lb-in-sec^2

W = weight of mass, lbs.

L = length of rod, inches

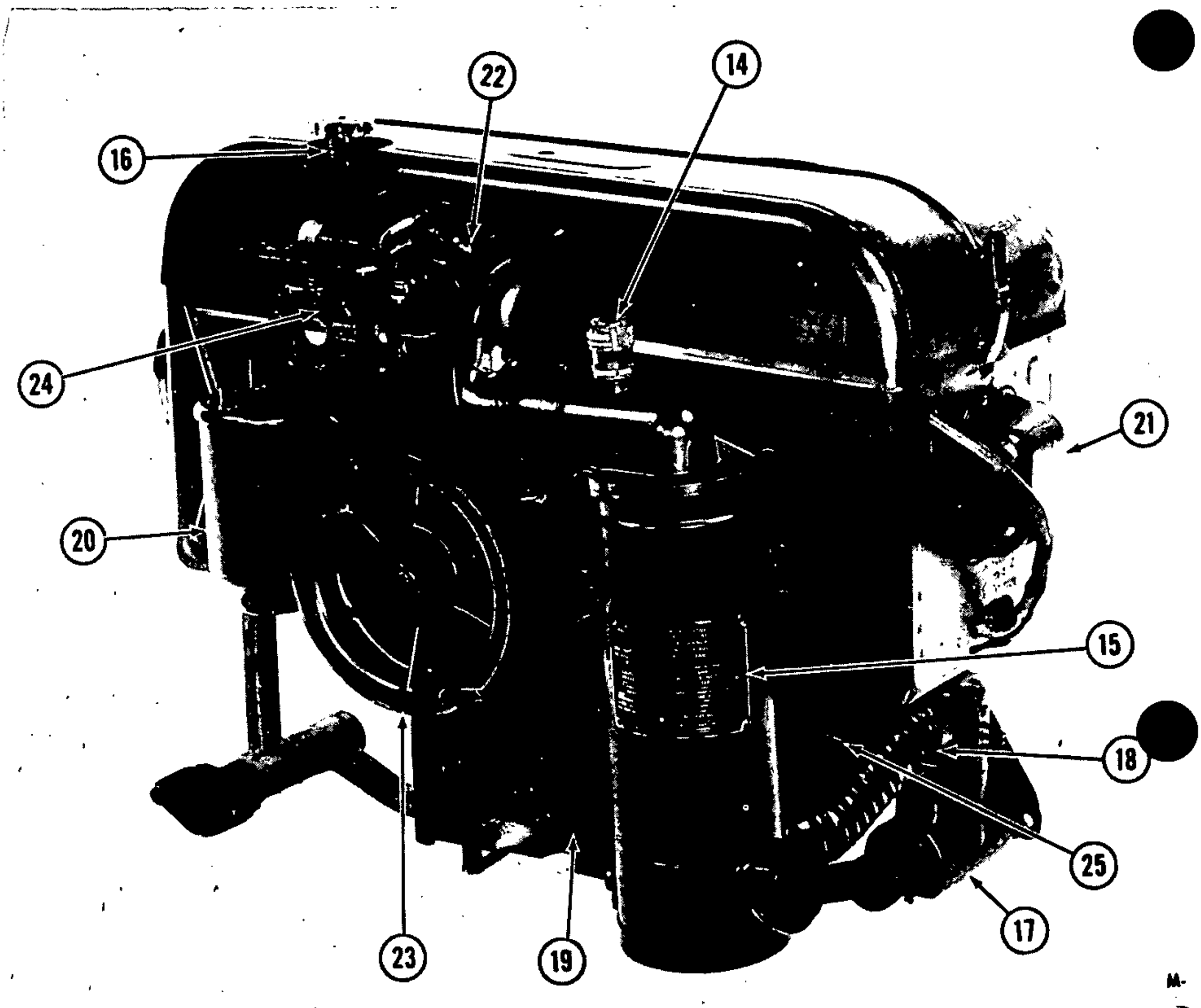
T = second/period

G = acceleration of gravity = 386 in/sec^2



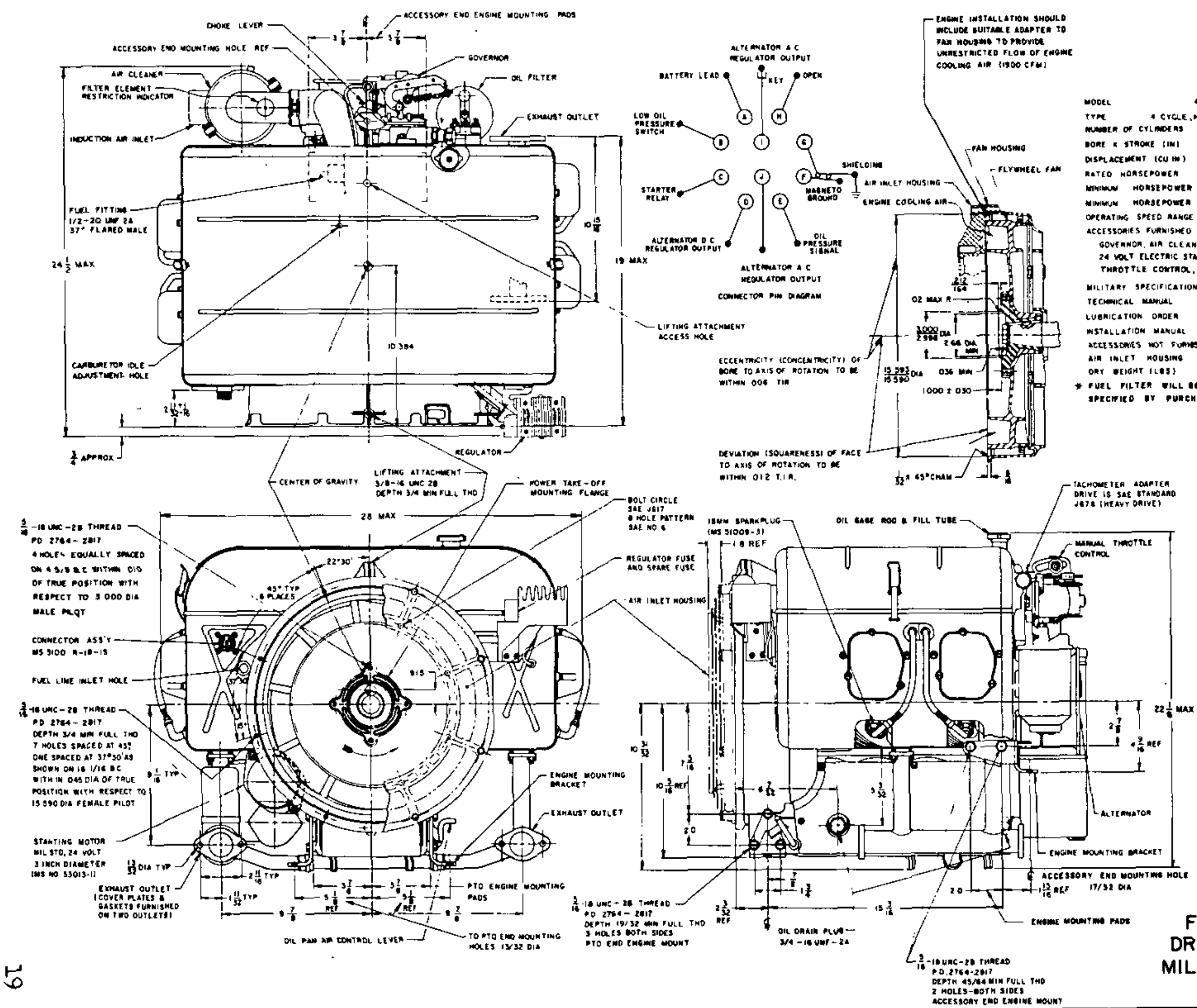
1. Sheet Metal Shroud
2. Top Cover
3. Oil Drain Plug
4. Flywheel Fan Housing
5. Flywheel Fan
6. Engine Mounting Brackets
7. Harness Connector (10 Pin)
8. Spark Plugs
9. High Tension Leads
10. Battery Charging Regulator
11. Oil Pan Air Baffle Control
12. Exhaust Manifold
13. Wiring Diagram

FIGURE 1. Model 4A084 - Military Design Engine - Drive End.



14. Air Filter Restriction Indicator
15. Air Cleaner
16. Oil Fill Tube and Dip Stick
17. Oil Drain Plug
18. Air Intake Preheater
19. Flexible Air Duct
20. Oil Pan
21. Oil Filter
22. Exhaust Manifold
23. Rocket Box Cover
24. Manual Choke Control
25. Alternator Rotor and Rope Starter Pulley
26. Governor
27. Engine Mounting Bracket

FIGURE 2. Model 4A084 - Military Design Engine - Accessory End.



SPECIFICATIONS

MODEL	4A084	FSN-2805-872 5972
TYPE	4 CYCLE, HORIZ. OPP., OVERHEAD VALVE, AIR COOLED, GASOLINE	
NUMBER OF CYLINDERS		4
BORE x STROKE (IN)		3 X 3
DISPLACEMENT (CU IN)		84
RATED HORSEPOWER		20 BHP AT 3600 RPM
MINIMUM HORSEPOWER (AS SHIPPED) WOT		29.7 BHP AT 3600 RPM
MINIMUM HORSEPOWER (AFTER BREAK-IN) WOT		33 BHP AT 3600 RPM
OPERATING SPEED RANGE		2000 TO 4000 RPM

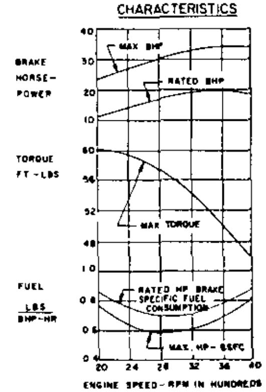
ACCESSORIES FURNISHED WITH ENGINE.
GOVERNOR, AIR CLEANER, FUEL PUMP, FUEL FILTER*, ROPE STARTER, 24 VOLT ELECTRIC STARTER, ALTERNATOR AND REGULATOR MANUAL THROTTLE CONTROL, AUTOMATIC CHOKE, MOUNTING BRACKETS

MILITARY SPECIFICATION	MIL-E-62014 (MO)
TECHNICAL MANUAL	TM 5-2805-204-14
LUBRICATION ORDER	LO 5-2805-204-14
INSTALLATION MANUAL	MIL-STD-

ACCESSORIES NOT FURNISHED WITH ENGINE (MUFFLER, FUEL TANK, BATTERY)
AIR INLET HOUSING AVAILABLE WHEN SPECIFIED BY PURCHASER
DRY WEIGHT (LBS) 206

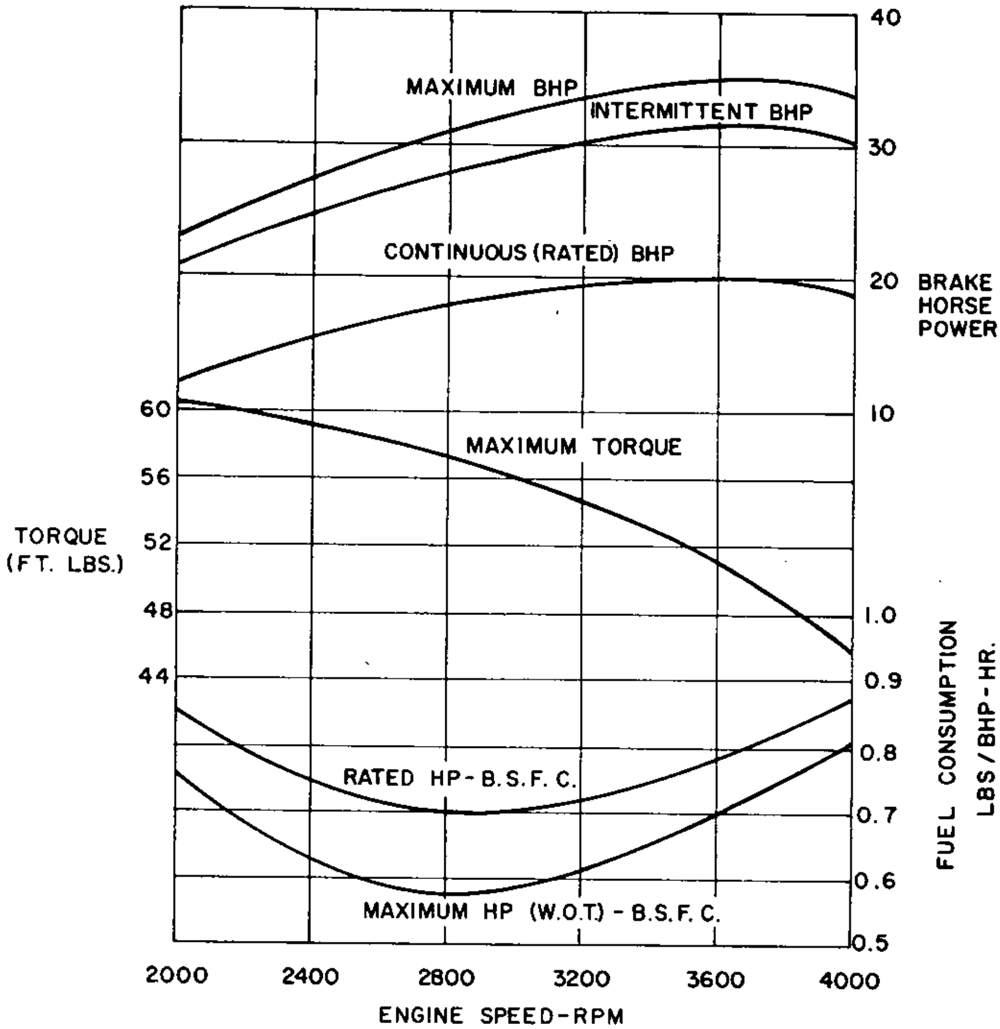
* FUEL FILTER WILL BE SUPPLIED UNLESS OTHERWISE SPECIFIED BY PURCHASER

PERFORMANCE CHARACTERISTICS



DATA CORRECTED TO STANDARD CONDITIONS (29.92 HG @ 60°F)

FIGURE 3. INSTALLATION DRAWING MODEL 4A084 MILITARY STANDARD ENGINE
DX-477



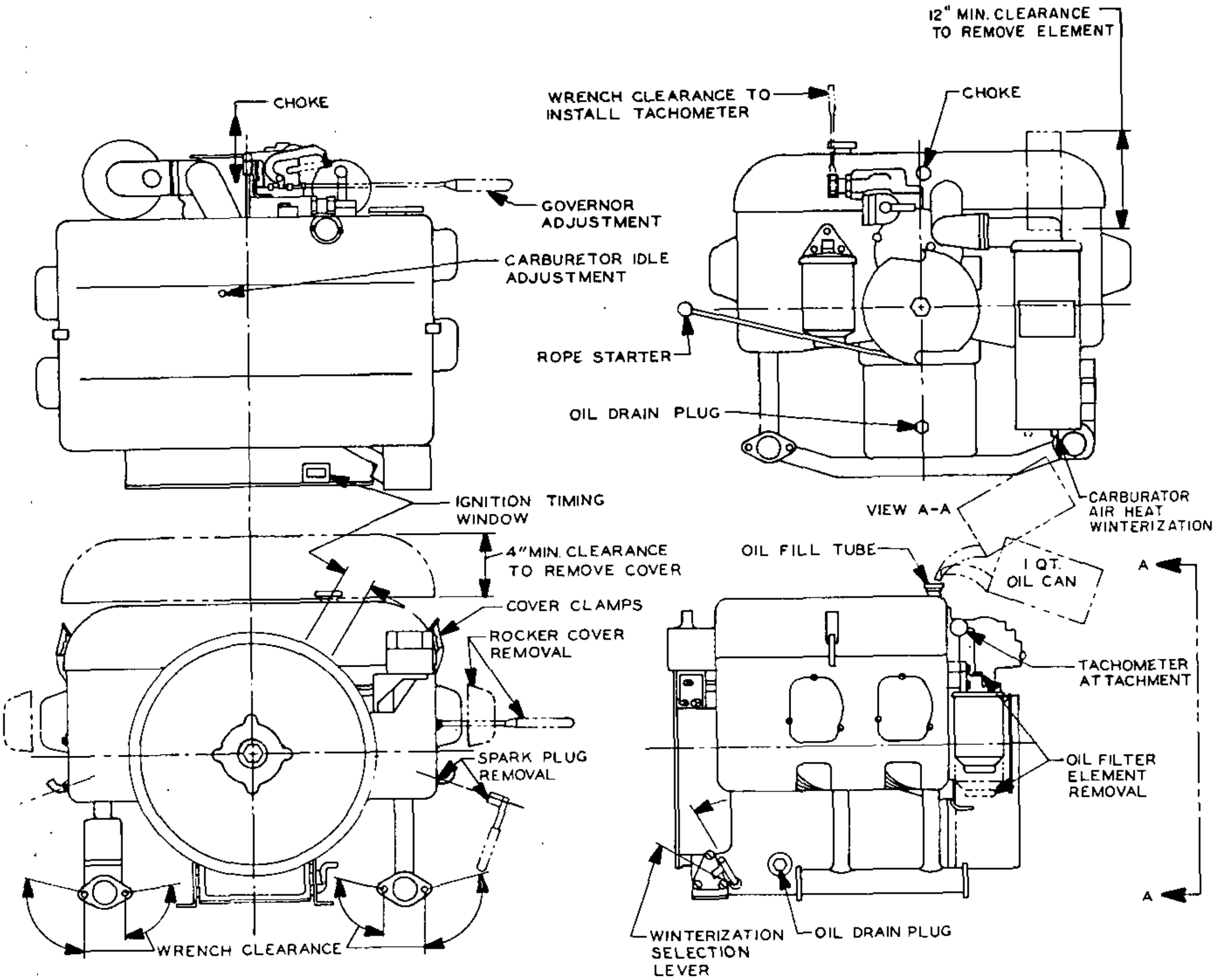
MAXIMUM BHP CURVE DEVELOPED BY LABORATORY TEST ENGINES. PRODUCTION ENGINES DEVELOP NOT LESS THAN 29.75 MAXIMUM BHP WHEN SHIPPED, AND NOT LESS THAN 33.3 MAXIMUM BHP AFTER RUN-IN TO REDUCE FRICTION.

INTERMITTENT HORSE POWER RATING OF EACH ENGINE IS APPROXIMATELY 90% OF MAXIMUM HORSE POWER WHICH THE ENGINE WILL PRODUCE FOR SHORT PERIODS OF CONTINUOUS OPERATION.

CONTINUOUS HORSE POWER RATING OF EACH ENGINE IS APPROXIMATELY 57% OF MAXIMUM HORSE POWER RATING AT ANY GIVEN SPEED IN OPERATING SPEED RANGE. THIS POWER RESERVE PROVIDES AGAINST LOSSES RESULTING FROM ALTITUDE AND HIGH TEMPERATURE OPERATION, NORMAL WEAR, AND MANUFACTURING TOLERANCES.

DATA CORRECTED TO STANDARD CONDITIONS (29.92" HG & 60° F)

FIGURE 4. PERFORMANCE CHARACTERISTICS



NOTE:
FOR ARCTIC CONDITIONS ALLOW CLEARANCE FOR HEAVY GLOVES TO SERVICE AND OPERATE ENGINE.

FIGURE 5. MAINTENANCE CLEARANCES

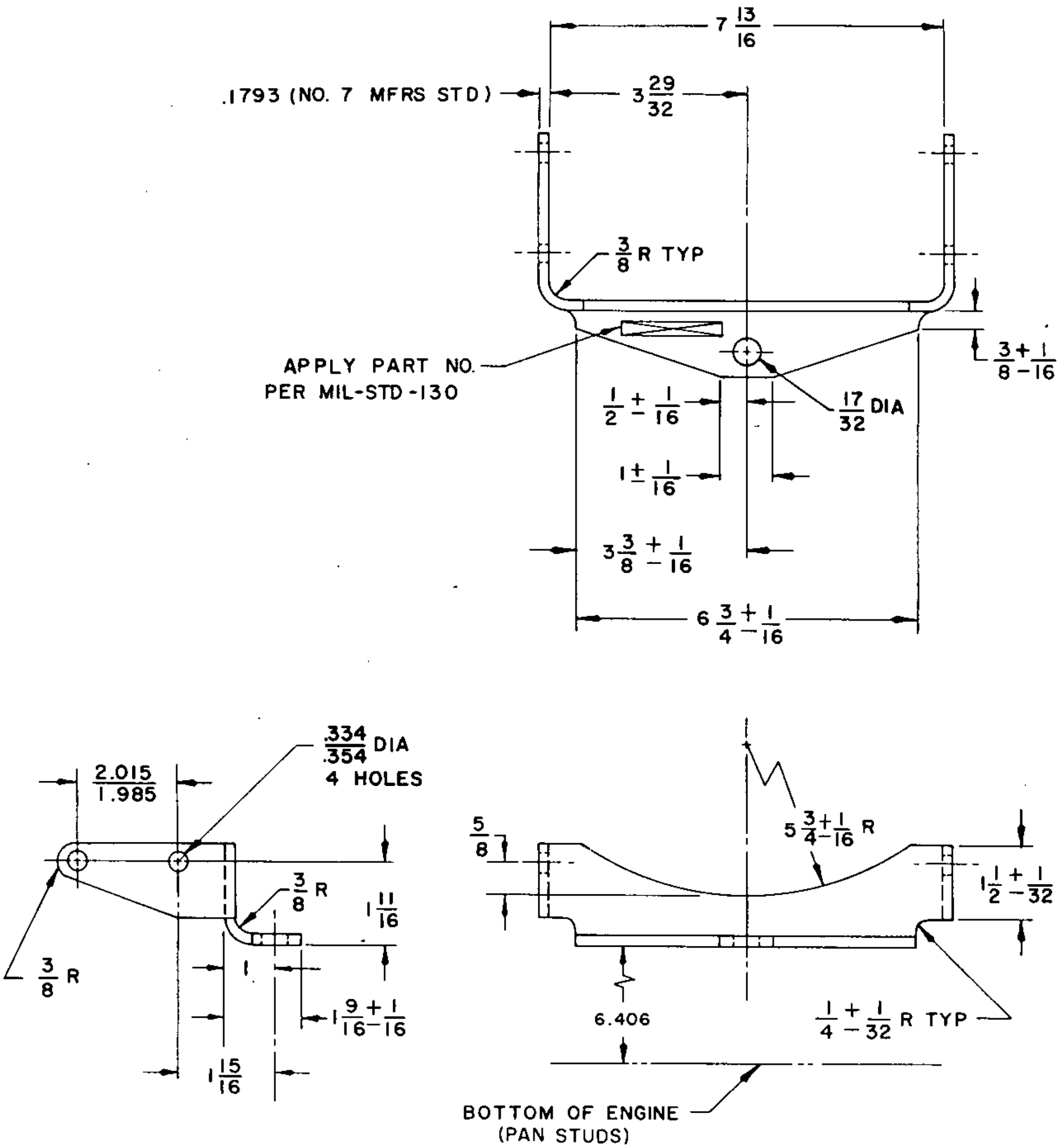


FIGURE 6. ENGINE FRONT MOUNTING BRACKET

CX-480

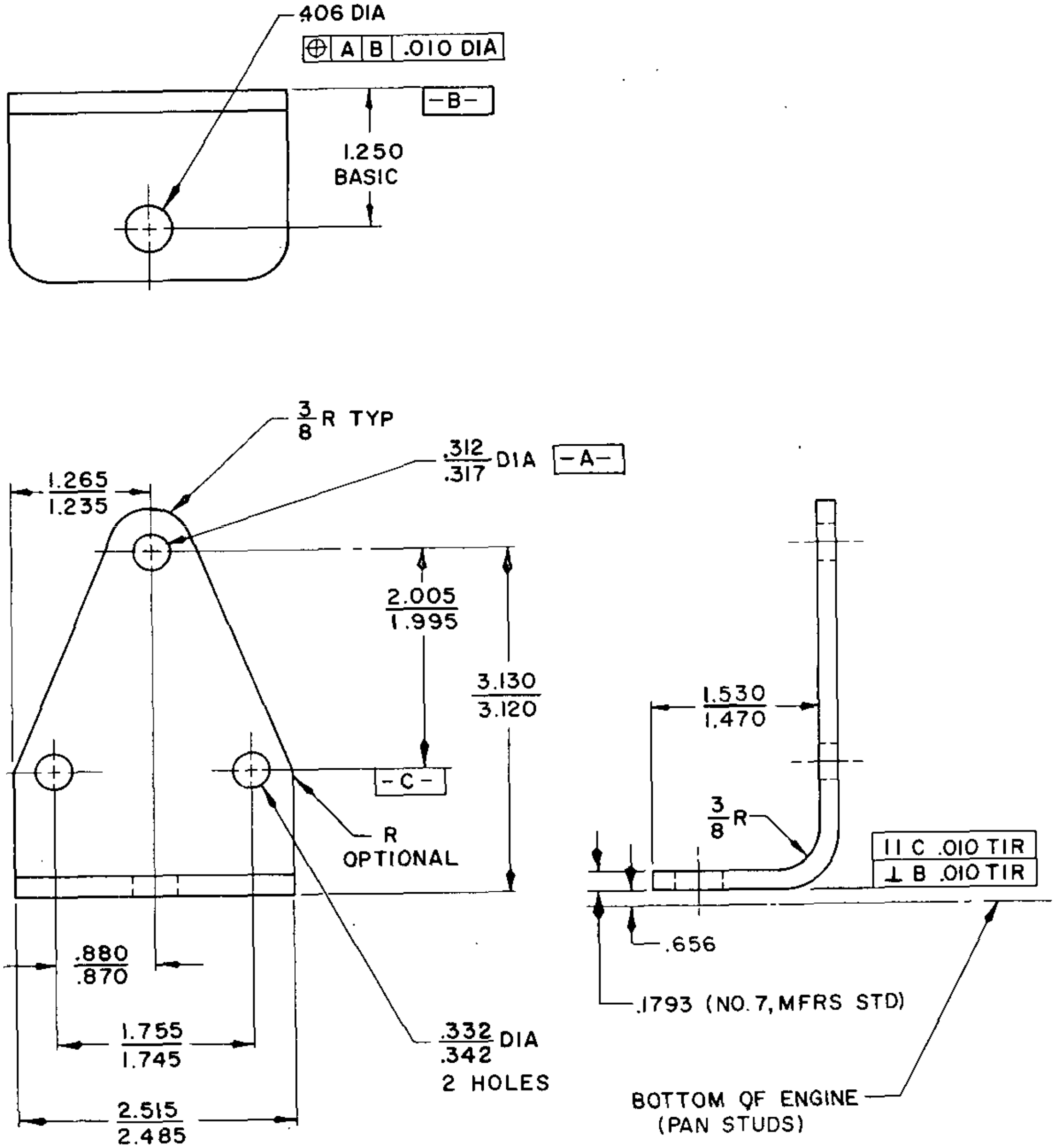


FIGURE 7. ENGINE REAR MOUNTING BRACKET

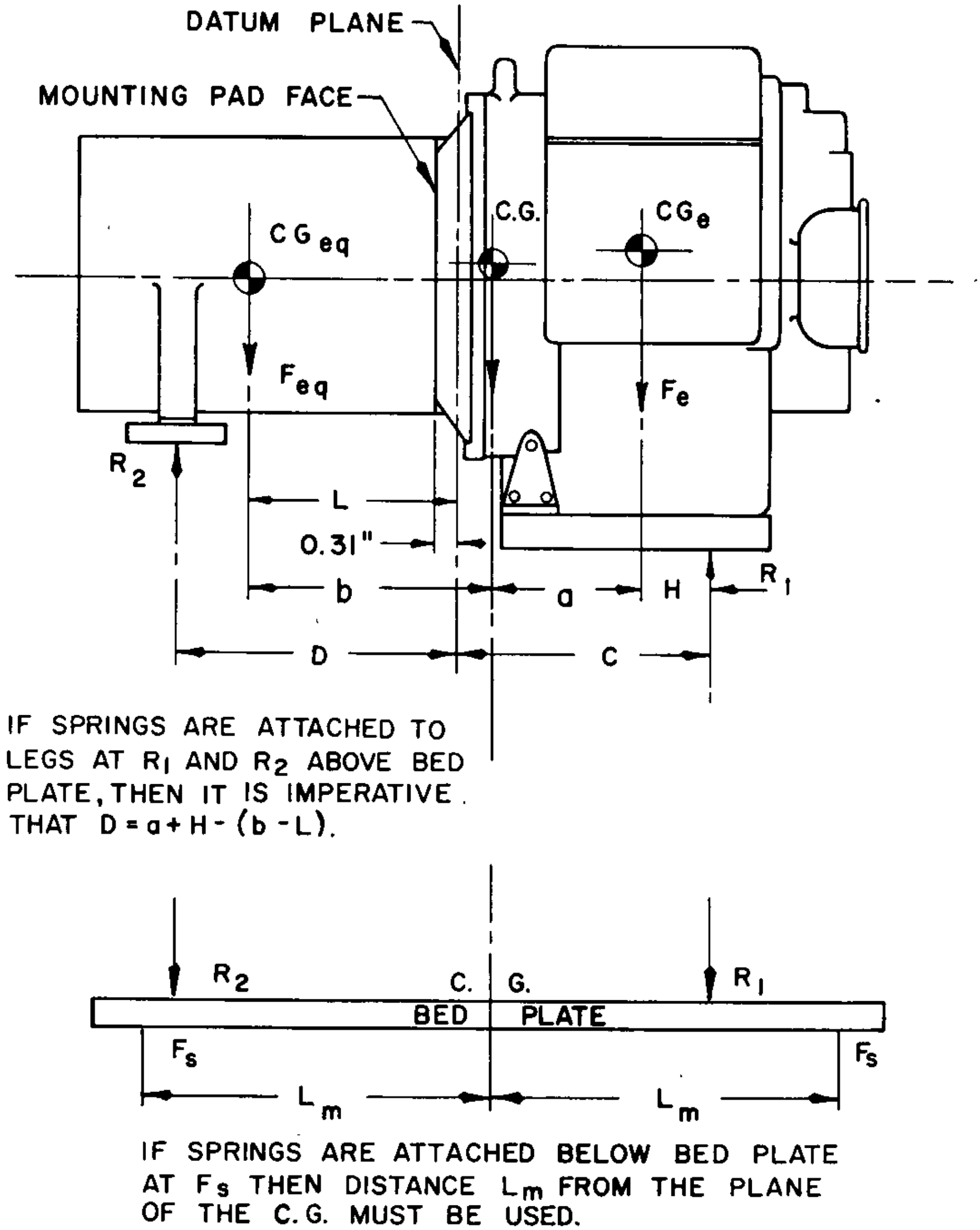


FIGURE 8. BEAM MOUNTING INSTALLATION FOR ENGINE WITH DIRECT MOUNTED EQUIPMENT

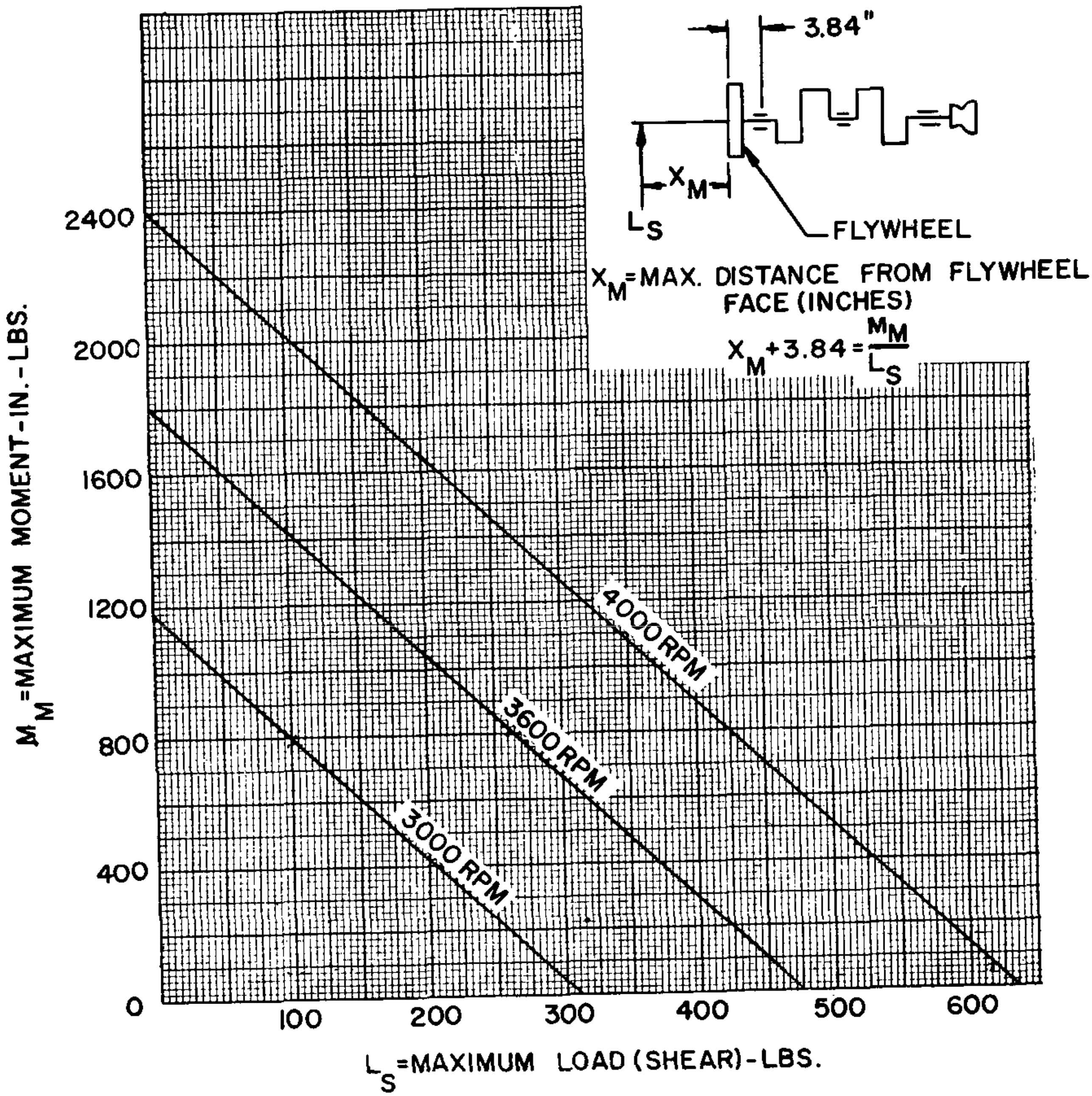


FIGURE 9. POWER TAKE OFF END ALLOWABLE MOMENT & LOAD DIAGRAM

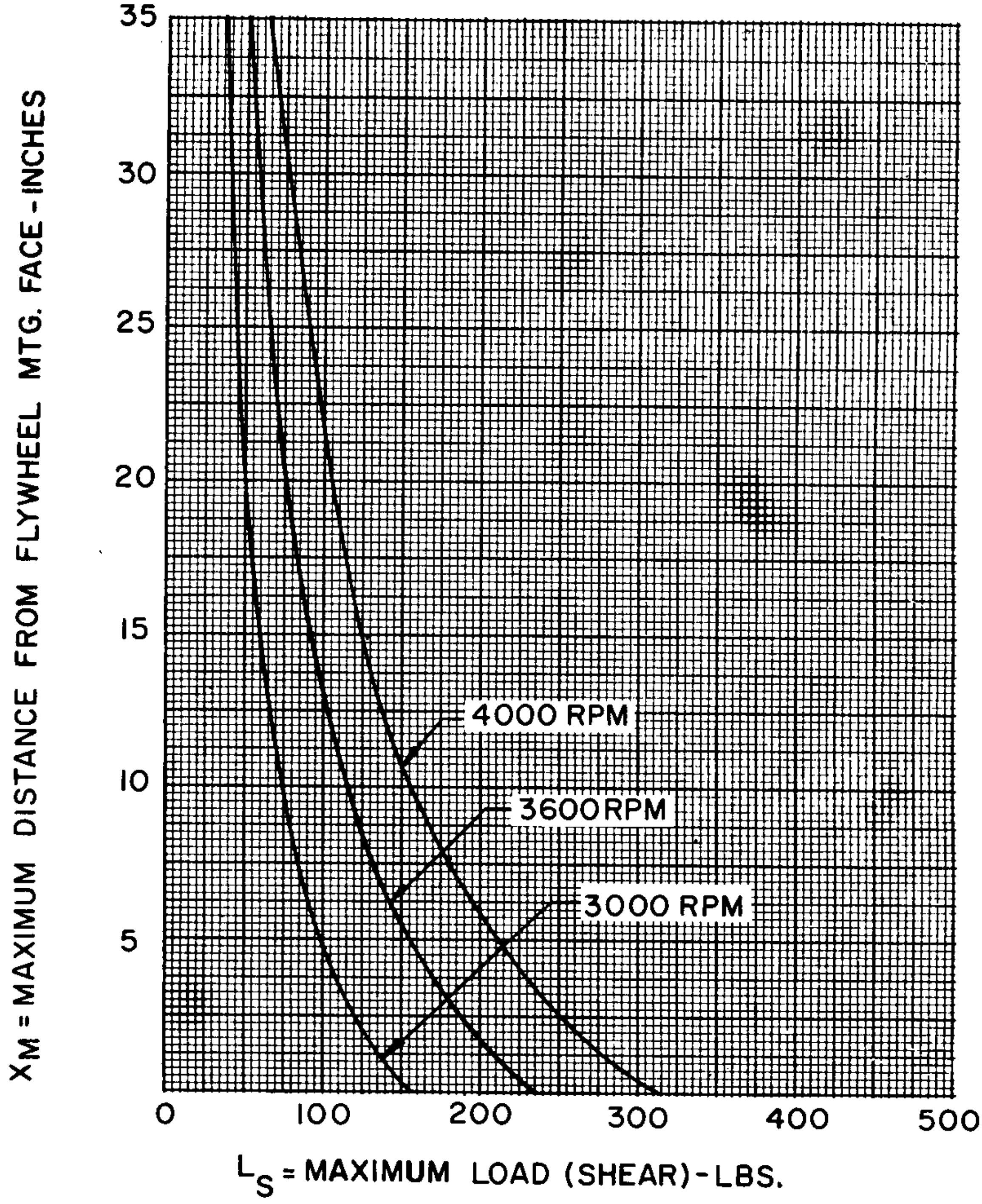


FIGURE 10. POWER TAKE OFF END MAXIMUM DISTANCE FOR OVERHUNG LOADS

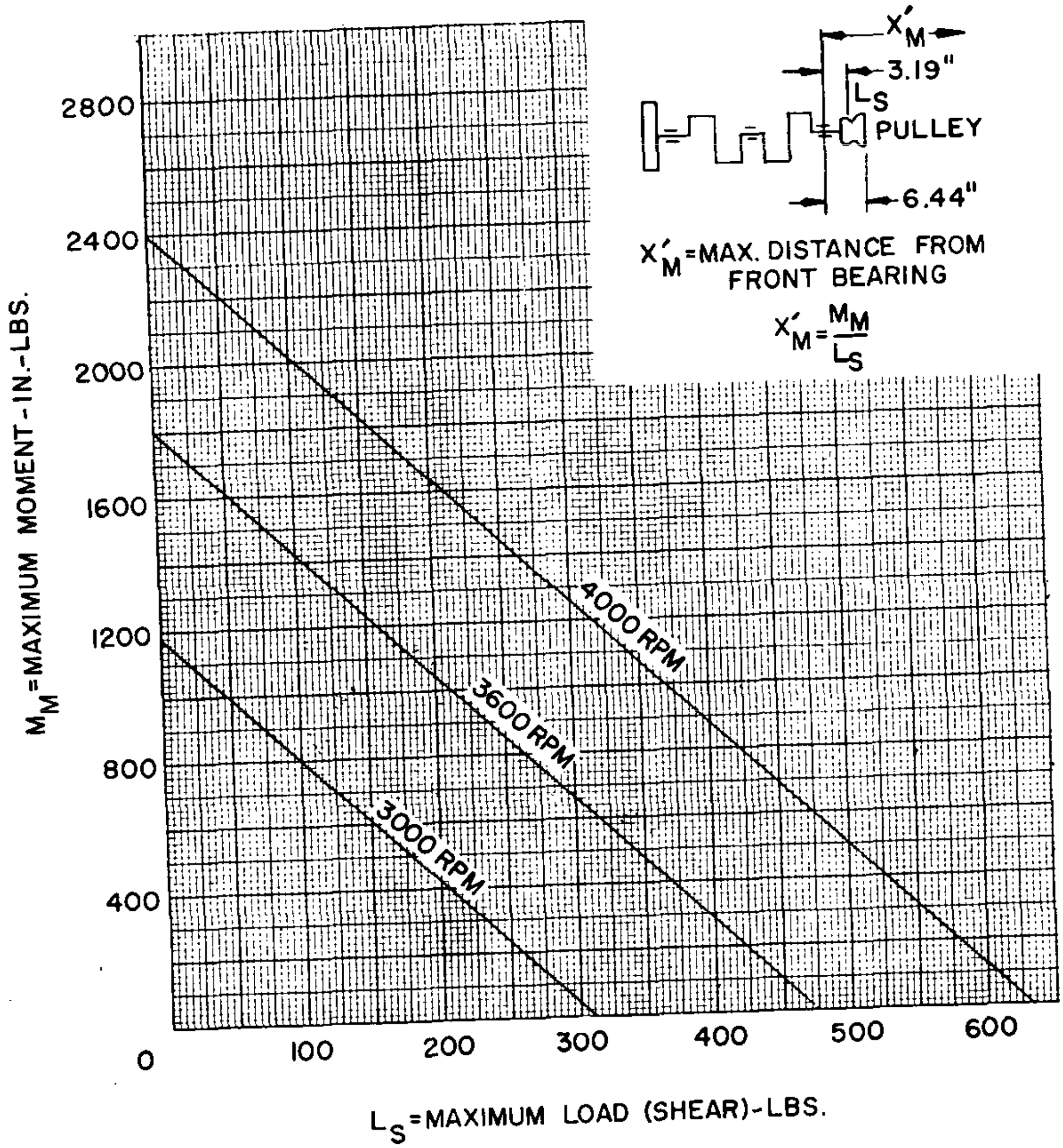


FIGURE 11. ACCESSORY END ALLOWABLE MOMENT & LOAD DIAGRAM

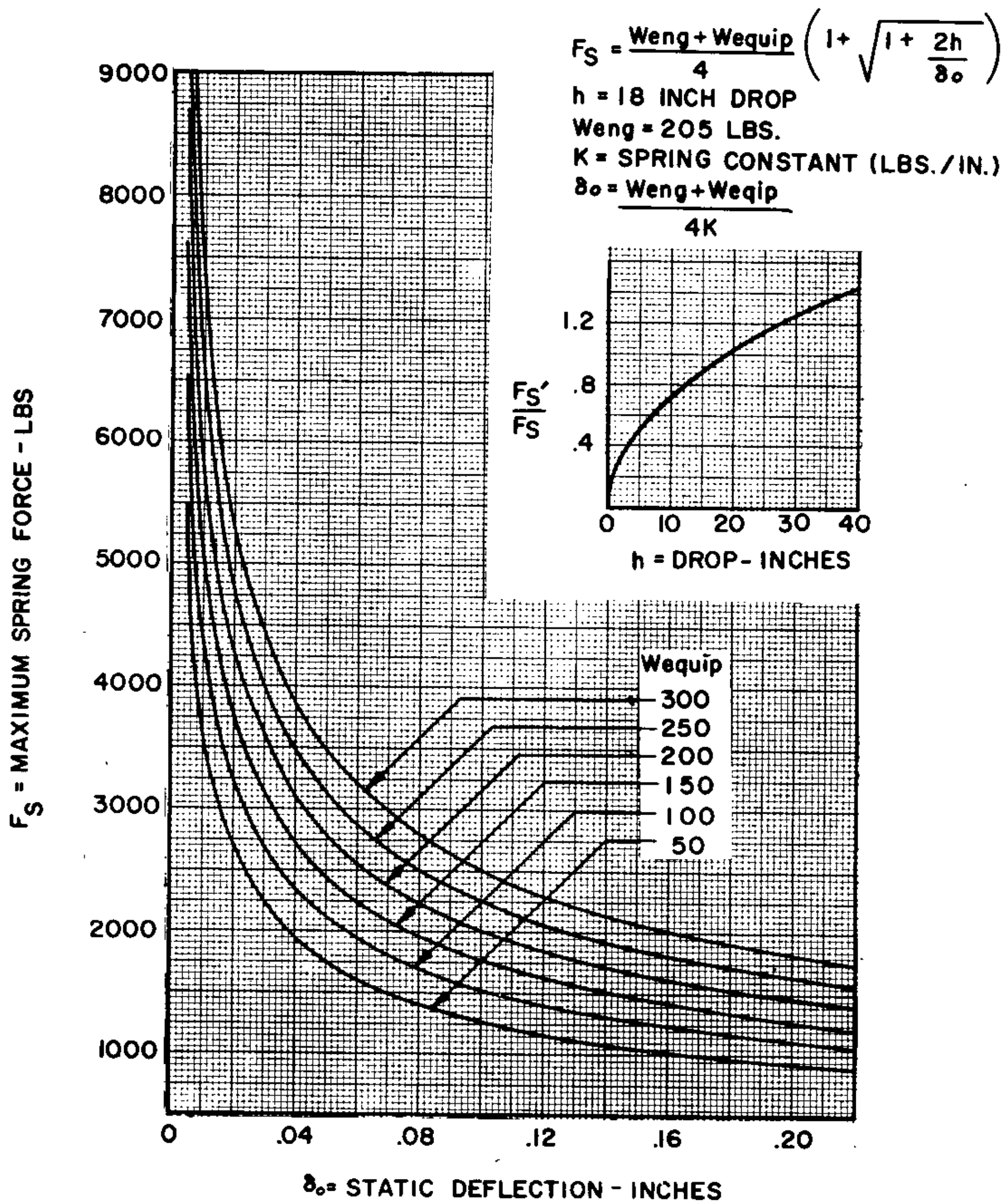


FIGURE 12. MAXIMUM SPRING FORCE-VIBRATION MOUNTS

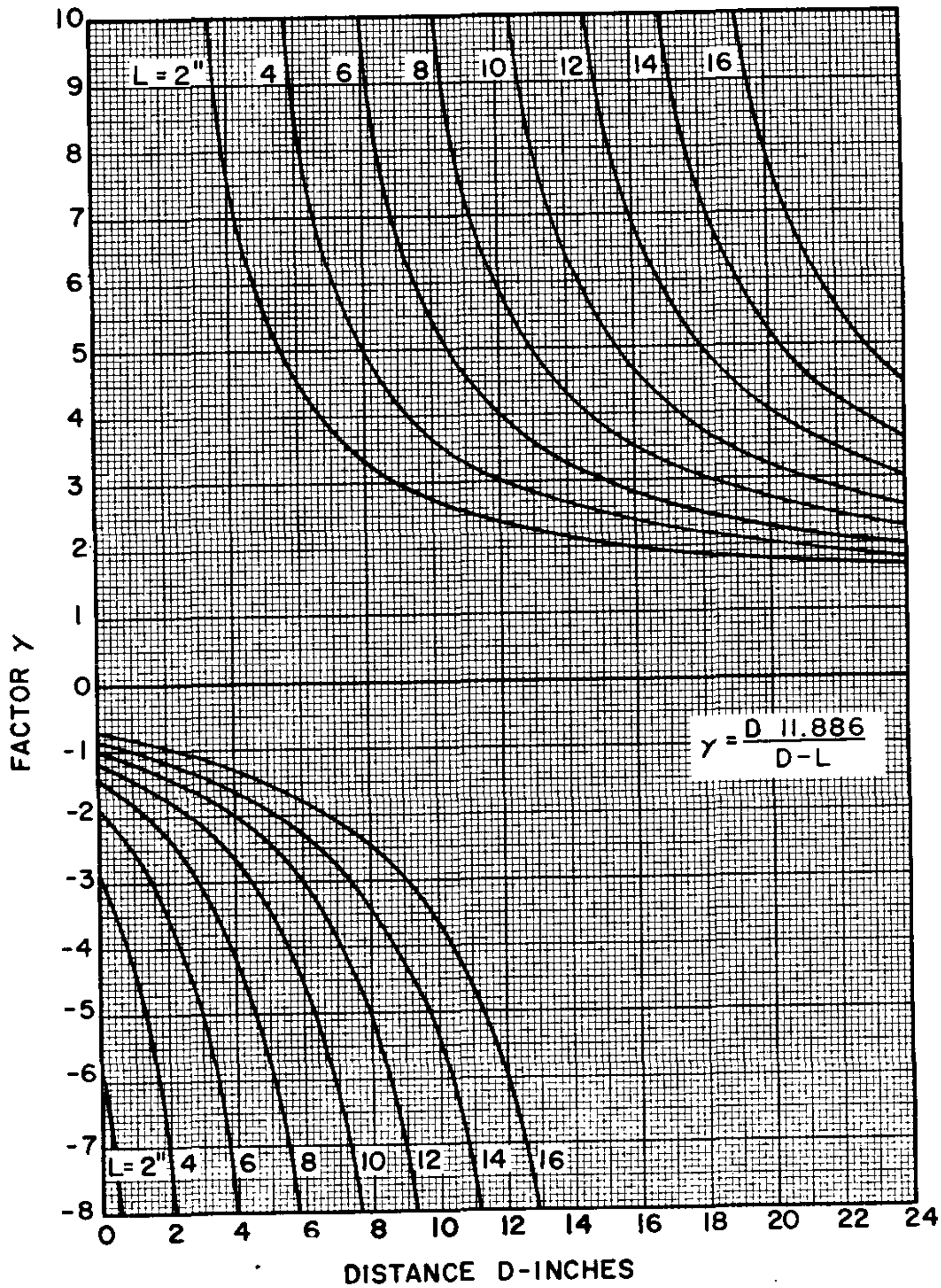


FIGURE 13. FACTOR γ WHEN H = 0

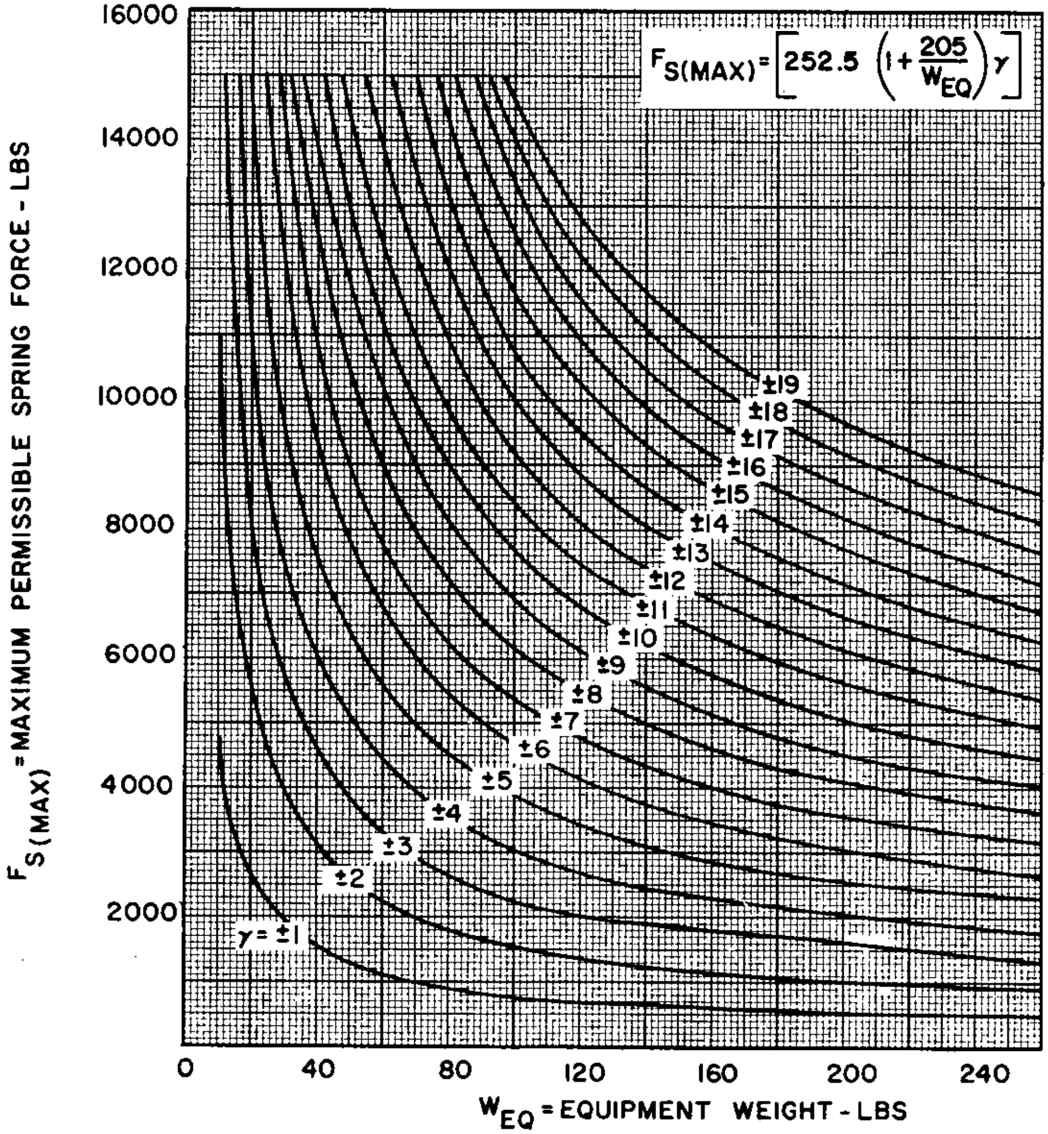


FIGURE 14. MAXIMUM PERMISSIBLE SPRING FORCE (PER SPRING) FOR BEAM MOUNTING WHEN H=O

CX-488

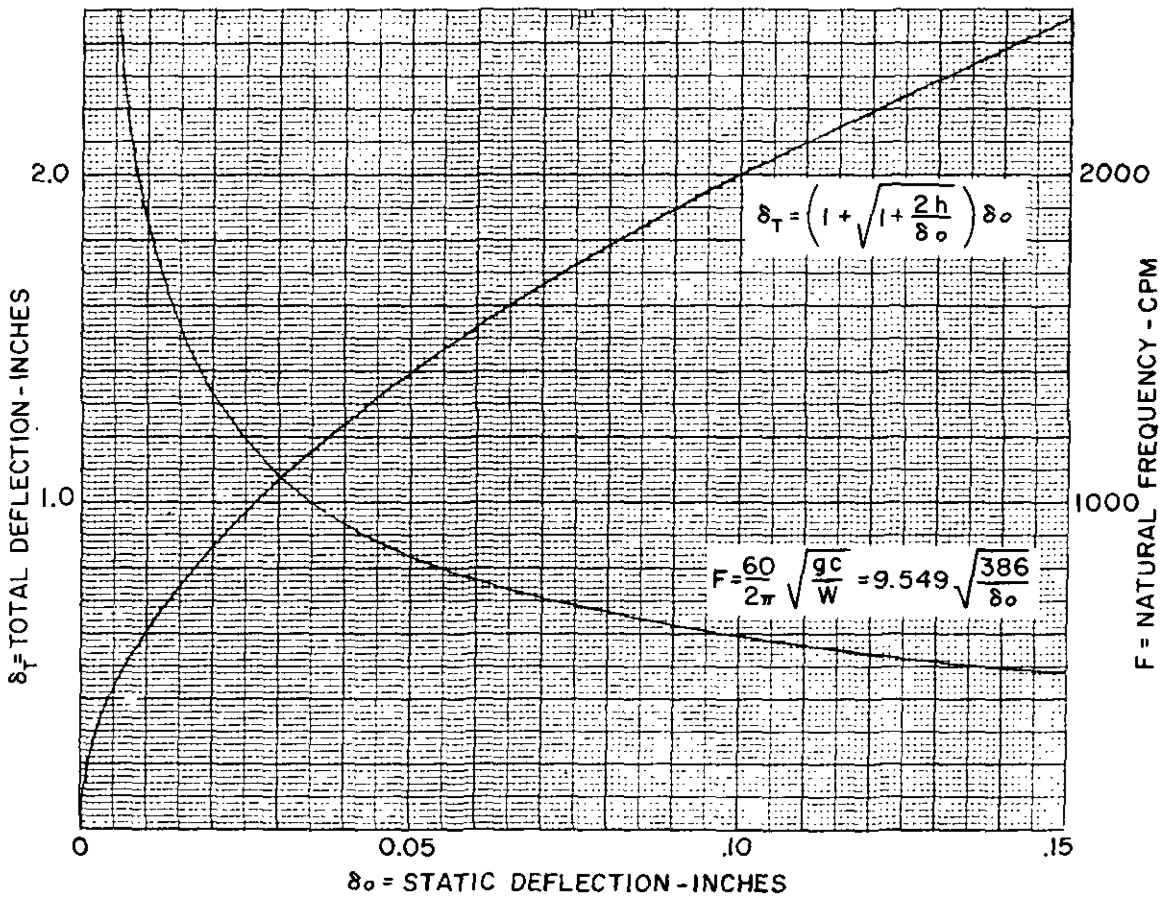


FIGURE 15. NATURAL FREQUENCY AND TOTAL DEFLECTION DIAGRAM

CX-489

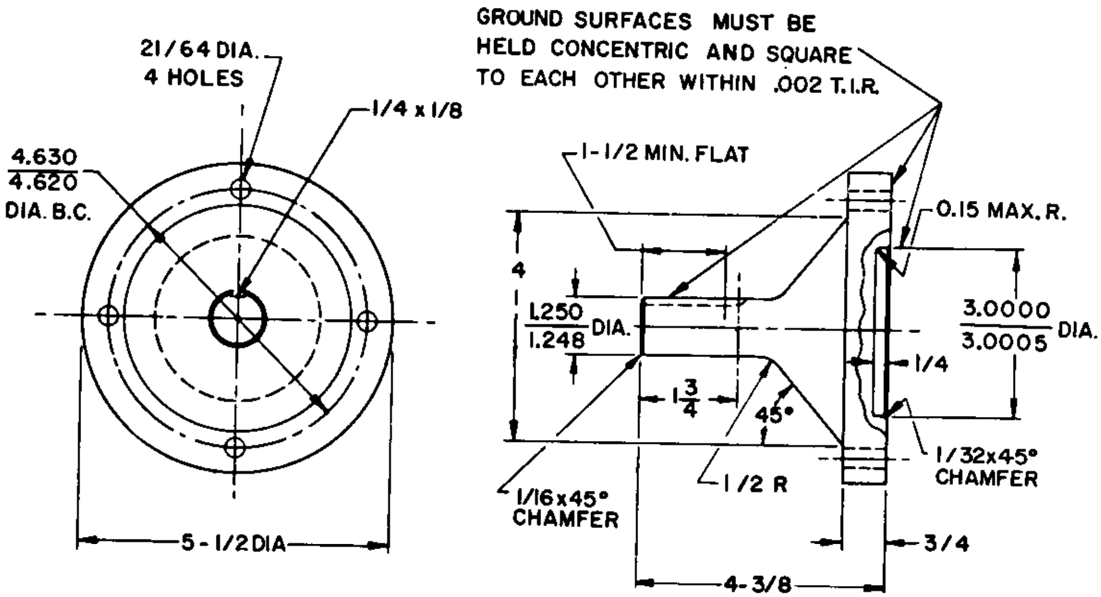
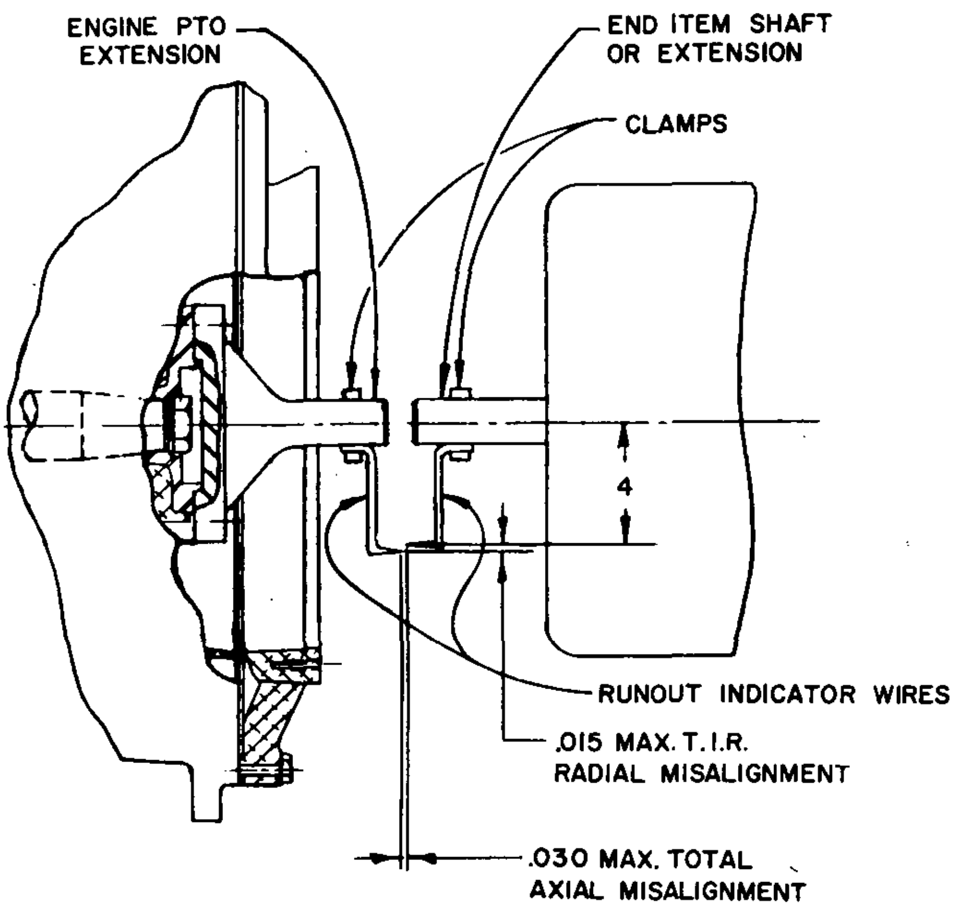


FIGURE 16. FLYWHEEL COUPLING ADAPTER
(NOT AVAILABLE AS G.F.E.)



NOTE:
FOR RIGID COUPLINGS A MAX OF .006 T.I.R. RUN OUT BETWEEN SHAFTS

FIGURE 17. SHAFT ALIGNMENT METHOD (FLEXIBLE COUPLING)

CX-491

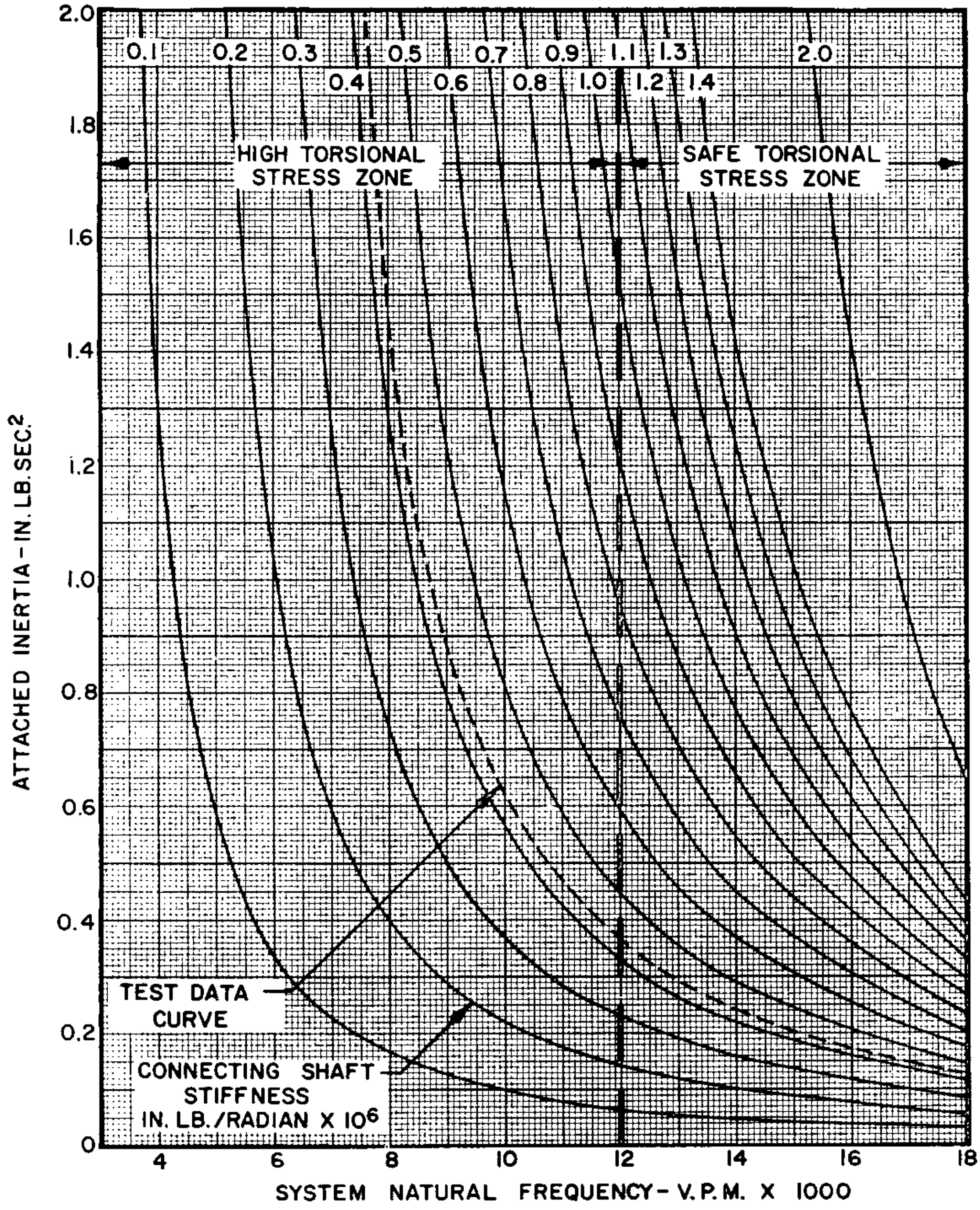


FIGURE 18. TORSIONAL TUNING CURVES DIRECT COUPLED END ITEM

CX-492

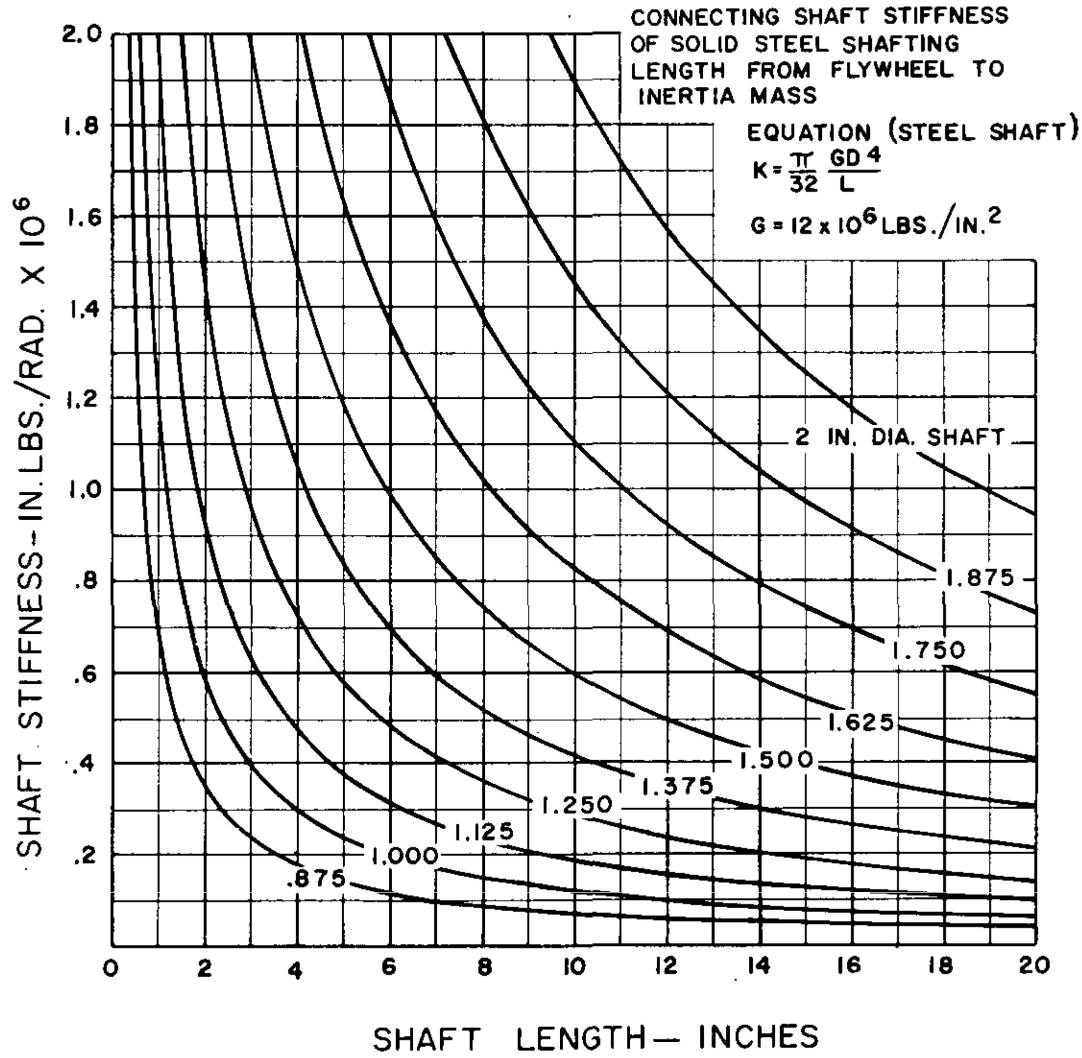


FIGURE 19. COUPLING ADAPTER SHAFT STIFFNESS

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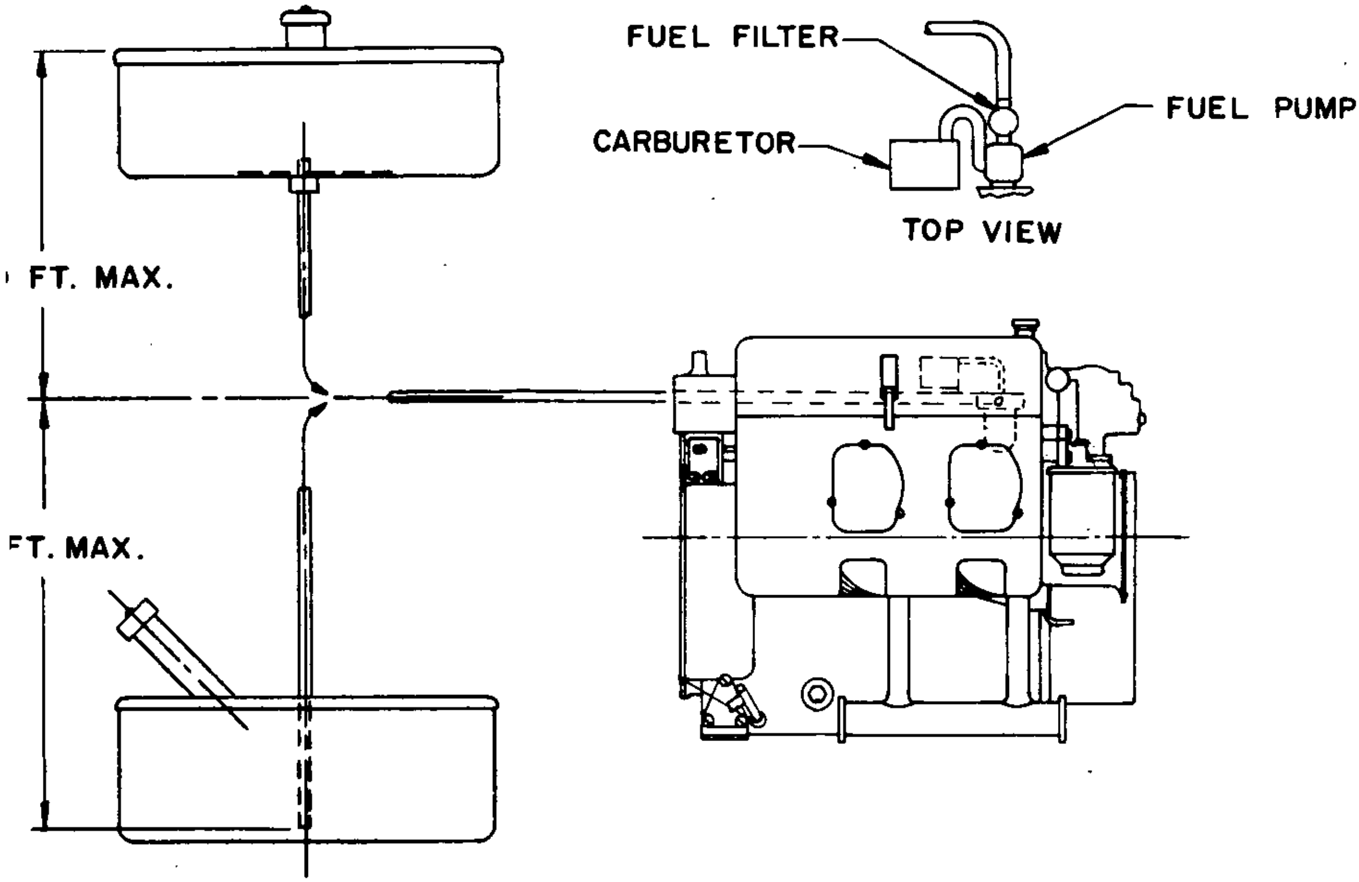

NOTE:
MAXIMUM LENGTH OF FUEL SUPPLY LINE — 10 FEET.

FIGURE 20. MAXIMUM LIMITS FOR FUEL TANK LOCATION

CX-494

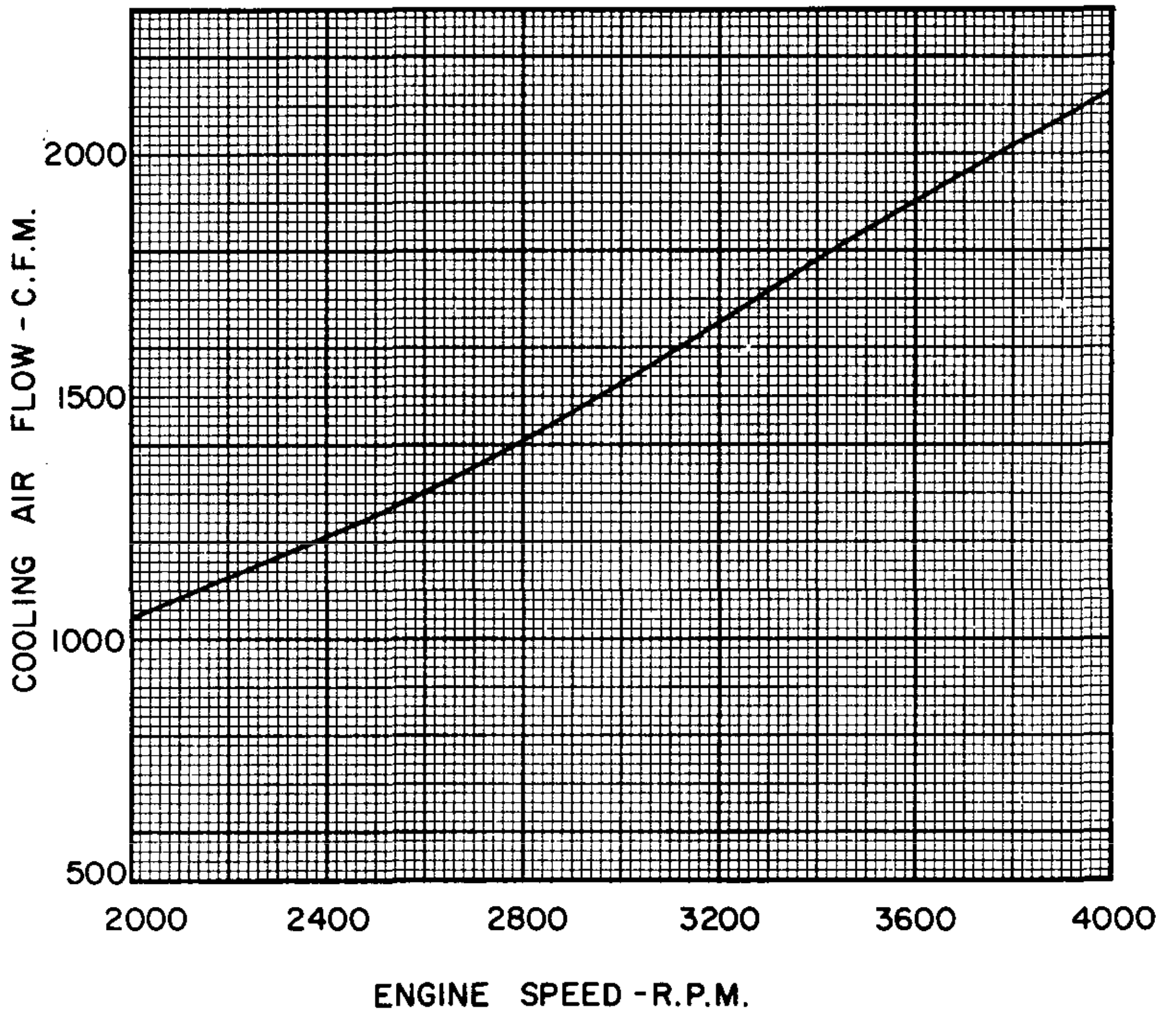

FIGURE 21. COOLING AIR CAPACITY

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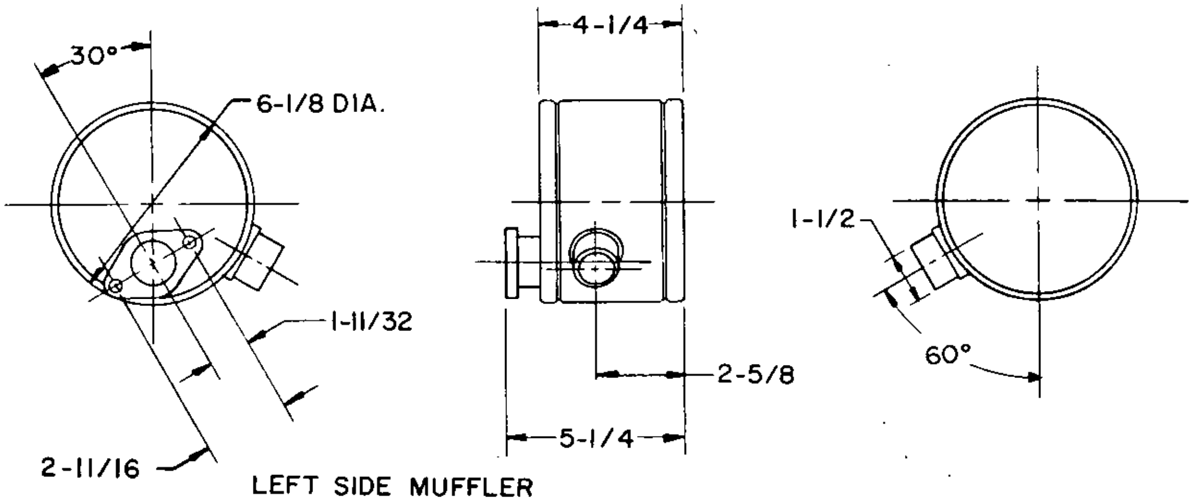

NOTES:

1. MAXIMUM BACK PRESSURE 20 INCHES OF WATER
2. USE A FLEXIBLE TUBE CONNECTION FOR INSTALLATIONS WHERE THE MUFFLER IS NOT DIRECTLY ATTACHED TO ENGINE
3. DO NOT CANTILEVER MUFFLERS ON THE EXHAUST MANIFOLD. EITHER SUPPORT THE MUFFLER OR THE END OF THE EXHAUST MANIFOLD

FIGURE 22. TYPICAL MUFFLER

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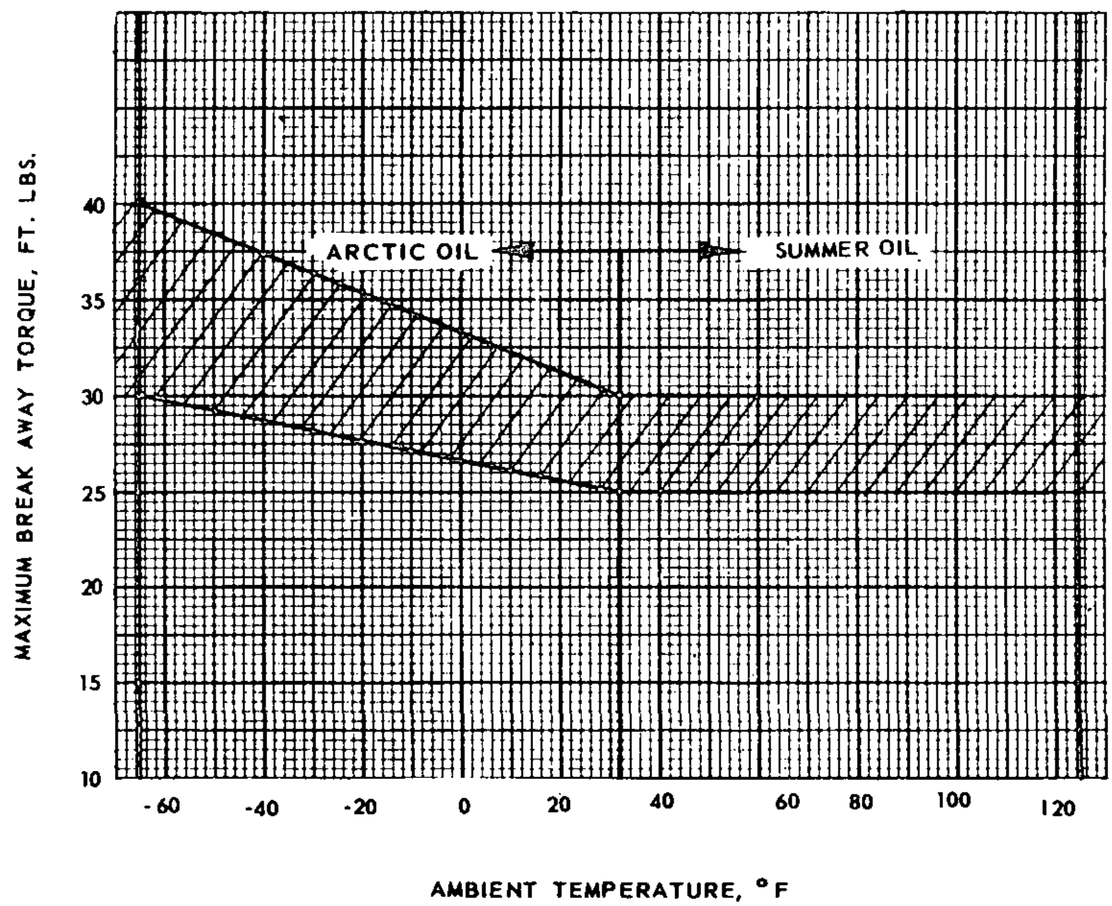
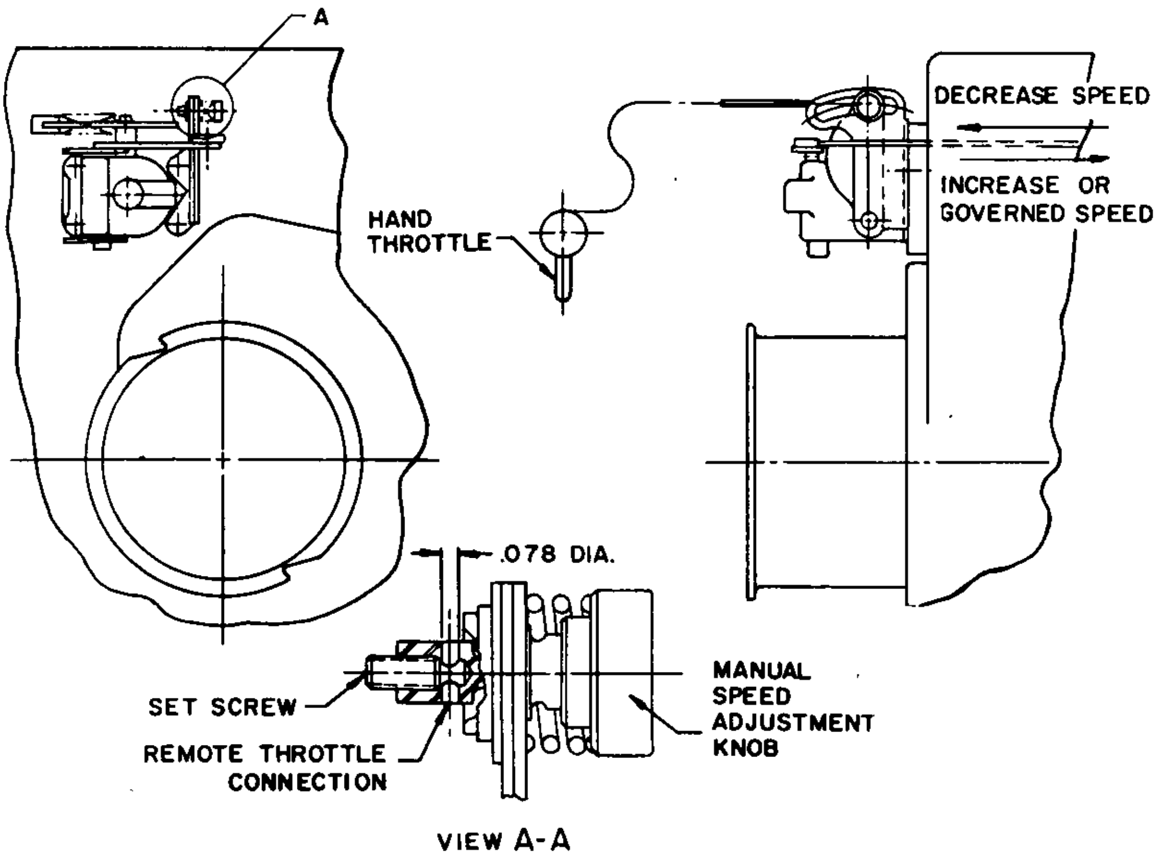


FIGURE 23. STARTING TORQUE REQUIREMENTS



NOTE: USING THIS THROTTLE CONTROL AS SHOWN, THE STANDARD GOVERNOR IS THEN USED AS AN OVER SPEED GOVERNOR.

FIGURE 24. MANUAL THROTTLE CONTROL

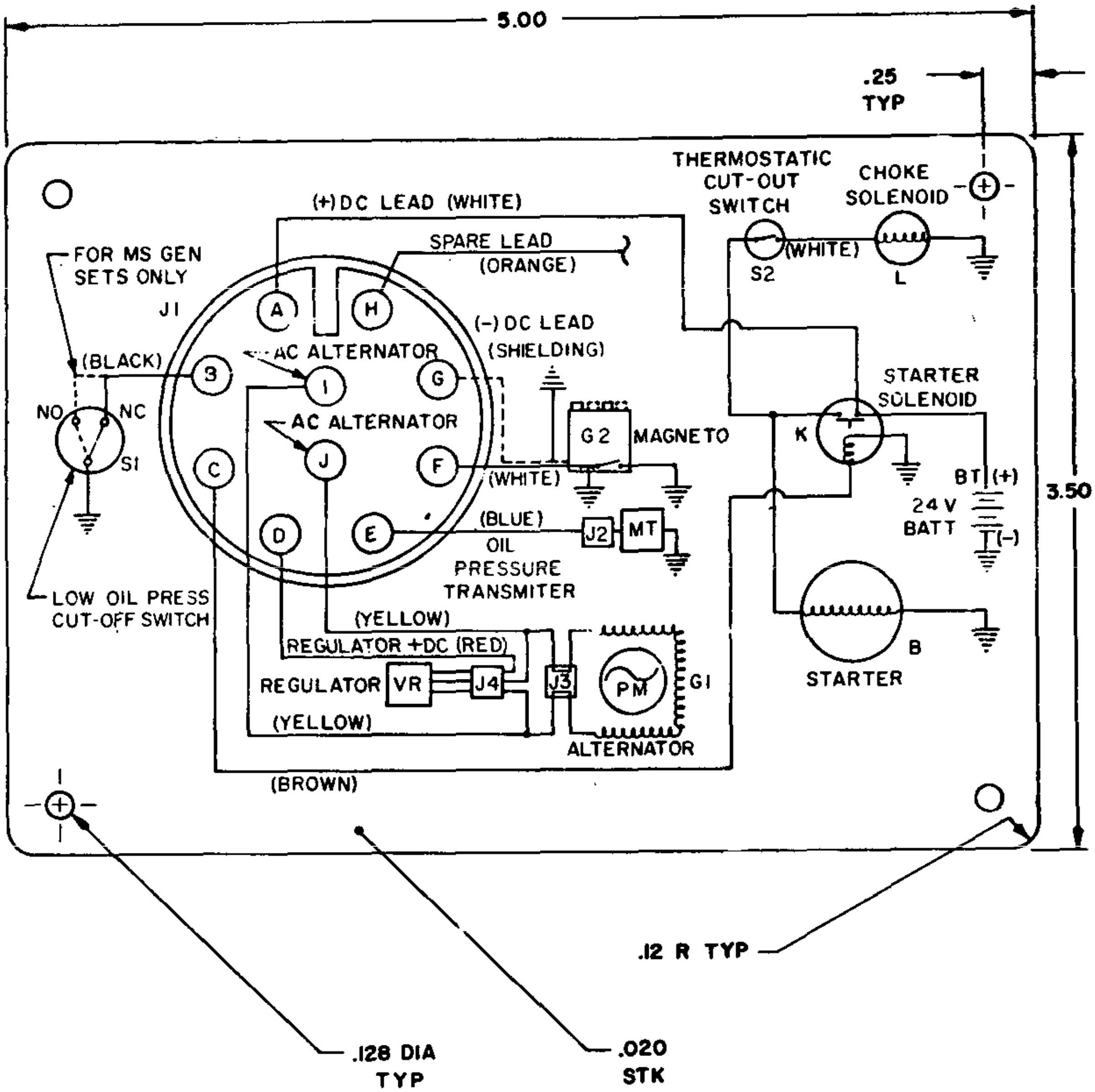


FIGURE 25. ENGINE WIRING DIAGRAM

DX-499

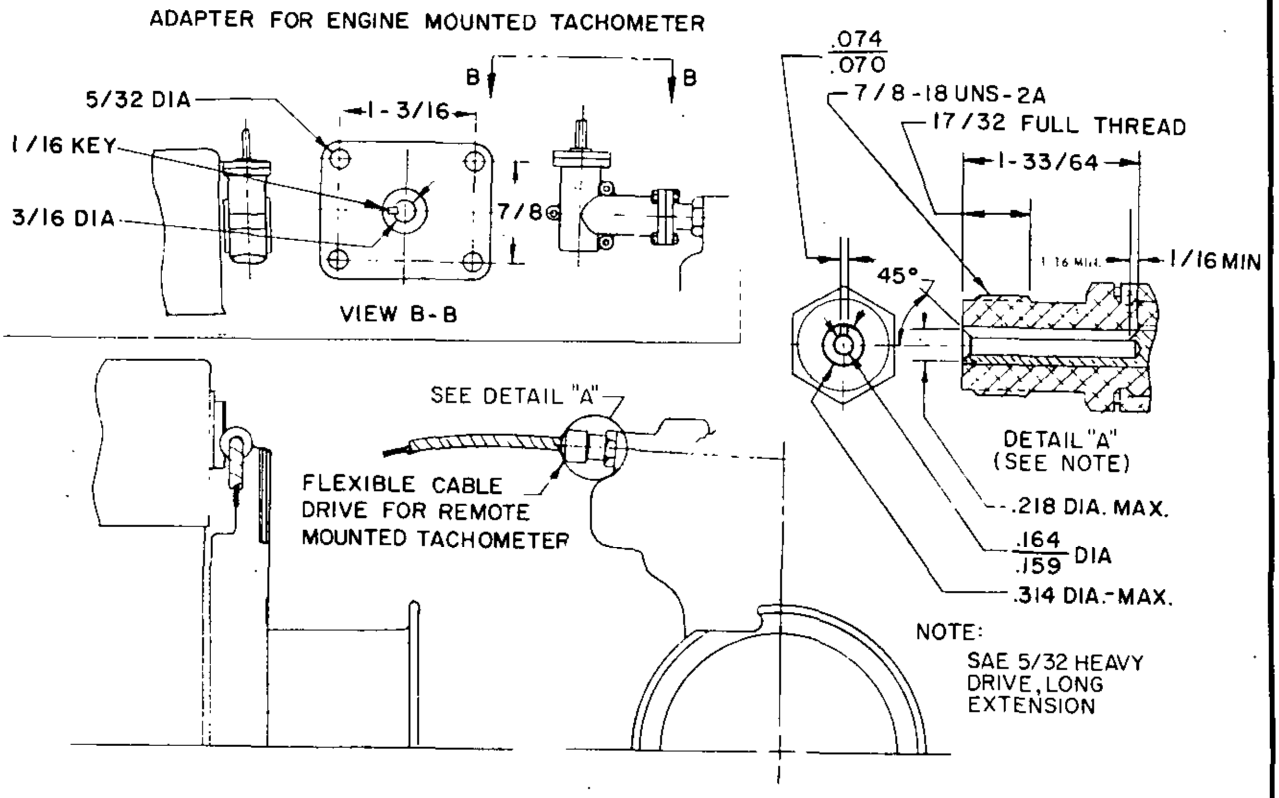


FIGURE 26. TYPICAL TACHOMETER INSTALLATION (MECHANICAL)(NOT AVAILABLE AS G.F.E.)

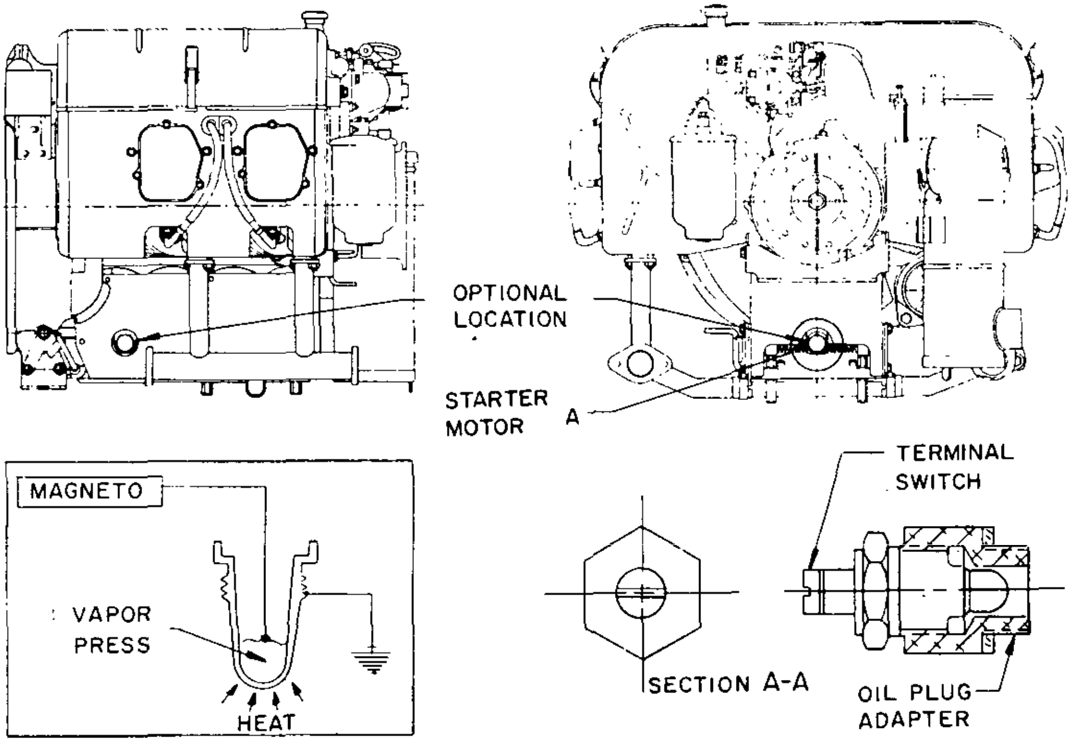
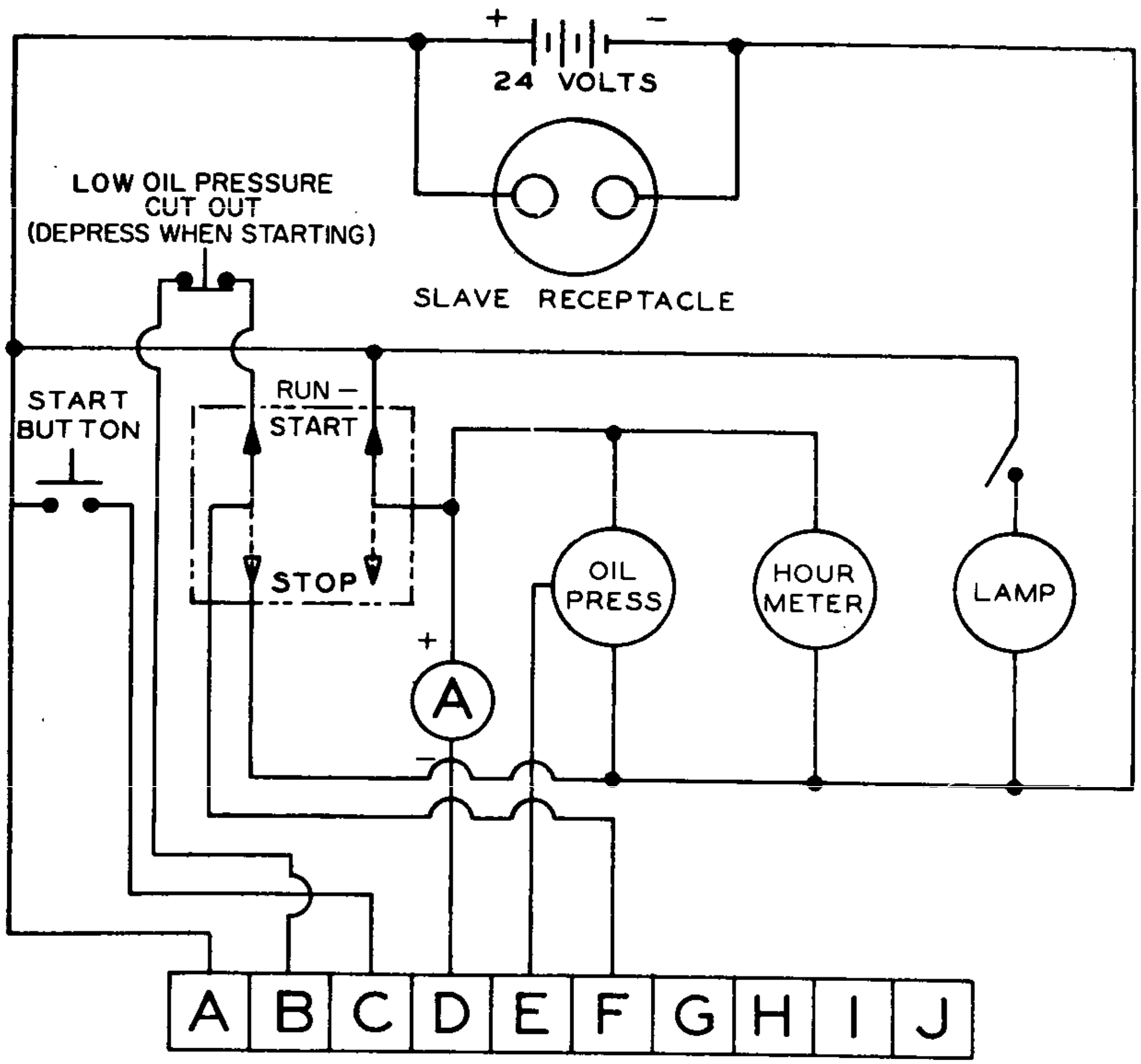


FIGURE 27. TYPICAL HIGH OIL TEMPERATURE CONTROL INSTALLATION & DIAGRAM (NOT AVAILABLE AS GFE)



NOTES:

1. SEE ENGINE WIRING DIAGRAM (FIG 25) FOR A THRU J CONNECTIONS.
2. DESCRIPTION OF RUN-START, STOP SWITCH DP DT: CONTINUOUS KEYWAY IN EACH THROW POSITION: MIN RATING IS 10 AMP @ 100 VOLTS
3. START BUTTON NORMALLY OPEN, LOW OIL PRESSURE CUT OUT NORMALLY CLOSED.

FIGURE 28. END ITEM WIRING DIAGRAM

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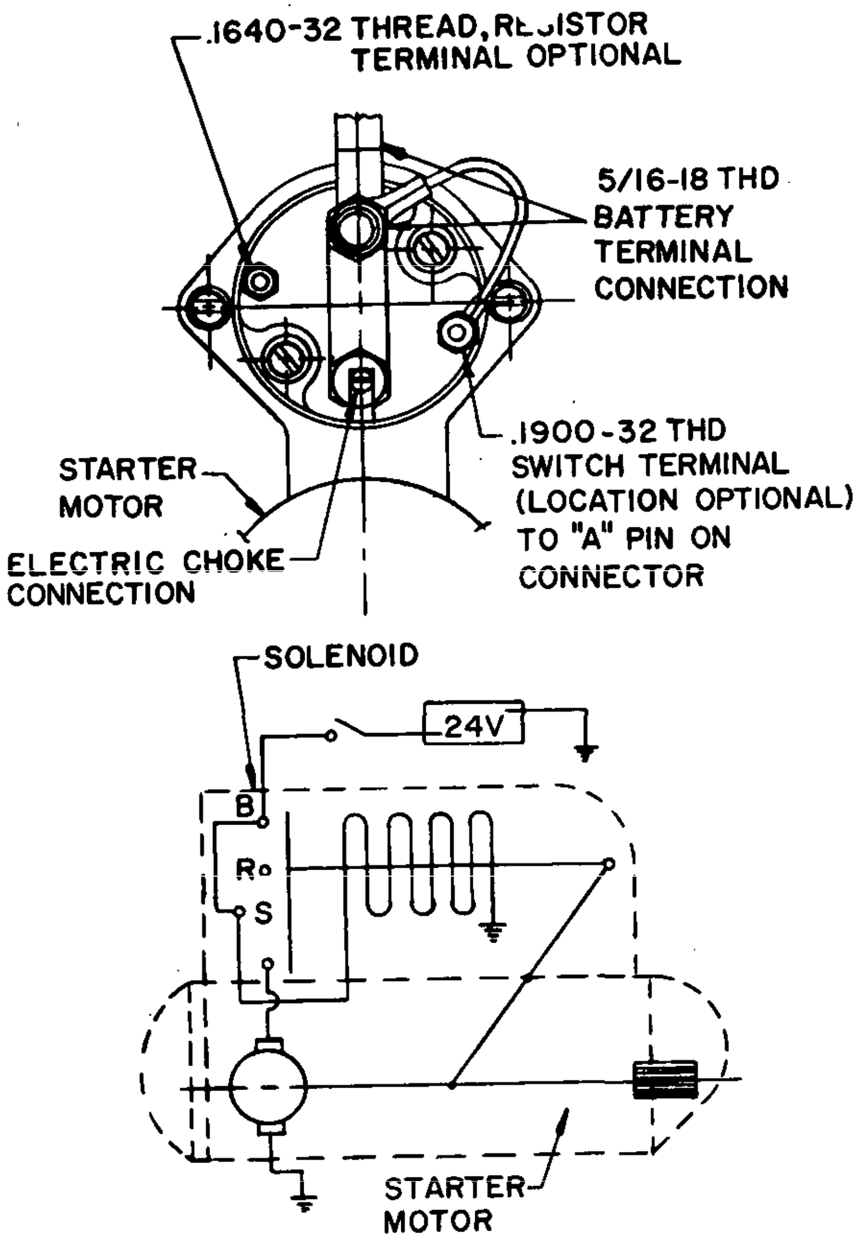

FIGURE 29. MILITARY STANDARD ELECTRIC STARTER WIRING DIAGRAM

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