MIL-STD-1300A
22 January 1970

SUPERSEDING
MIL-STD-1300
21 June 1965

MILITARY STANDARD

ENGINE, GASOLINE, AIR-COOLED, 6 BHP, MILITARY DESIGN, MODEL 4A032, INSTALLATION PROCEDURES

FSC 2805

DEPARTMENT OF DEFENSE
Washington, D. C. 20301

Engine, Gasoline, Air-Cooled, 6 BHP, Military Design, Model 4A032, Installation Procedures

MIL-STD-1300A

1. This Military Standard is mandatory for use by all Departments and Agencies of the Department of Defense.
2. Recommended corrections, additions, or deletions should be addressed to the U. S. Army Mobility Equipment Command, Directorate of Research, Development and Engineering, Fort Belvoir, Virginia 22060, ATTN: AMSME-RZK-KE.

CONTENTS

FIGURES

FIGURES (Cont'd)

TABLES

APPENDIX

1. SCOPE

1.1 Coverage. This standard covers the recommended installation procedures for the model 4A032, 6-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-V-173	- Varnish, Moisture-and-Fungus-Resistant (for the Treatment of Communications, Electronic, and Associated Electrical Equipment).
MIL-L-2104	- Lubricating Oil, Internal Combustion Engine (Heavy Duty).
MIL-G-3056	- Gasoline, Automotive, Combat.
MIL-L-10295	- Lubricating Oil, Internal Combustion Engine, Sub-Zero.
MIL-B-11040	- Belt, V; Engine Accessory Drive.
MIL-I-24092	- Insulating Varnish, Electrical, Impregnating.

STANDARDS

MIL-STD-461	- Electromagnetic Interference Characteristics Requirements for Equipment.
MS35802	- Filter Elements, Fluid, Pressure-Oil, Full-Flow.
MS35876	- Generator, Engine Accessory, D.C., 28-Volt, 5-Ampere.
MS51009	- Spark Plug, Shielded, 18 MM; 1-1/4-Inch Well (Other than Aircraft).
MS51086	- Filter, Fluid, Pressure and Strainer, Sediment; Automotive, Fuel (10 GPH, Coarse Filtration).
MS53013	- Starter, Engine, Electrical, 24-Volt D.C., 3-Inch Frame Diameter, Solenoid-Actuated, Light-Duty.

FSC 2805

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

2.2 Nongovernmental. 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:

SOCIETY OF AUTOMOTIVE ENGINEERS

SAE Handbook.

(Application for copies should be addressed to the Society of Automotive Engineers, Two Pennsylvania Plaza, New York, N. Y. 10001.)

3. DEFINITIONS

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

3.1.1 Military design engine, model 4A032. A horizontally-opposed, 4-cylinder, air-cooled, overhead-valve, 32-cubic-inch-displacement gasoline engine having a rating of 6 net continuous horsepower at 3,600 rpm (see figures 1, 2, 3, and 4).

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 conditions at all engine speeds within the operating range with all accessories (including fan, air cleaner, and exhaust system) corrected to standard atmospheric conditions.

3.1.3 Intermittent net brake horsepower. The intermittent net brake horsepower rating is 90 percent of maximum net corrected brake horsepower and intermittent duty is defined as one hour at intermittent horsepower followed by 15 minutes at rated load or less.

3.1.4 Continuous net brake horsepower. The continuous net brake horsepower rating is 6 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
Lubricating oil	In oil sump	265
Cooling air*	At cooling air outlet	225
Carburetor inlet air*	Air cleaner inlet	150

* 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 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 choke control.
(d) Operation of the ignition switch.
(e) Removal of the electric starter.*
(f) Generator belt adjustment.*

* When these accessories are required by the end-item specification.

5.3.2 Fuel system. Clearance shall be provided for:

(a) Carburetor adjustments.
(b) Removal 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 spark plugs, high-tension cables, breaker points, and capacitors, and for adjustment of the breaker points.
(b) Viewing the ignition timing mark.

5.3.7 Valves. Clearance shall be provided for the removal of rocker-arm covers and setting of valve tappet clearance.

5.4 Engine mounting requirements. The mounting brackets as shown in figures 6 and 7 are furnished with model 4A032-II engines. Mounting brackets for all other model 4A032 engines shall be furnished by the end-item manufacturer. The use of mounting brackets of an alternate design shall utilize all of the engine mounting flanges. 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. The maximum allowable spring force for four vibration isolators equally spaced about the center of gravity of the end item shall be calculated in accordance with 5.4.3. When isolators are not equally spaced about the center of gravity, a complete analysis shall be conducted to determine the maximum permissible spring force for each isolator. The maximum permissible spring force for each isolator shall be limited by the design requirements specified in 5.4.2.

5.4.2 Design requirements for mounting end item. The critical stress point of the engine due to mounting the end item is in the fan housing 0.75 inch from the end-item mounting flange (see figure 8). The maximum resultant moment at this point shall not exceed 500 pound-feet (lb-ft) at any time. Cantilever mounting of the end item to the engine is prohibited. Figures 9, 10, and 11 show the allowable shear and end moment loads that may be applied to the engine bearings by items attached directly to the crankshaft such as belt pulleys, generator rotors, and pump rotors.

5.4.3 Method for calculating maximum allowable spring force. The final spring force of four vibration isolators equally spaced about the center of gravity of the end item shall not apply a G-magnification factor to the weight of the end item that will cause a moment at the critical plane in the fan housing exceeding 500 lb-ft when calculated as shown in figures 8, 12, 13, 14, and 15.

5.4.4 Procedure. The following procedure shall be followed in selecting four vibration mounts equally spaced about the center of gravity of the end item to withstand free-fall shock load requirements for a beam-mounted end item (see figure 8):

(a) Determine weight of the driven equipment, e.g., W_{eq} = 67 lb.
(b) Select a vibration isolator, e.g., k = 1,000 lb/inch (obtain spring constant from manufacturer).
(c) Calculate the static deflection using the following equation:

$$\delta_o = \frac{W_e + W_{eq}}{4k}$$

Where δ_o = static deflection in inches
k = spring constant in lb/inch
W_e = weight of engine = 80 lb
W_{eq} = weight of equipment in pounds

Therefore, δ_o = 0.0368 inch

(d) From design chart (figure 12), determine the maximum spring force for an 18-inch free-fall shock load.

F_s = 1,187 lb/spring

(e) If the spring force F_s' is desired for a free fall other than 18 inches, then read the ratio F_s'/F_s from the extra plot given in figure 12.

EXAMPLE: For a 24-inch free fall, F_s'/F_s = 1.145
Therefore, F_s' = 1,187 x 1.145 = 1,360 lb/spring

(f) Determine the maximum spring force permitted by the 500 lb-ft critical moment using the following equation (see figure 8):

$$F_{s(max)} = 1{,}500 \left(1 + \frac{80}{W_{eq}}\right) \left(\frac{C+D}{C(D-L) + \frac{80(D)}{W_{eq}}(H)}\right) \text{ lb/spring}$$

$$1{,}500 = \frac{(500 \text{ lb-ft})(12 \text{ in./ft})}{4 \text{ springs}}$$

Where $F_{s(max)}$ = maximum permissible spring force in lb/spring

W_{eq} = weight of equipment in pounds.

C = distance in inches between reaction force R_1 and the limiting moment plane located 0.75 inch inward and parallel to the fan housing mounting face.

D = distance in inches between reaction force R_2 and the limiting moment plane.

H = distance in inches between engine C. G. and reaction force R_1 (H is negative when R_1 is between engine C. G. and limiting moment plane).

L = distance in inches between equipment C. G. and the limiting moment plane.

EXAMPLE: Equipment C. G. to mounting face distance = 4.80 inches

L = 4.80 + 0.75 = 5.55 inches

Equipment mounting leg R_2 to mounting face Distance = 3.25 inches.

D = 3.25 + 0.75 = 4 inches.

H = +1 inch (engine mounting leg, R_1 , is located to the right side of engine C. G., see figure 8).

Engine C. G. to mounting face distance = 8.45 inches (see figure 3).

C = 8.45 - 0.75 + 1 = 8.7 inches

W_{eq} = 67 lb.

$$F_{s(max)} = 1{,}500 \left(1 + \frac{80}{67}\right) \left(\frac{8.7 + 4}{8.7(4-5.55) + \frac{80(4)(1)}{67}}\right)$$

= -4,800 lb/spring.

Note: Only the numerical value of $F_{s(max)}$ is required and the minus sign can be ignored when it occurs; consider $F_{s(max)}$ = 4,800 lb/spring.

Determination of the maximum permissible spring force $F_{s(max)}$ can be simplified by placing the rigid engine support R_1 in line with the engine C. G.; i.e., make H = 0.

Therefore, C = 8.45 - 0.75 = 7.7 inches and the equation for the maximum permissible spring force reduces to

$$F_{s(max)} = 195 \left(1 + \frac{80}{W_{eq}}\right)^{\gamma}$$

Where $\gamma = (7.7 + D)/(D-L)$

γ is plotted in figure 13 for various values of D and L.

F_s is plotted in figure 14 for various values of γ and W_{eq}.

EXAMPLE: Determining $F_{s(max)}$ by use of figures 13 and 14 where engine support R_1 is in the same vertical plane as the engine C.G.,

H = 0
D = 4 inches
L = 5.55 inches
γ = -7.55 (figure 13)
W_{eq} = 67 lb
$F_{s(max)}$ = 3,240 lb/spring (figure 14)

Note: The maximum spring force F_s' of 1,360 lb/spring for a 24 inch free fall is less than the permissible spring forces $F_{s(max)}$ of 4,800 lb/spring when H = 1 and and 3,240 lb/spring when H = 0.

Therefore, four vibration isolators with spring constants of 1,000 pounds per inch will be suitable for either design providing the natural frequency and total deflection are within the design specification.

(g) Determine natural frequency and total deflection (see figure 15). For an 18-inch free fall:

Static deflection δ_o = 0.0368 inch
Natural frequency F = 979 CPM
Total deflection δ_t = 1.19 inches

To find the total deflection δ_t' for a free fall from a height other than 18 inches, read the ratio δ_t' / δ_t from the extra plot in figure 15.

EXAMPLE: For a 24-inch free fall, $\delta_t' / \delta_t = 1.152$

Therefore, $\delta_t' = 1.152 \times 1.19 = 1.37$ inches

The natural frequency 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 400 pounds.

5.5 Power transmission requirements. The driven unit shall be connected to the engine by one of the following methods. Torsional vibration determinations shall be made as specified in 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 and the overhung moment shall not exceed the limits shown in figures 9 and 10. The taper on the coupling adapter shaft shall have not less than 80 percent contact with the driven shaft.

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 658 lb-in. (see 5.5.5.2).

5.5.2.1 Shaft misalinement. The misalinement of the engine shaft and driven equipment shaft shall not exceed the limits shown in figure 17 when a flexible coupling is used between the engine and end item.

5.5.2.2 Coupling installation. The flexible coupling flange or coupling adapter shaft shall be fastened to the engine flywheel by a piloted 4-bolt connection (see figure 16).

5.5.3 Belt drive. V-belts shall conform to MIL-B-11040. The belt load shall not exceed the limits shown in figures 9, 10, and 11.

5.5.3.1 Pulley alinement. The alinement of the pulleys shall insure belt life and power transmission.

5.5.3.2 Pulley installation. The pulley shall be positively located on the engine flywheel by a flywheel coupling adapter shaft (see 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 (see 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) Obtain the polar moment of inertia of the end-item rotating mass or use the procedure of 10.4 to calculate the inertia.
(b) Determine the stiffness of the shaft between the flywheel and the inertia mass (see figure 19). Use the minimum shaft diameter in the span between the flywheel and the attached inertia mass. The minimum diameter should be at least 10 percent of the span length.
(c) Determine the torsional natural frequency of the system from the curves as shown in figure 18. Use the natural frequency corresponding to an attached inertia mass of 1.4 lb-in.-sec^2 for all inertia values over 1.4 lb-in.-sec^2.
(d) Example:

End item inertia WR^2 = 182 lb-in.^{2}
J_m = 0.471 lb-in.-sec^2

Shaft length from flywheel to attached inertia mass = 12 inches

Minimum shaft diameter = 1.00 in.

Shaft stiffness = 0.99 x 10^5 lb-in./rad (figure 19)

System natural frequency = 7,500 vpm (figure 18)

The natural frequency is in the high torsional stress zone (below 12,000 vpm and the selected shaft cannot be used.

Therefore, increase the minimum shaft diameter to 1.25 inches.

Shaft stiffness = 2.43 x 10^5 lb-in./rad (figure 19)

System natural frequency = 12,000 vpm (figure 18)

The natural frequency is above 12,000 vpm and within the safe torsional zone.

5.5.5.2 Procedure for flexible coupling connected load. The curves as shown in figures 18 and 19 are applicable only when the load is connected to the engine with a rigid coupling. When a flexible coupling is used, a complete torsional analysis shall be conducted utilizing the stiffness of the flexible coupling. The maximum vibration torque shall not exceed 658 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 Cooling-air outlet. Adequate clearance shall be provided for the outlet of cooling air (see figures 5 and 21).

5.6.4 Exhaust system. The back pressure of the exhaust system, including mufflers, 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 8 inches of water at 6 hp load, 3,600 rpm.

5.6.5 Air cleaner inlet. The air cleaner inlet shall be free from obstructions.

Custodians:

Army - ME
Navy - MC
Air Force - 82

Preparing activity:

Army - ME

Project No. 2805-0448

User interest:

Army - AT, EL
Navy - YD

APPENDIX

10. General description of engine. The model 4A032 military design engine is a horizontally-opposed-4-cylinder, overhead valve, air-cooled, spark-ignition, 4-cycle, gasoline engine. Performance characteristics of the engine are shown in figure 4. Figures 1 and 2 are photographs of the model 4A032-II 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 takeoff flange.

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

10.1.1 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 operating at 1,800 strokes per minute. 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 3,600 rpm engine speed is 5 gallons per hour.

10.1.2 Exhaust system. The engine contains single exhaust manifolds on each side. Self-supported mufflers and exhaust pipes may be attached to either end of the exhaust manifolds (see figure 3).

10.1.3 Cooling system. A centrifugal fan draws cooling air past the cylinder heads, cylinder barrels, and oil pan and discharges the heated air out of the engine fan housing. A thermostatically controlled door on the winterization shroud regulates the engine operating temperatures under all environmental conditions. The cooling airflow is 970 cfm at 3,600 rpm (see figure 21).

10.1.4 Starting system. The engine is furnished with a rope starting system. A 24-volt electric starter (MS53013-1) is available as optional equipment. Figure 22 shows the wiring diagram for the electric starting system.

10.1.5 Generator. A 24-volt, 5-ampere military standard generator and cut-out regulator (MS35876-1) is available as optional equipment. The generator mounts on top of the engine as illustrated in figure 23.

Figure 22 shows the wiring diagram for the generator. Figure 24 contains the details necessary for fabricating the generator mounting brackets. Figure 25 shows the details necessary to fabricate the proper size generator pulley.

10.1.6 Manual throttle control. The manual throttle control permits operation below governed engine speed. The engine speed can be controlled remotely by attaching a control cable to the manual throttle control as illustrated in figure 26.

10.1.7 High-oil-temperature control. The engine is not furnished with a high-oil-temperature control device. However, one of the two drain plugs can be replaced with a high-oil-temperature control switch as illustrated in figure 27.

10.1.8 Low-oil-pressure-control. The engine is not furnished with a low-oil-pressure-control device, or oil pressure gage. However, a low-oil-pressure cut-off switch or a pressure gage may be connected by inserting a pipe tee in the governor lubrication supply pipe. The normal minimum lubricating oil pressure is 20 psi at 3,600 rpm.

Table II. Engine Specifications

Military design engine, model 4A032:

A. Engine:	
Number of cylinders	4
Bore, inches	2.25
Stroke, inches	2.00
Total displacement, cubic inches	32
Rated horsepower at 3,600 rpm	6.0 BHP
Maximum horsepower at 3,600 rpm (as shipped)	9.0 BHP
Maximum horsepower at 3,600 rpm (after break-in)	10.1 BHP
Maximum torque at 2,000 rpm, lb-ft	18.9
Compression ratio	6.2:1
Speed range, rpm (for continuous operation)	2,000 - 4,000
B. Fuel system:	
Fuel pump	diaphragm
Fuel filter	MS51086
Fuel consumption at rated load and speed, lb/bhp/hr	0.95
Fuels	MIL-G-3056

Table II. Engine Specifications (cont'd)

C. Lubrication system:

Lubrication system	forced feed and splash
Oil sump capacity without filter, quarts	1-5/8
Oil filter capacity, quarts	1/2
Oil consumption, maximum at rated load and speed, lb/bhp/hr	0.005 average for 1,500 hours
Oil filter element	MS35802-1
Lubricants	MIL-L-2104 and MIL-L-10295

D. Ignition:

Ignition system	magneto
Spark plug	18-mm (MS51009-1)
Radio-interference suppression	MIL-STD-461 (table A-1)*

E. Governor characteristics:

Speed regulation, percent	3
Rated load speed, rpm	3,600
No load speed, rpm	3,708 (max)
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
Rated load to no load, rpm	180
No load to rated load, rpm	180

F. Engine and accessories:

Air cleaner	dry type cleanable element
Cranking system	rope
Main bearings	end - steel-backed copper-lead, center - tin-plated aluminum
Crankshaft rotation, viewed from drive end	counterclockwise
Dry weight, pounds	75
Life between major overhaul or rebuild, hours	1,500

* Engines covered by this standard have been designed to meet the electronic compatibility requirements of MIL-E-55301(EL).

Table II. Engine Specifications (conc'd)

G. Overall dimensions:	
Height, inches	14-1/2
Length, inches	19-1/16
Width, inches	20-1/8
H. Environmental extremes:	
Engine operation	+120° to -25° F.
Engine storage	+150° to -80° F.
Engine starting capacity without preheat	+120° to - 25° F.
Starting with preheat	-25° to -50° F.
Fungusproofing	MIL-V-173 and MIL-I-24092
Humidity extreme, percent relative humidity	85% at 85° F.
Tilt operation, degrees in any plane (max)	15
Maximum elevation for rated power, feet	8,000

10.2 Fuel consumption. The fuel consumption characteristics of the 6 bhp military design engine at 3,600 rpm are presented in table III. The effect of altitude is insignificant.

Table III. Fuel Consumption

Brake horsepower	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Fuel consumption, gal/hour	0.5	0.74	0.88	0.95	1.04	1.16	1.35

10.3 Moment of inertia of end item. Determine the polar moment of inertia of a balanced pivoted mass which is not easy to remove or handle, such as the rotor of an electric generator, as follows:

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

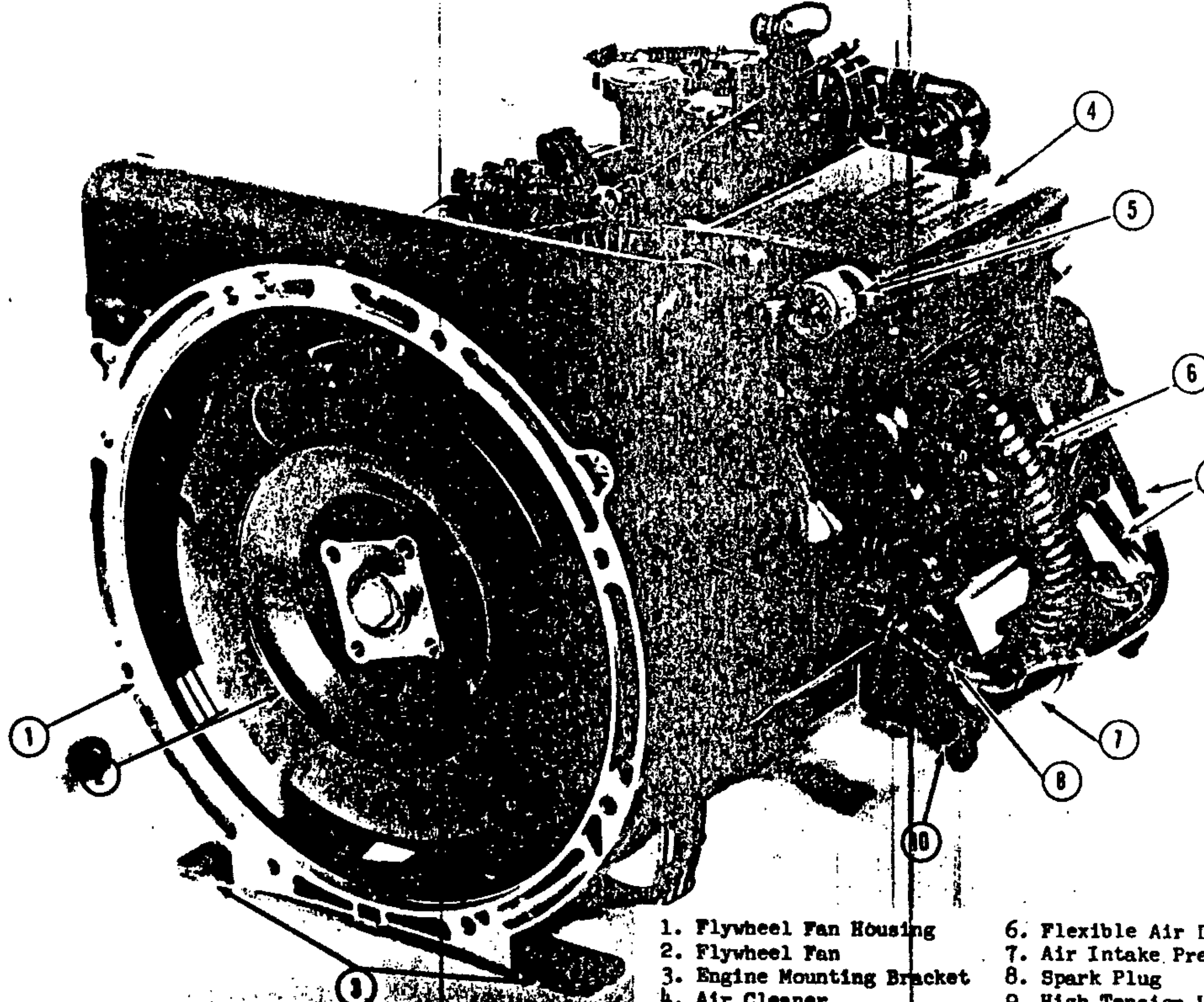
(b) Attach a known weight, W, to the mass at a distance, L, from the axis of rotation. (When the mass is not accessible and the shaft rotates with it, attach the weight to the shaft with a light rigid rod of length L.)

(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:

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

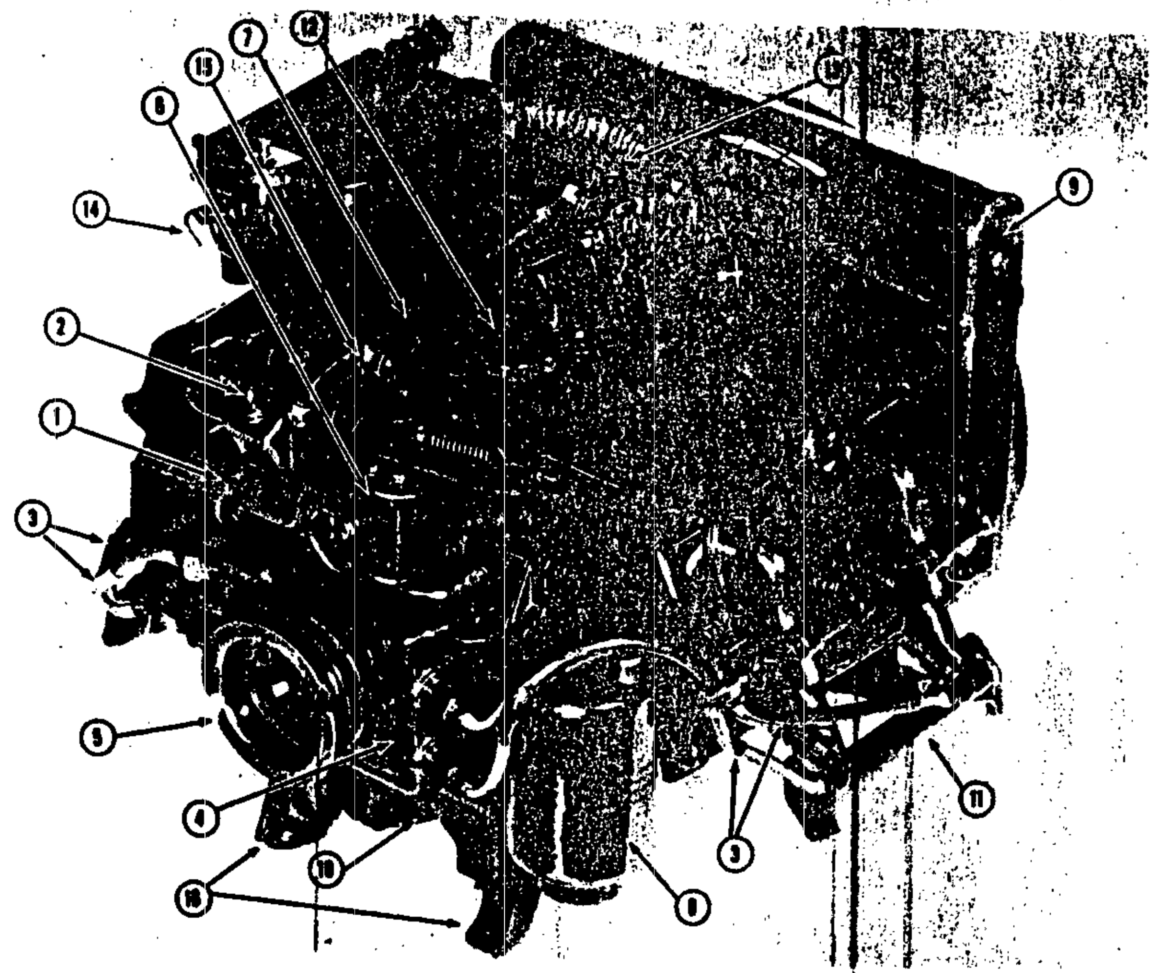
Where J = moment of inertia, lb-in.-sec^2
W = weight of mass, lb
L = length of rod, inches
T = second/period
G = acceleration of gravity = 386 in./sec^2



1. Flywheel Fan Housing
2. Flywheel Fan
3. Engine Mounting Bracket
4. Air Cleaner
5. Air Cleaner Restriction Indicator
6. Flexible Air Duct
7. Air Intake Preheater
8. Spark Plug
9. High Tension Lead
10. Exhaust Manifold

X-1746

FIGURE 1. MODEL 4A032-II MILITARY STANDARD ENGINE DRIVE END



1. Breaker Points Housing
2. Ignition Switch
3. High Tension Leads
4. Coil Cover
5. Rope Starter Pulley
6. Governor
7. Governor Control Rod
8. Oil Filter
9. Winterization Air Control Shroud
10. Drain Plug
11. Exhaust Manifold
12. Oil Fill Tube and Dip Stick
13. Choke Lever
14. Air Cleaner Selector Lever
15. Manual Throttle Control
16. Mounting Brackets

FIGURE 2. MODEL 4A032-II MILITARY STANDARD ENGINE ACCESSORY END

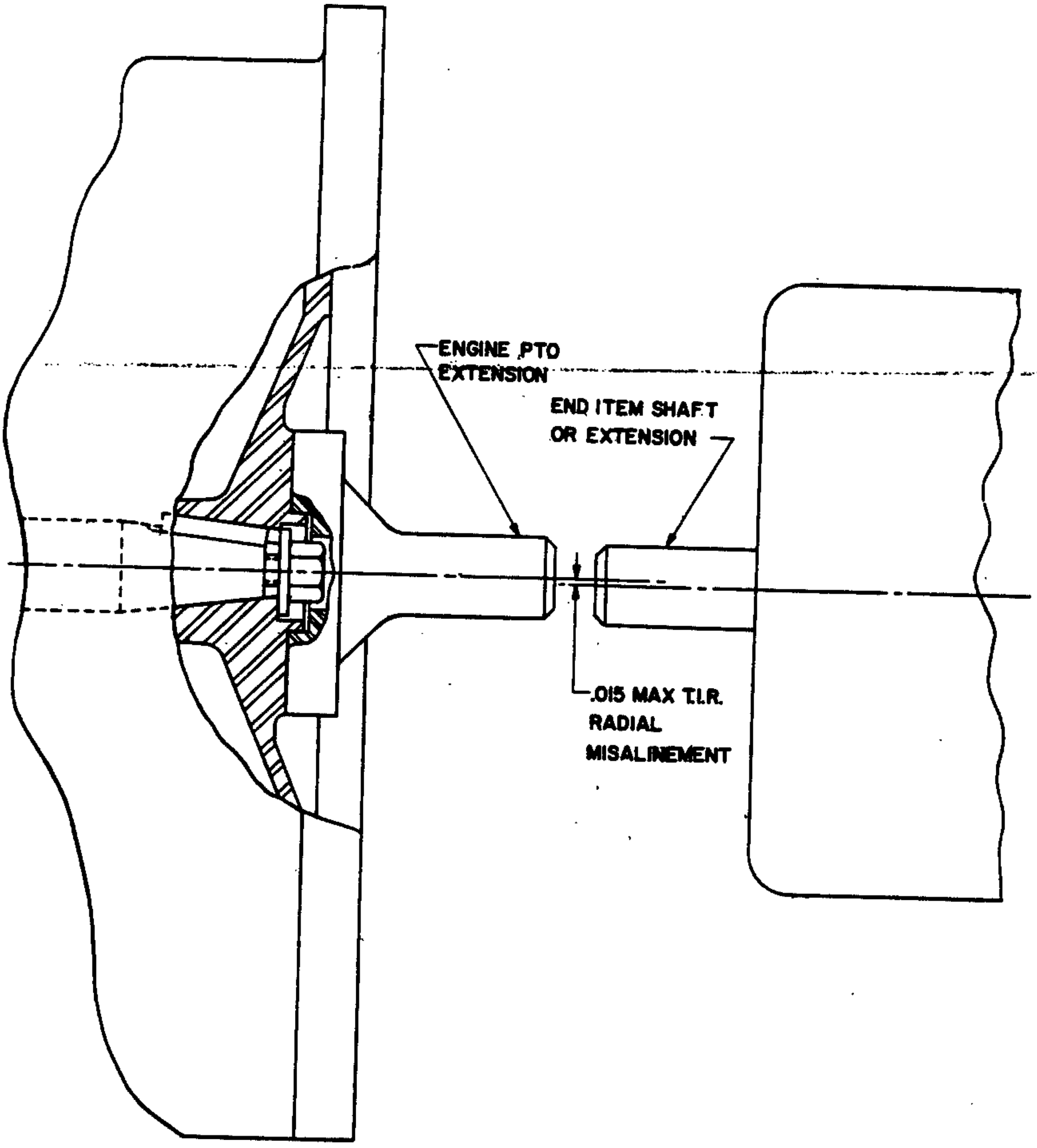


FIGURE 17

SHAFT ALINEMENT METHOD

(FLEXIBLE COUPLING)

X-1748

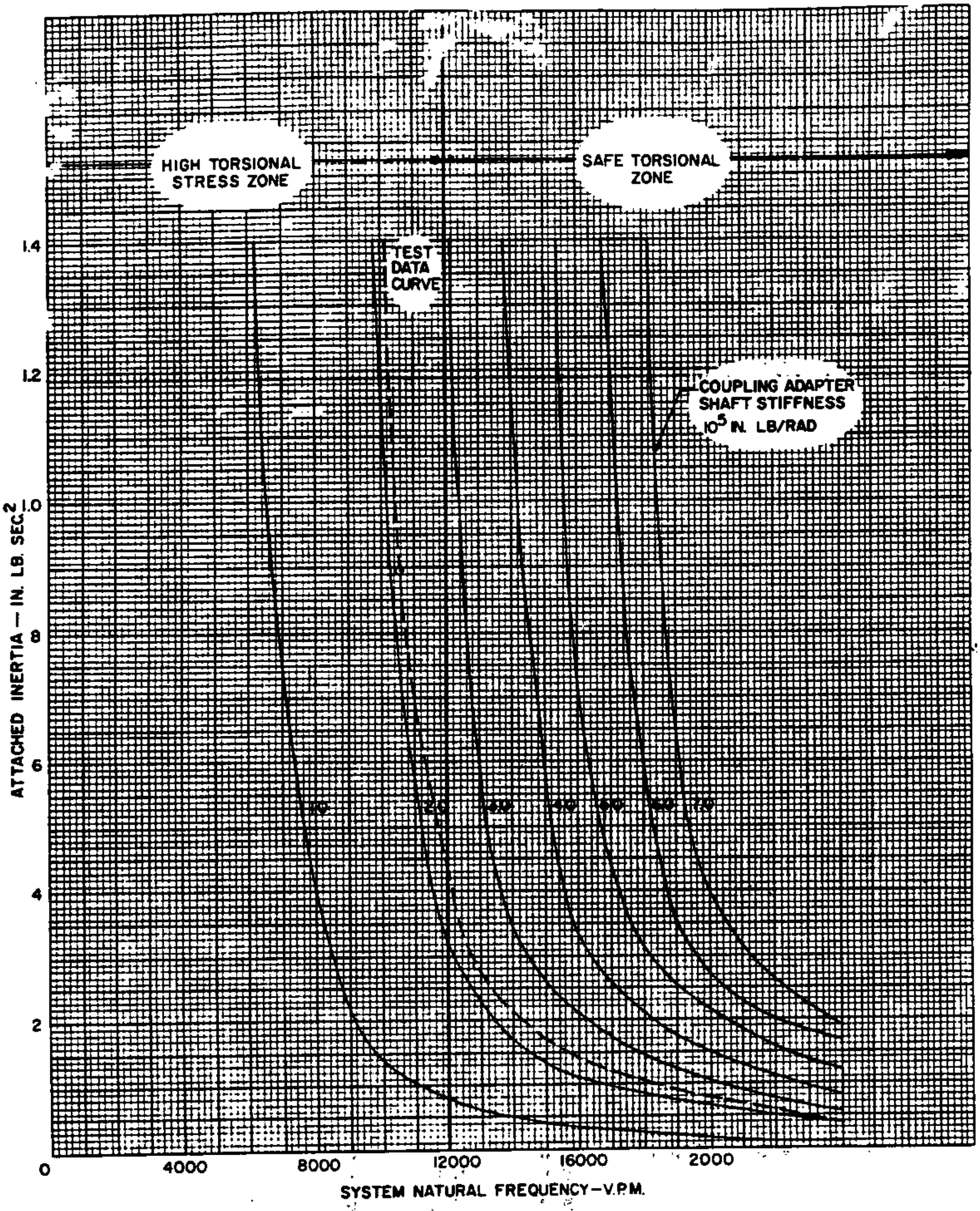


FIG. 18

TORSIONAL TUNING CURVES FOR DIRECT COUPLED END ITEM
(FOR ENGINE SPEED FROM 2880 TO 4320 R.P.M.)

X-1848

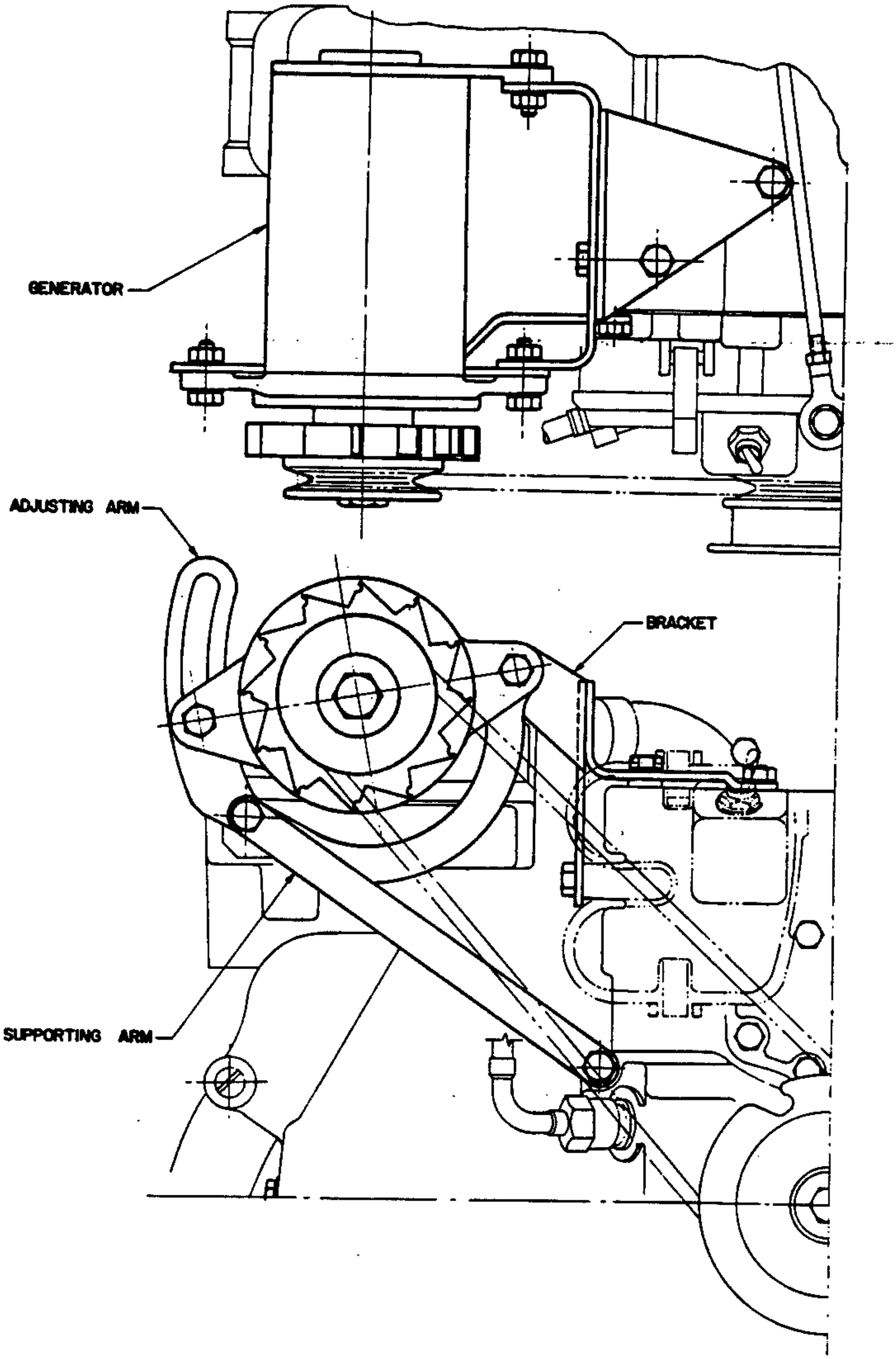
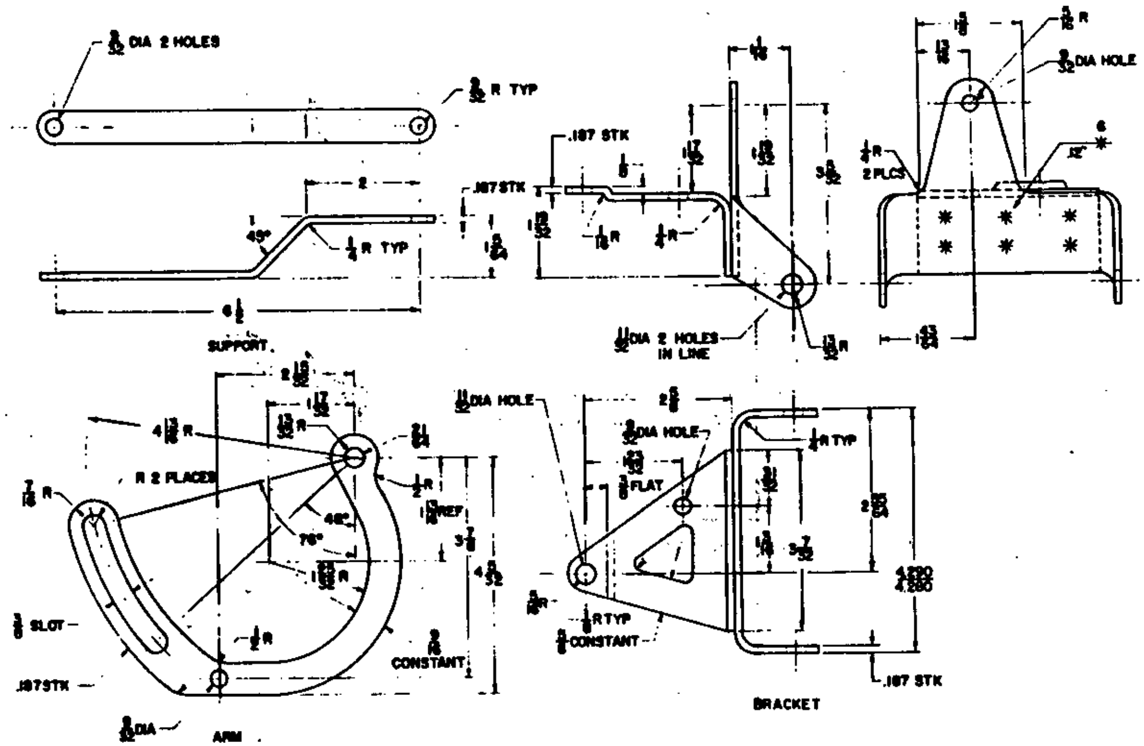


FIGURE 23
TYPICAL MOUNTING FOR MILITARY STANDARD GENERATOR

X-1853



NOTES
1. RECOMMENDED MATERIAL:
   1010-1030 STEEL
2. NOT AVAILABLE AS GFE
3. FINISH IN ACCORDANCE WITH MIL-STD-171, FINISH NO. 3.3.1 (BLACK OXIDE)

FIGURE 24
GENERATOR MOUNTING DETAILS

X-1749

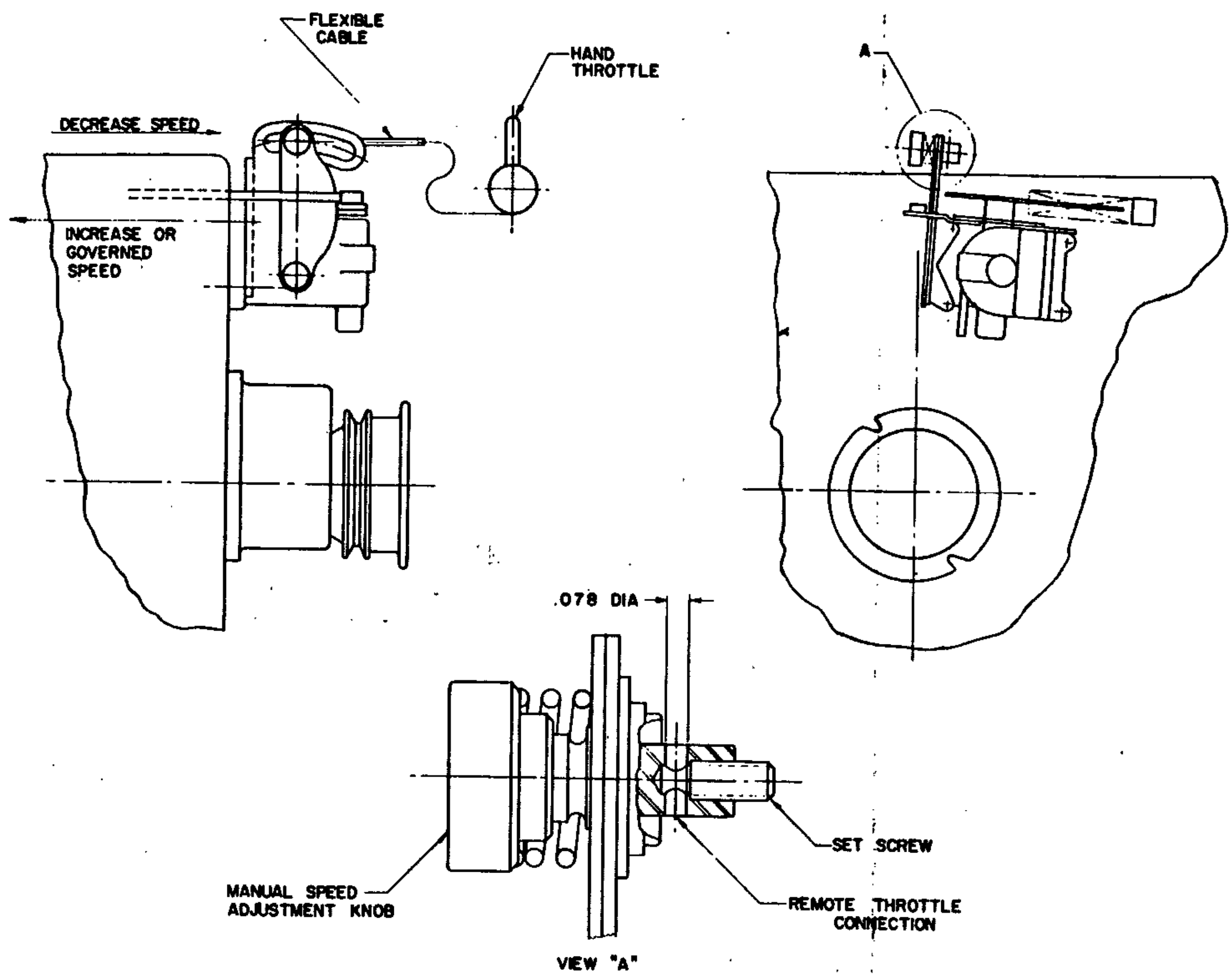
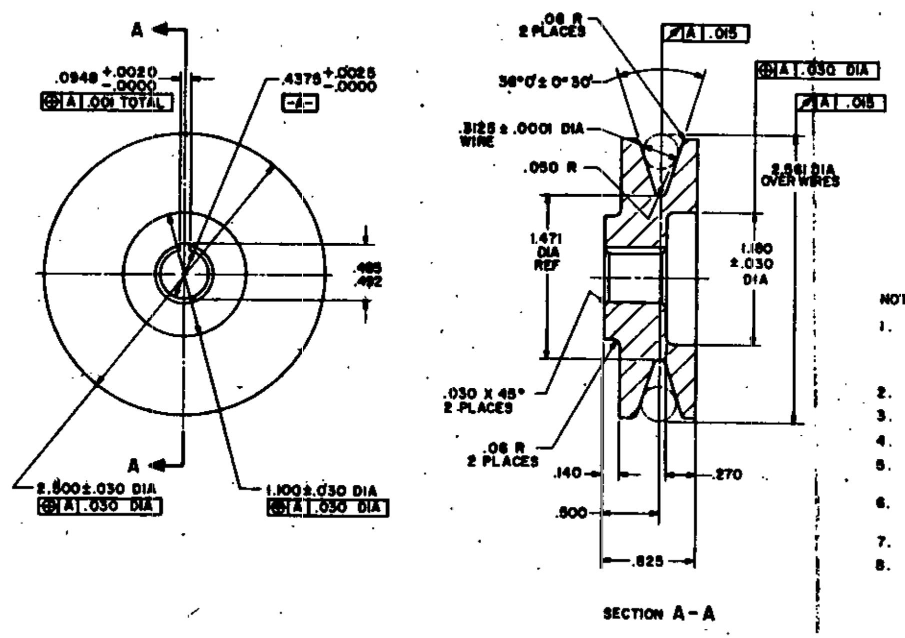


FIGURE 26
MANUAL THROTTLE CONTROL



NOTES:

1. UNLESS OTHERWISE SPECIFIED, TOLERANCES: .XX ± .03
   .XXX ± .010
   ANGLES ± 5°
2. MATERIAL: SAE J403, NO. 1010-1020
3. FINISH ALL OVER 125√
4. BALANCE WITHIN .25 OZ IN.
5. FINISH PER MIL-STD-171, FINISH NUMBER 1.1.2.2 CADMIUM PLATE
6. FOR INTERPRETATION OF: SURFACE FINISH, SEE USAS B46.1
7. BREAK SHARP EDGES AND DEBURR
8. DIMENSIONAL LIMITS AND SURFACE FINISH APPLY AFTER PLATING.

X-1854

FIGURE 25. PULLEY, GENERATOR

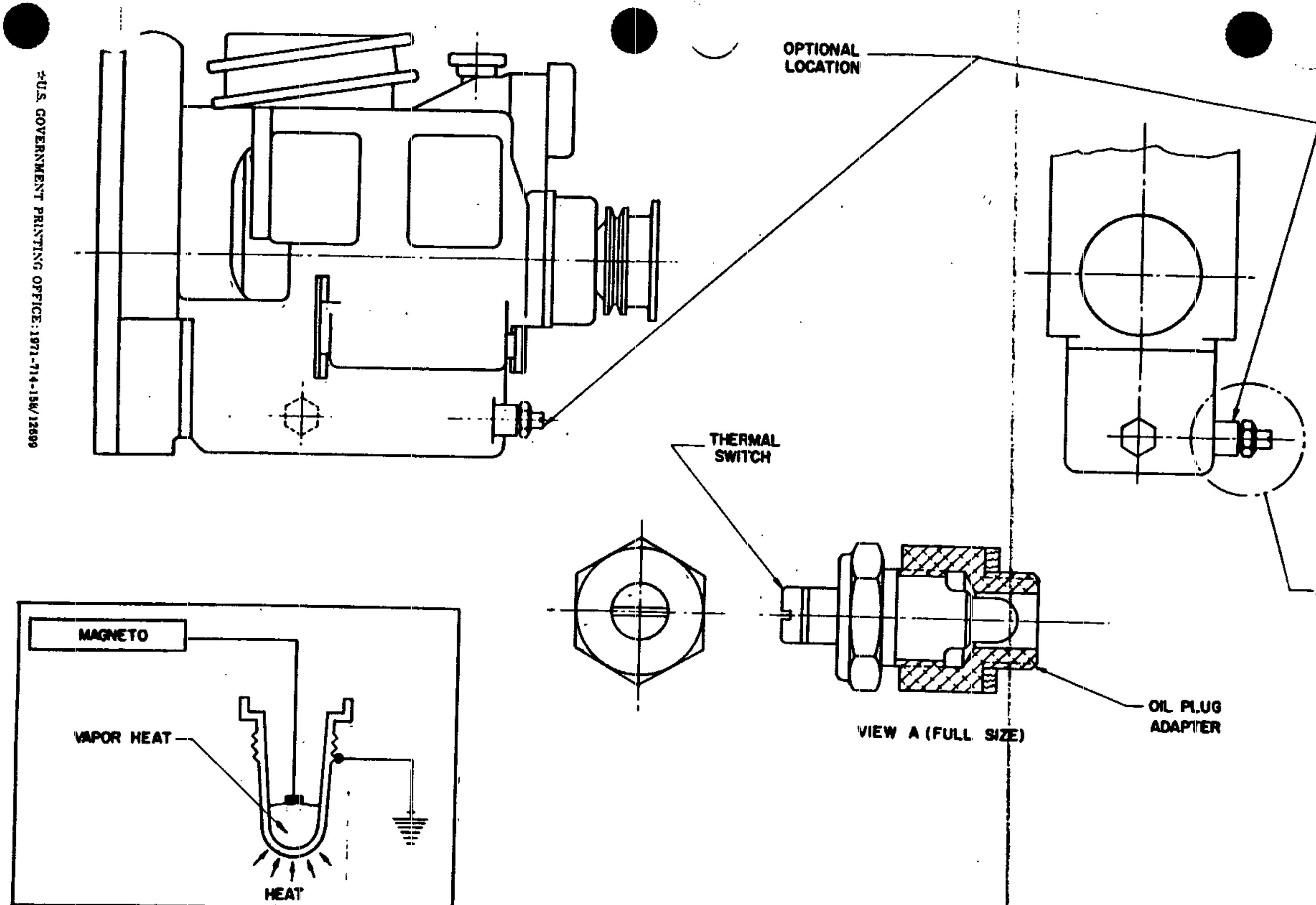


FIGURE 27
TYPICAL HIGH OIL TEMPERATURE CONTROL INSTALLATION AND DIAGRAM
(NOT AVAILABLE AS GFE)

X-1751

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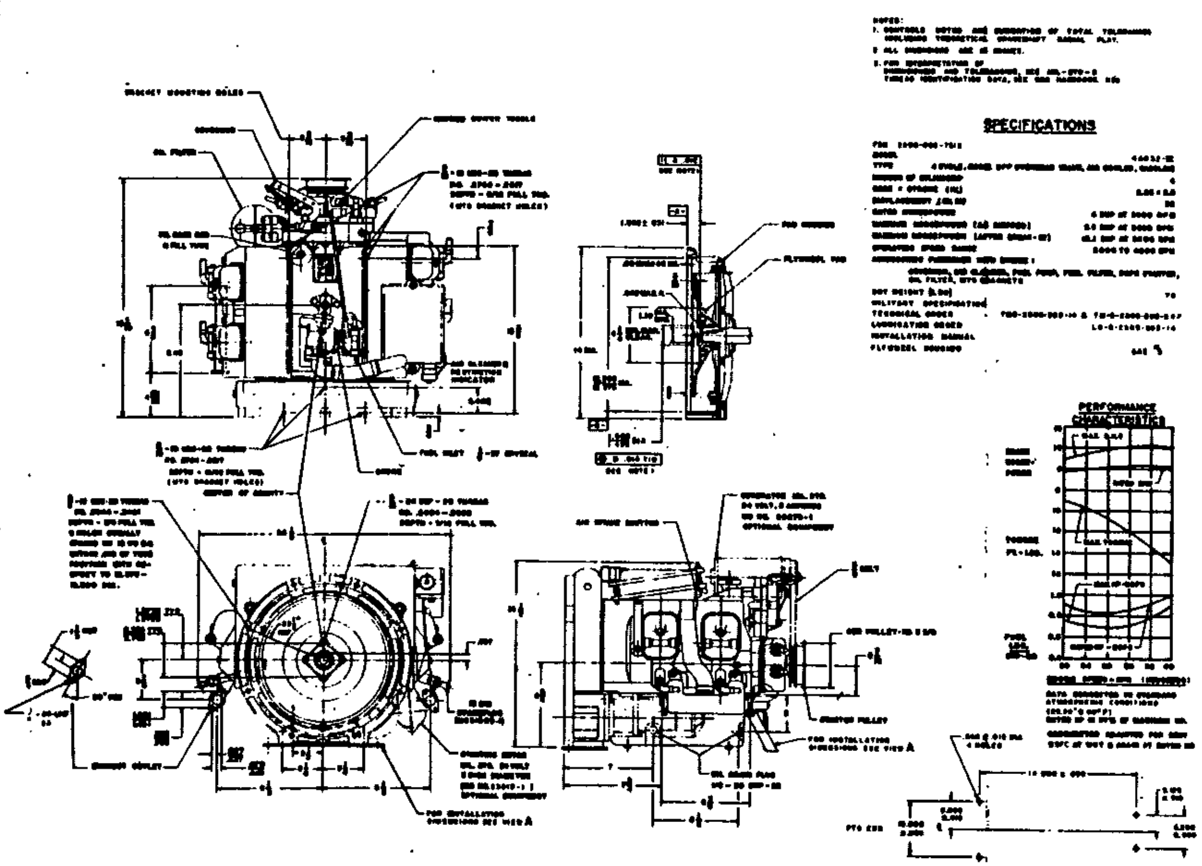
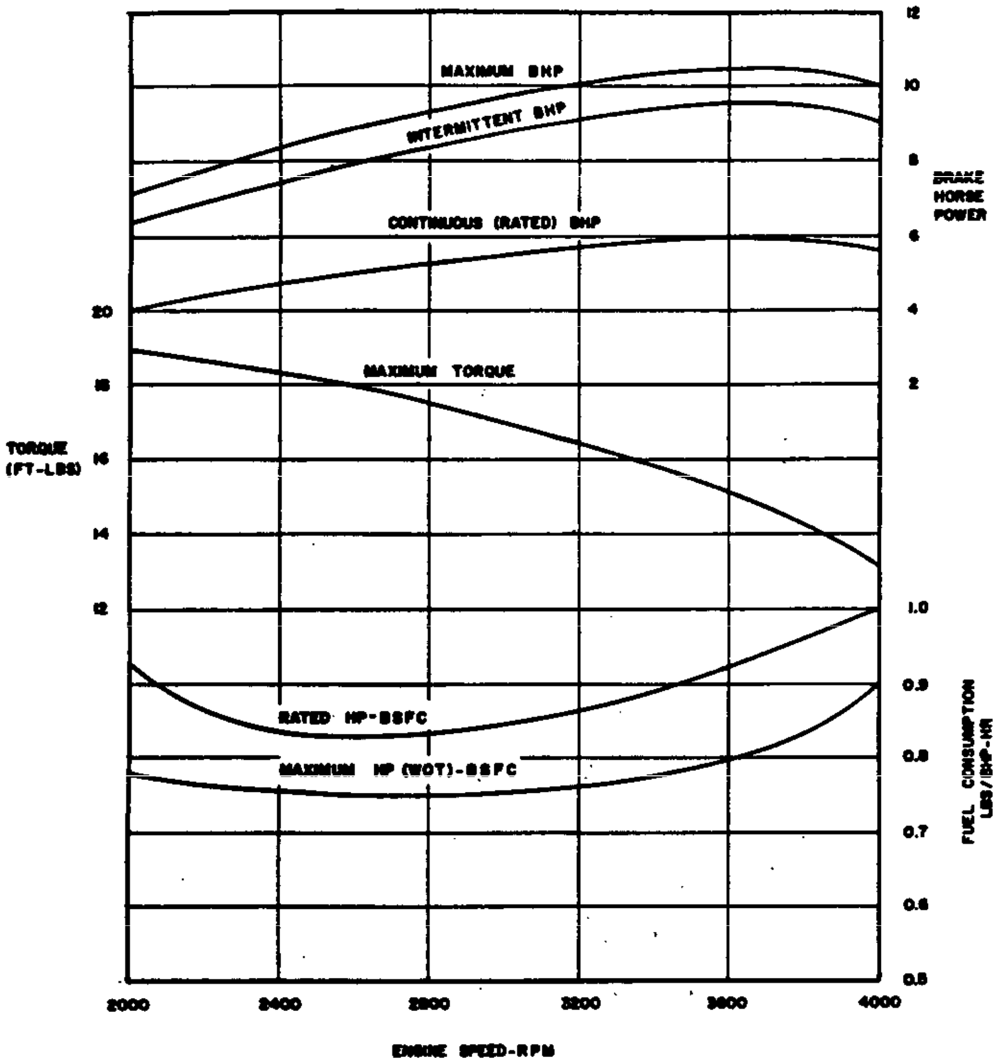


FIGURE 3 - INSTALLATION DRAWING FOR MS ENGINE MODEL 4A032 - II

X-1834



MAXIMUM BHP CURVE DEVELOPED BY LABORATORY TEST ENGINES. PRODUCTION ENGINES DEVELOP NOT LESS THAN 80% MAXIMUM BHP WHEN SHIPPED, AND NOT LESS THAN 90% MAXIMUM BHP AFTER RUN-IN TO REDUCE FRICTION.

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

CONTINUOS HORSEPOWER RATING OF EACH ENGINE IS APPROXIMATELY 57% OF MAXIMUM HORSEPOWER 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 ATMOSPHERIC CONDITIONS (29.92" HG & 60° F)

FIGURE 4
PERFORMANCE CHARACTERISTICS

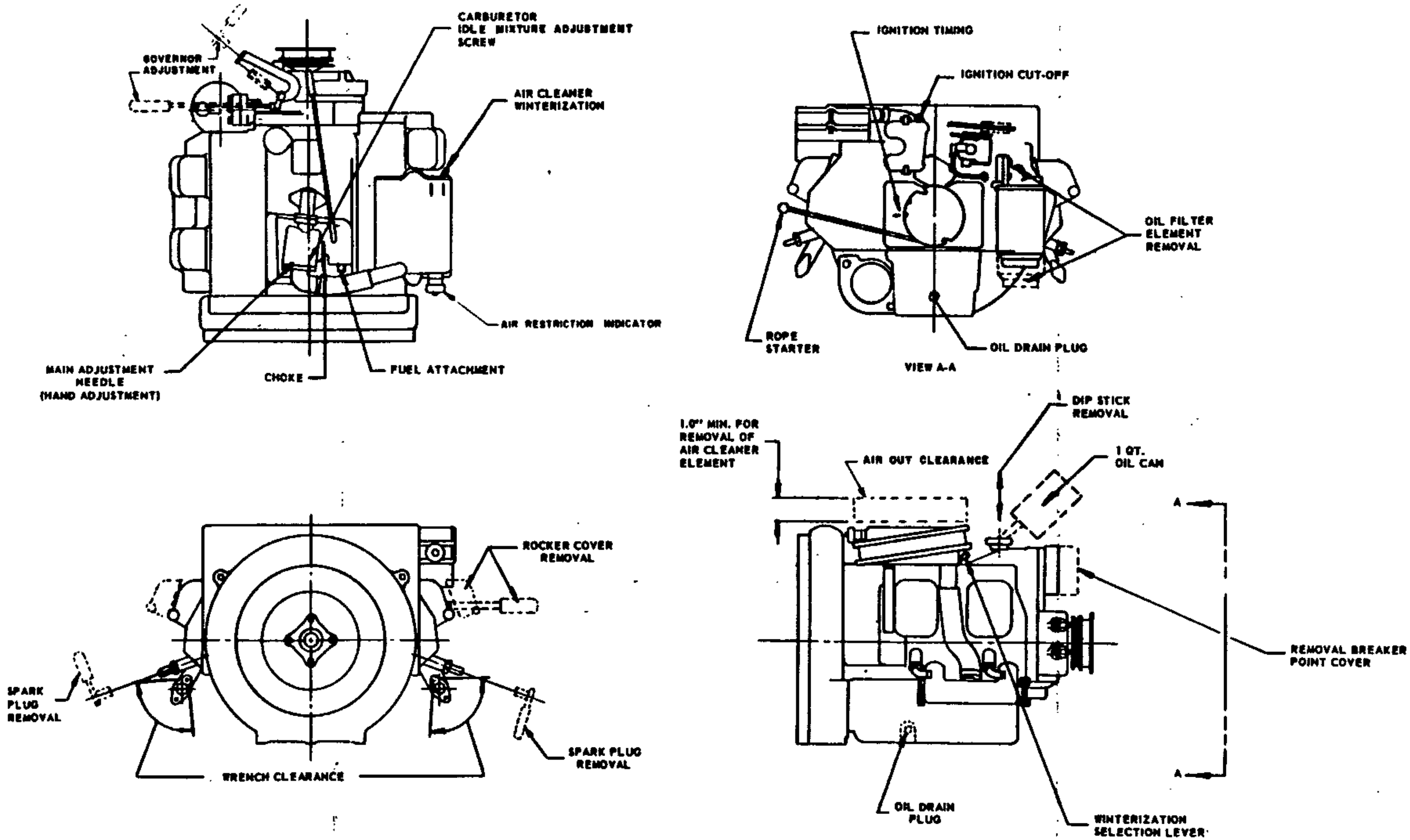


FIGURE 5. Maintenance Clearances for Model 4A032 Military Standard Engine

X-1836

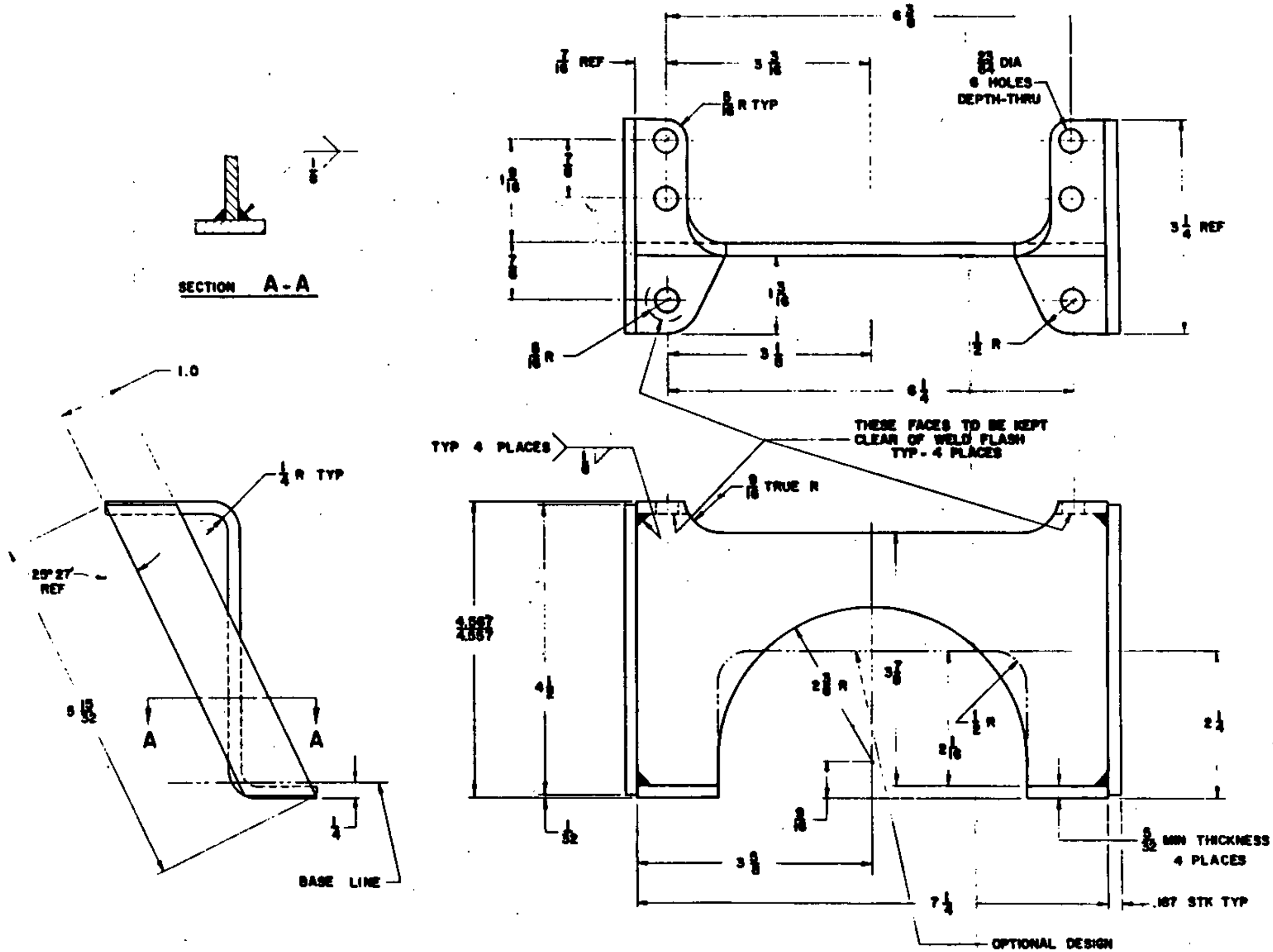


FIGURE 6
ENGINE FRONT MOUNTING BRACKET
ON THE 4A032-II MODEL

X-1837

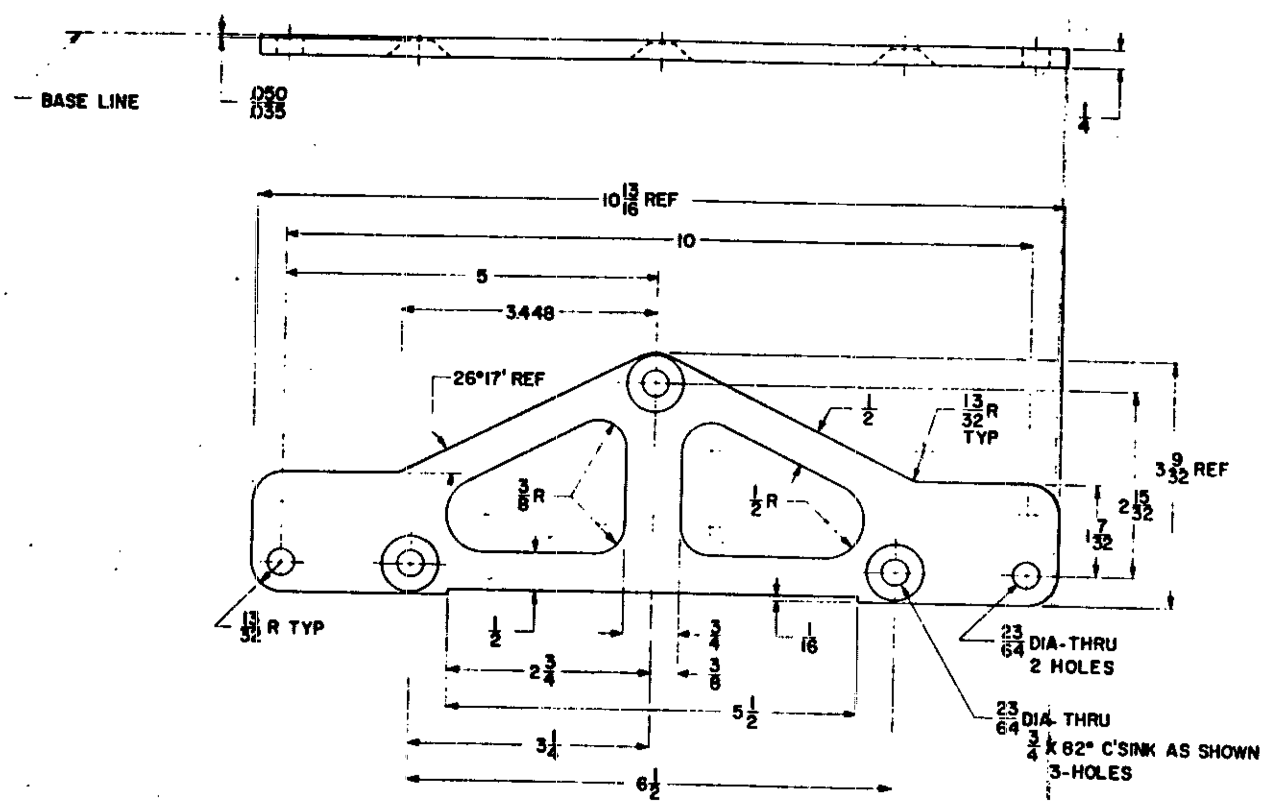


FIGURE 7

ENGINE REAR MOUNTING BRACKET
ON THE 4A032-II MODEL

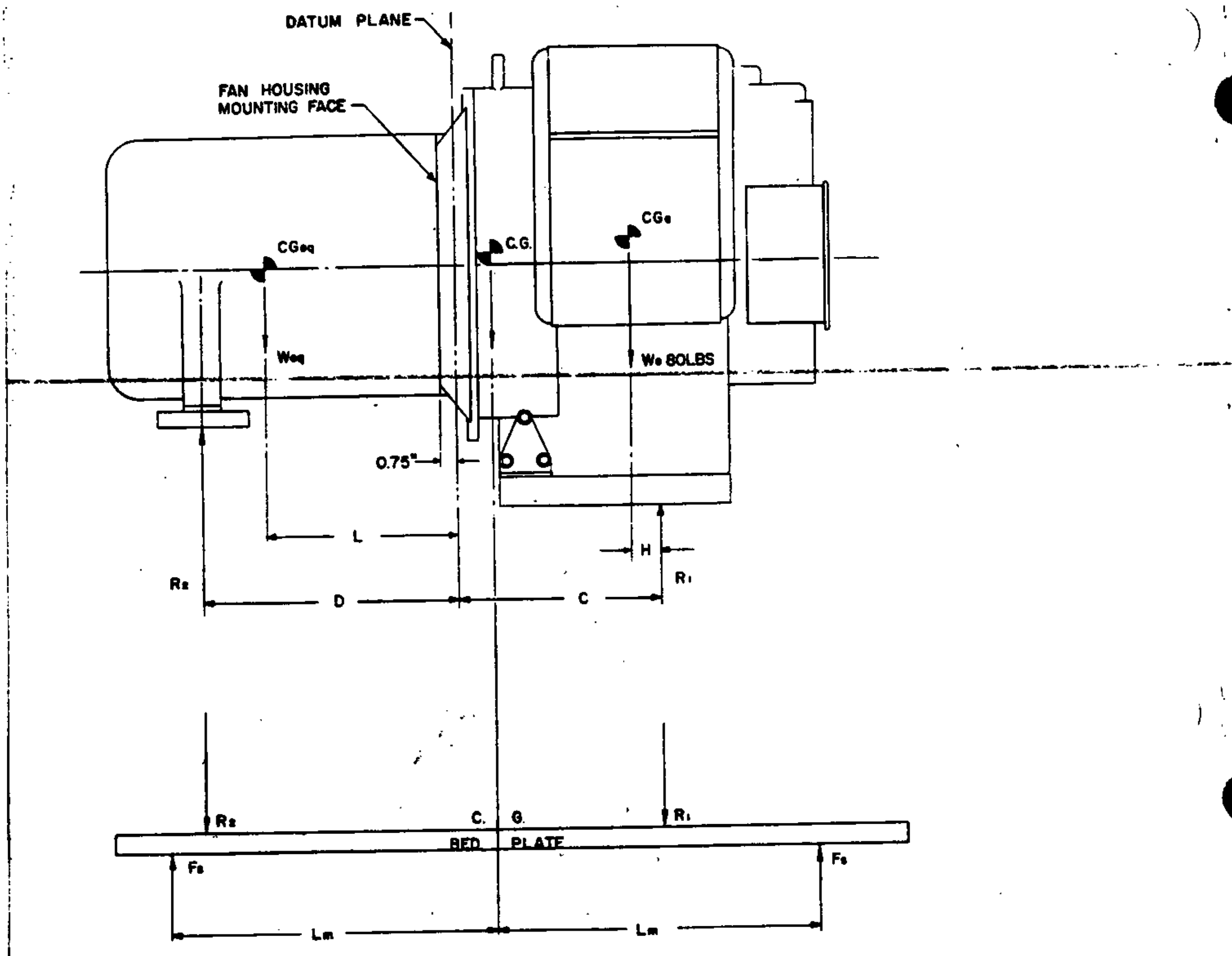


FIGURE 8

BEAM MOUNTING INSTALLATION FOR ENGINE
WITH DIRECT MOUNTED EQUIPMENT

X-1839

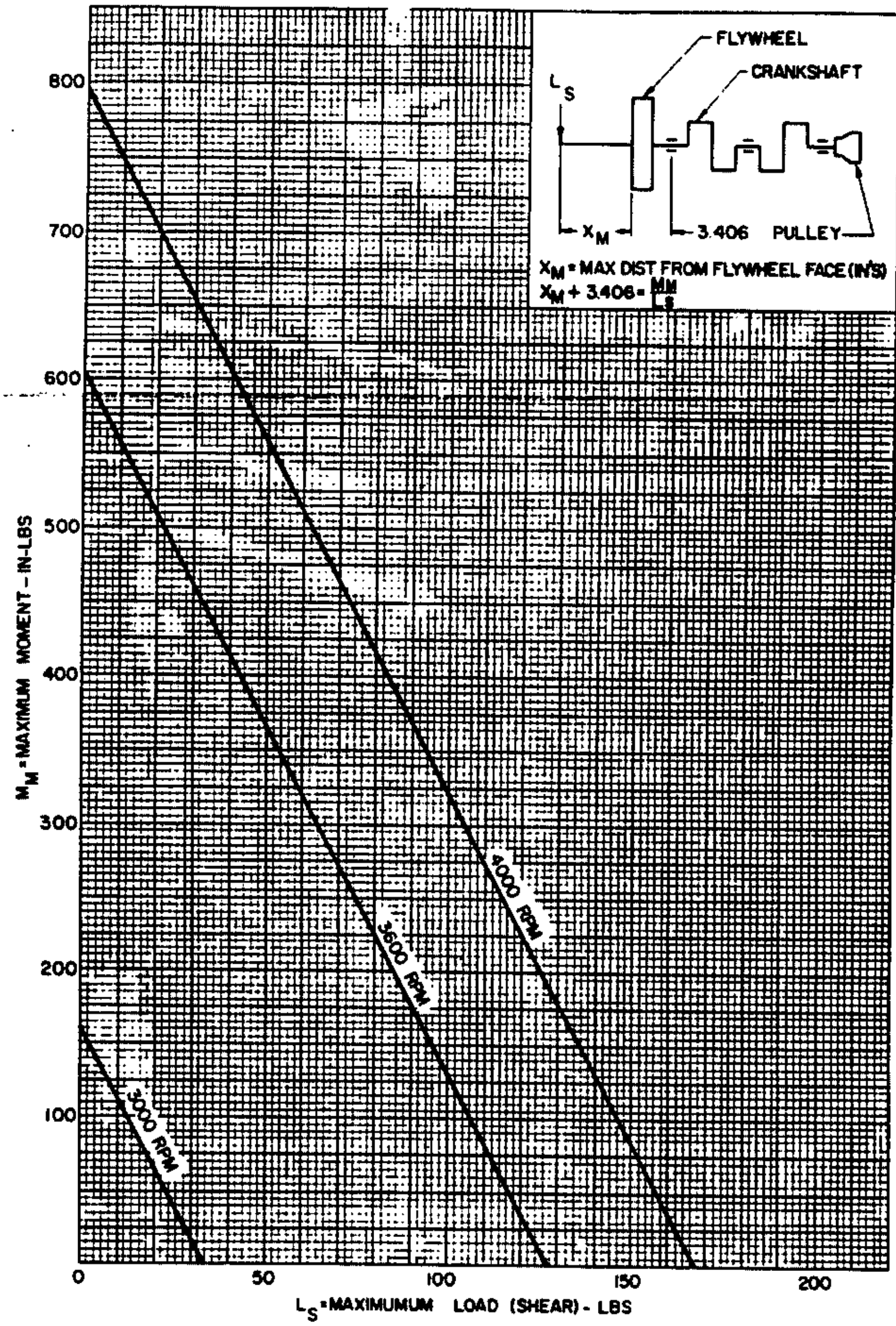


FIGURE 9
POWER TAKE OFF END
ALLOWABLE MOMENT & LOAD DIAGRAM

X-1840

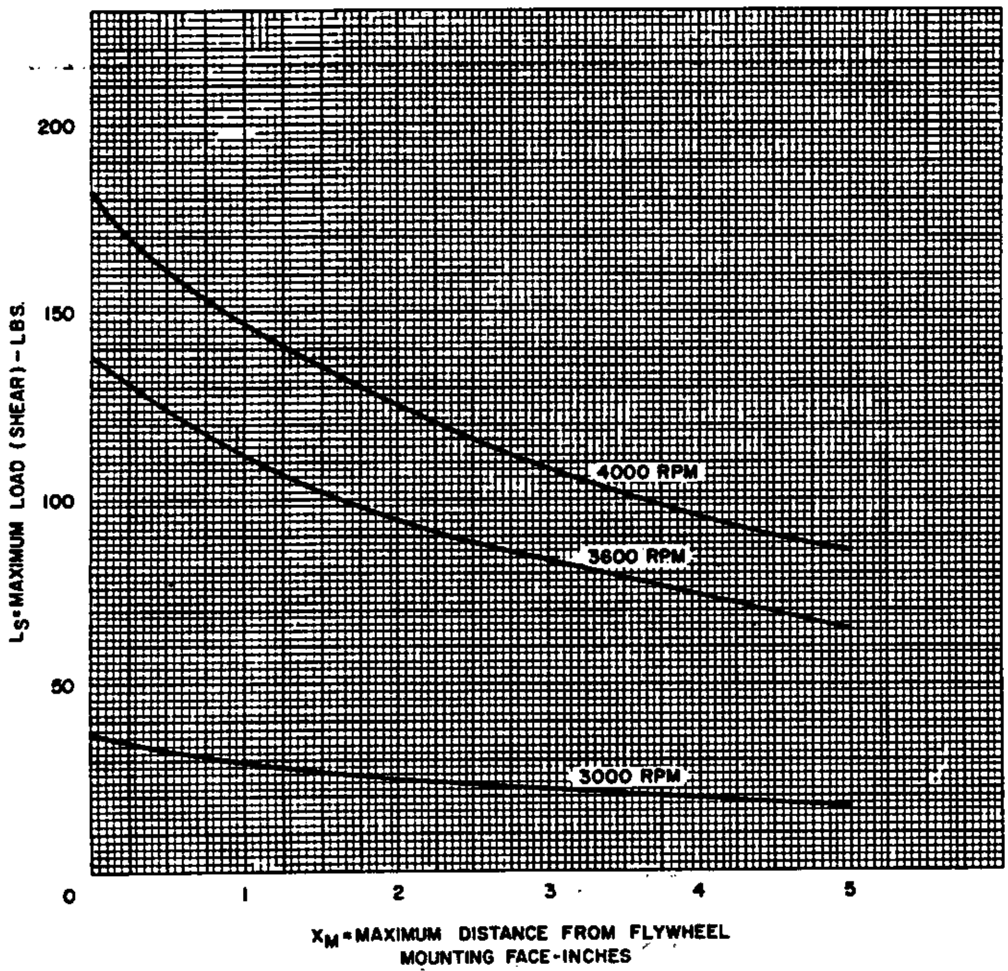


FIGURE 10
POWER TAKE OFF END
MAXIMUM DISTANCE FOR OVERHUNG LOADS

X-1841

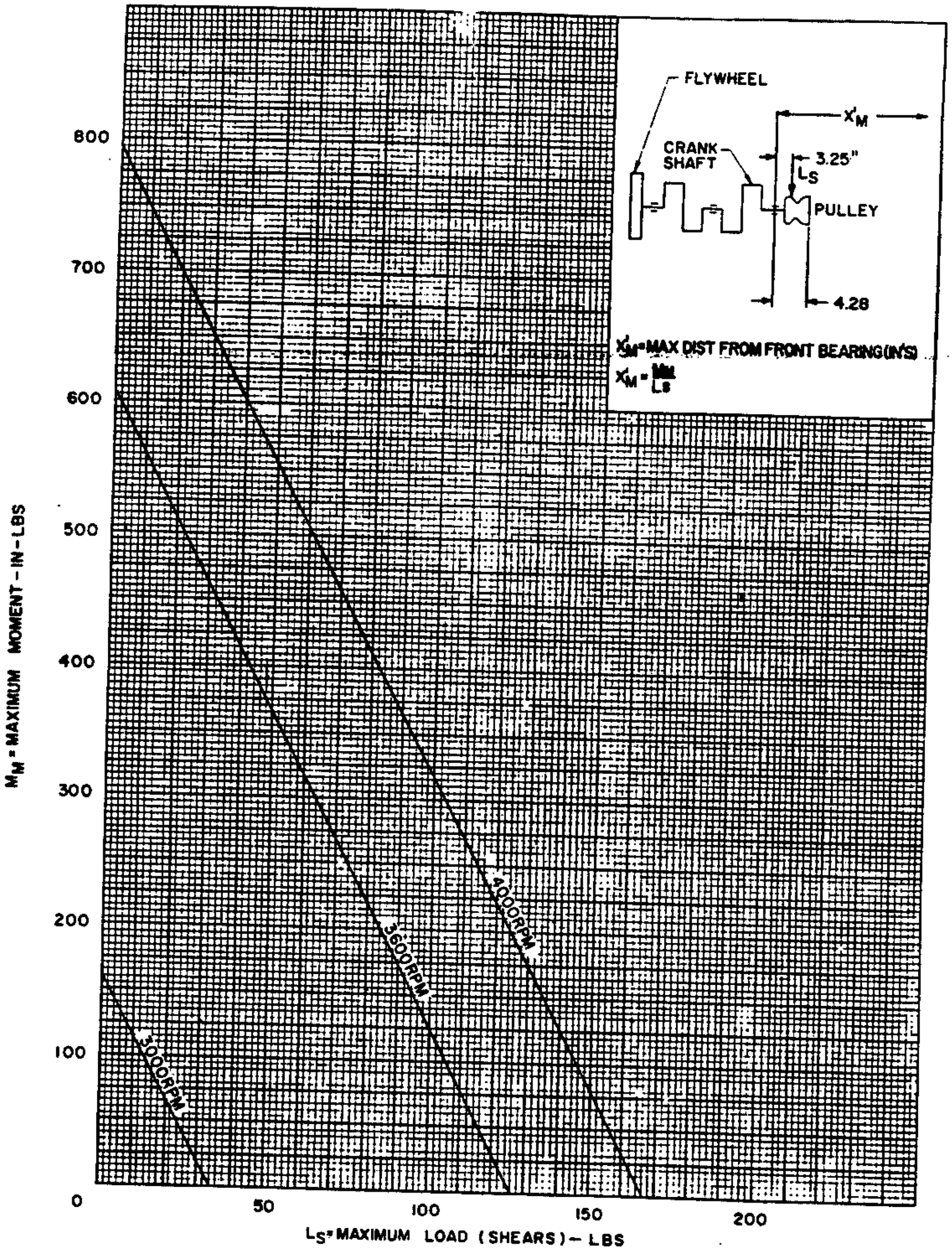


FIGURE 11
ACCESSORY END
ALLOWABLE MOMENT & LOAD DIAGRAM

X-1842

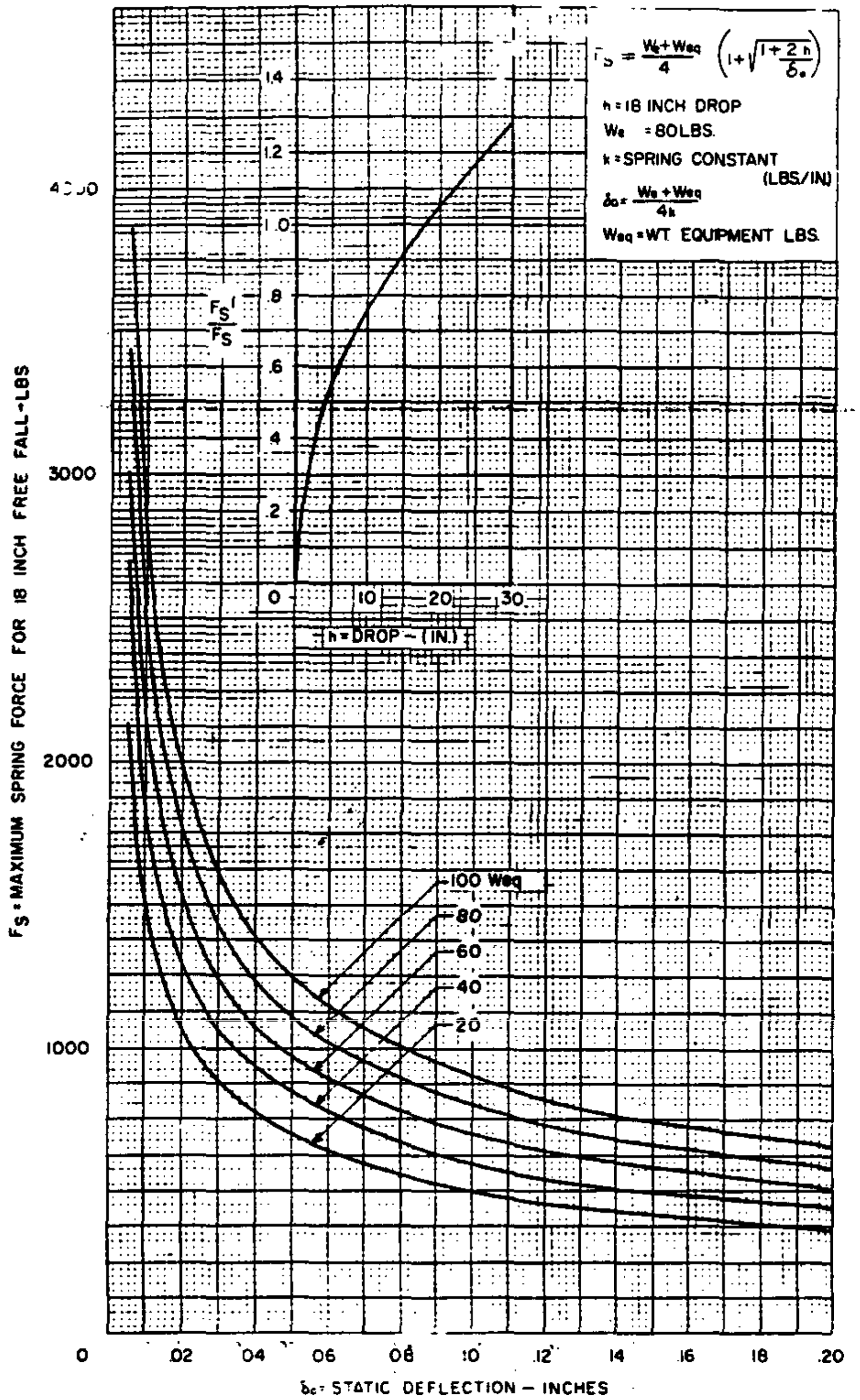


FIGURE 12
MAXIMUM SPRING FORCE OF VIBRATION MOUNTS
AS A FUNCTION OF STATIC DEFLECTION

X-1843

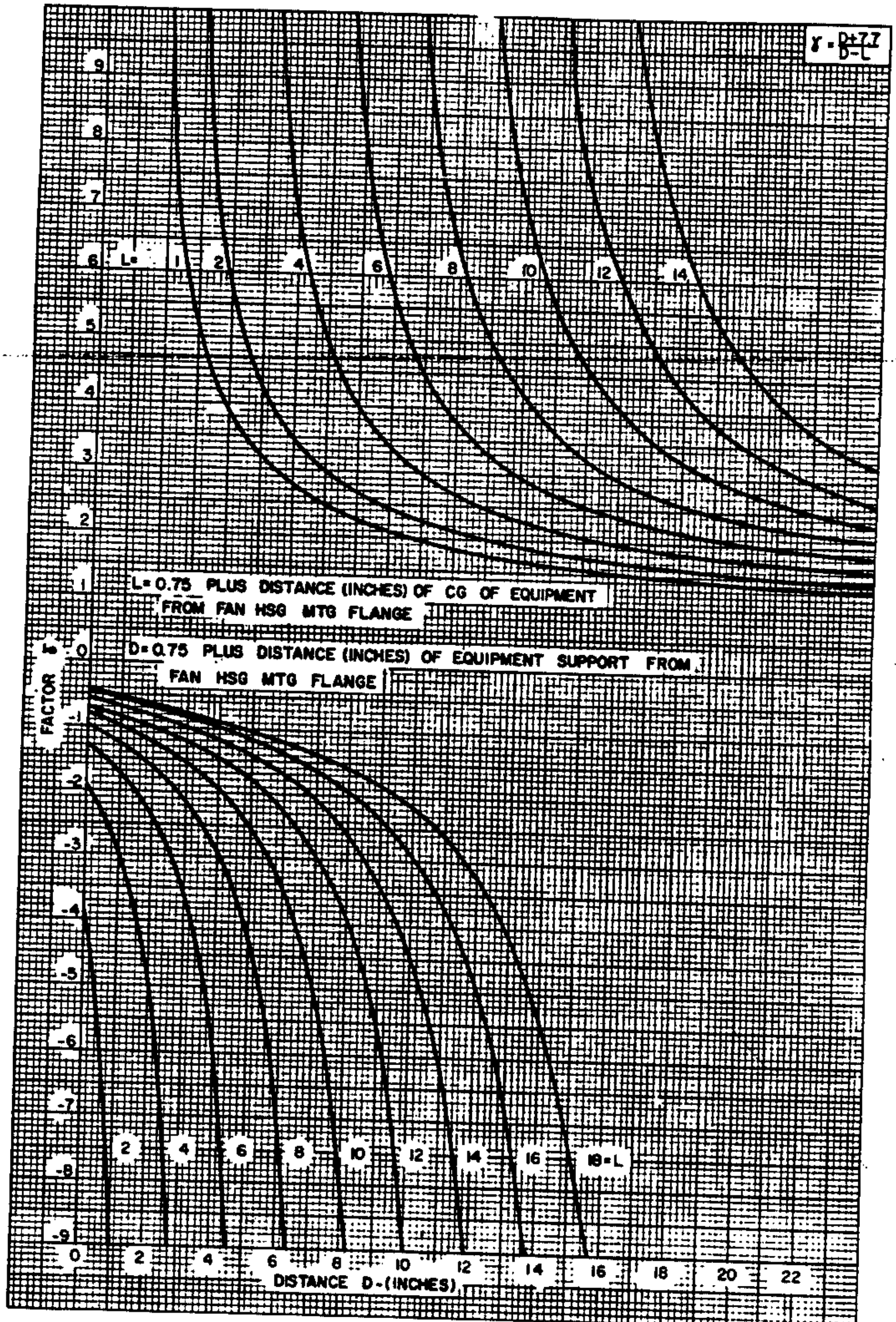


FIGURE 13

FACTOR γ AS FUNCTION OF L AND D FOR BEAM MOUNTING WHEN H=0

X-1844

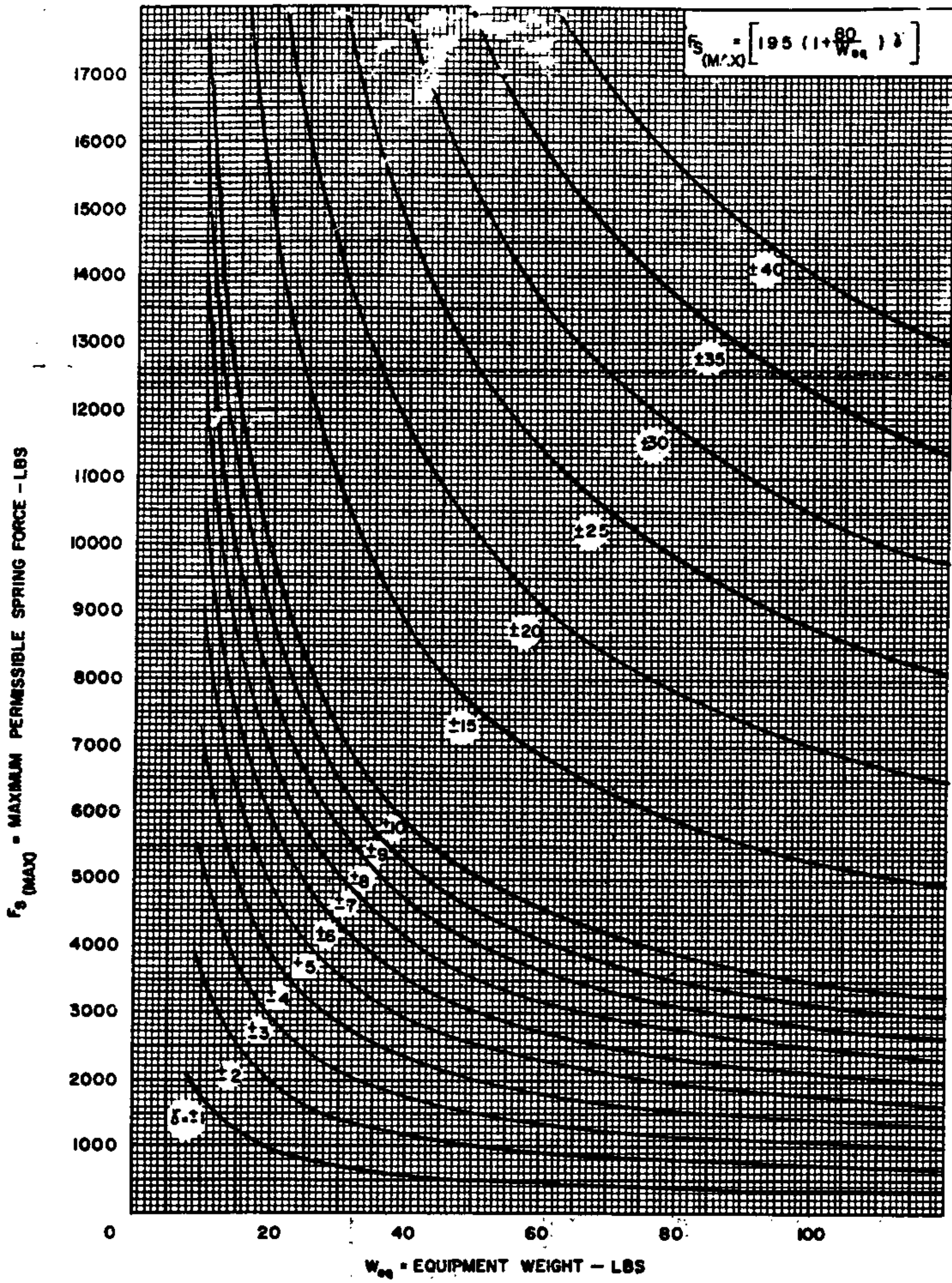


FIGURE 14
MAXIMUM PERMISSIBLE SPRING FORCE
(PER SPRING) FOR BEAM MOUNTING WHEN H=0

X-1845

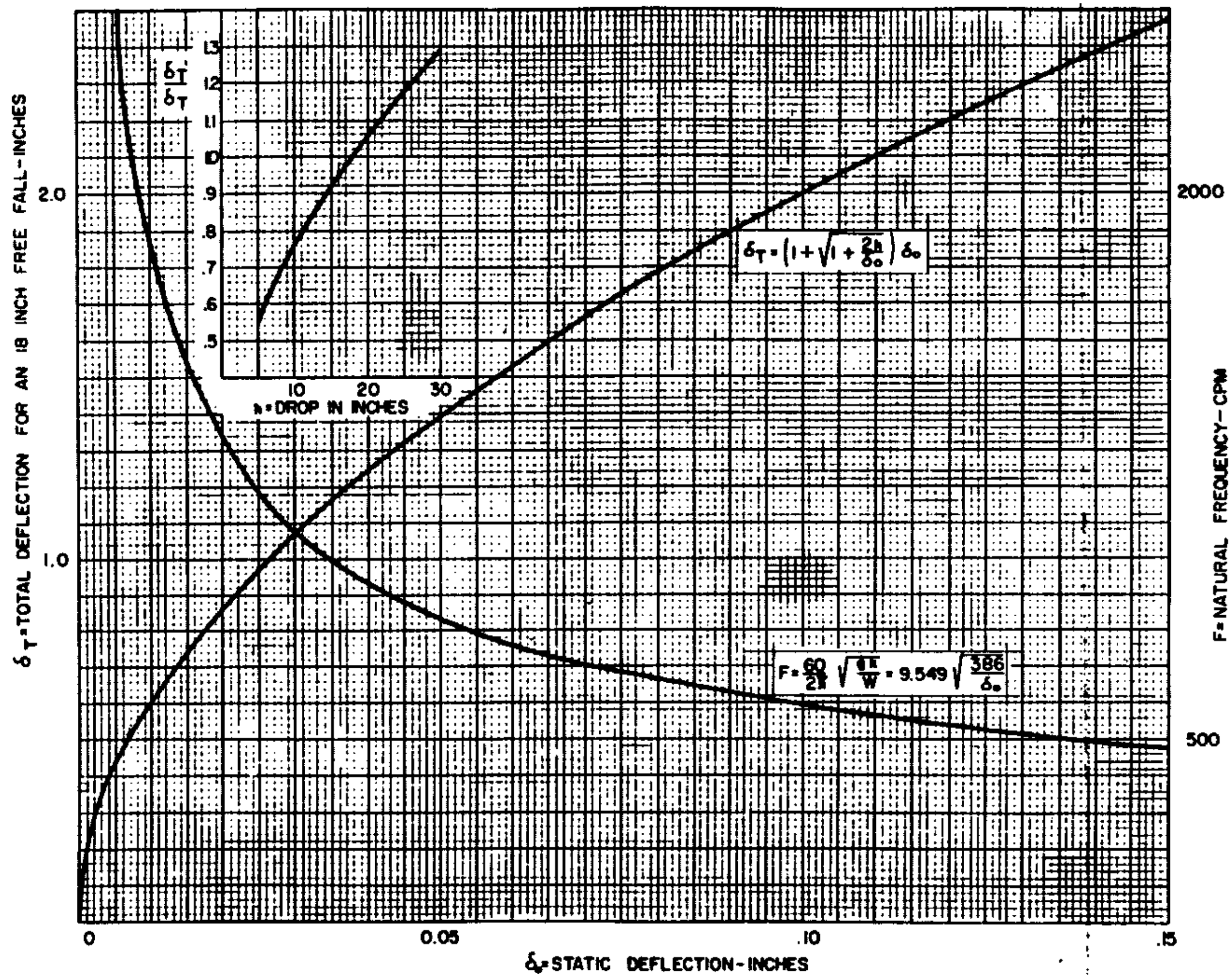
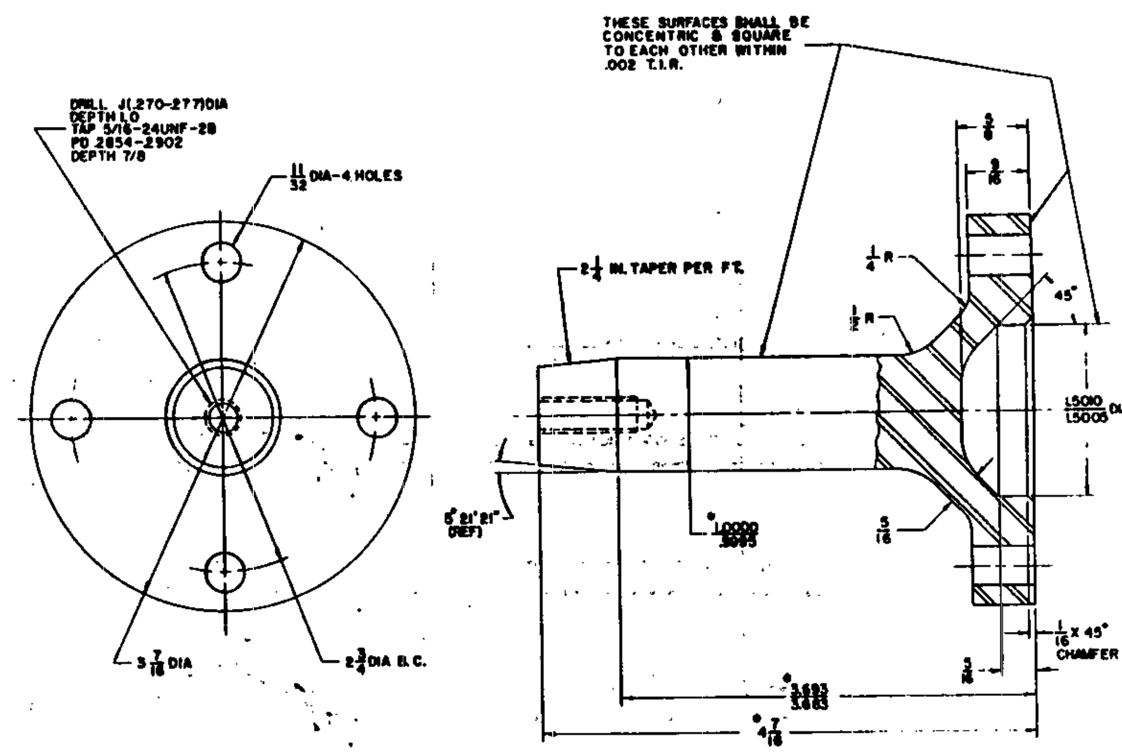


FIGURE 15
NATURAL FREQUENCY AND TOTAL DEFLECTION
AS A FUNCTION OF STATIC DEFLECTION

X-1846



NOTES

1. DIMENSIONS TO BE DETERMINED PER 5.8.5.1, FOR DIRECT MOUNTED END ITEMS
2. NOT AVAILABLE AS GFE
3. RECOMMENDED MATL: STEEL 4140 RC 40-46
4. FINISH IN ACCORDANCE WITH MIL-STD-171, FINISH NO.3.3.1 (BLACK OXIDE)

FIGURE 16
FLYWHEEL COUPLING ADAPTER SHAFT

X-1847

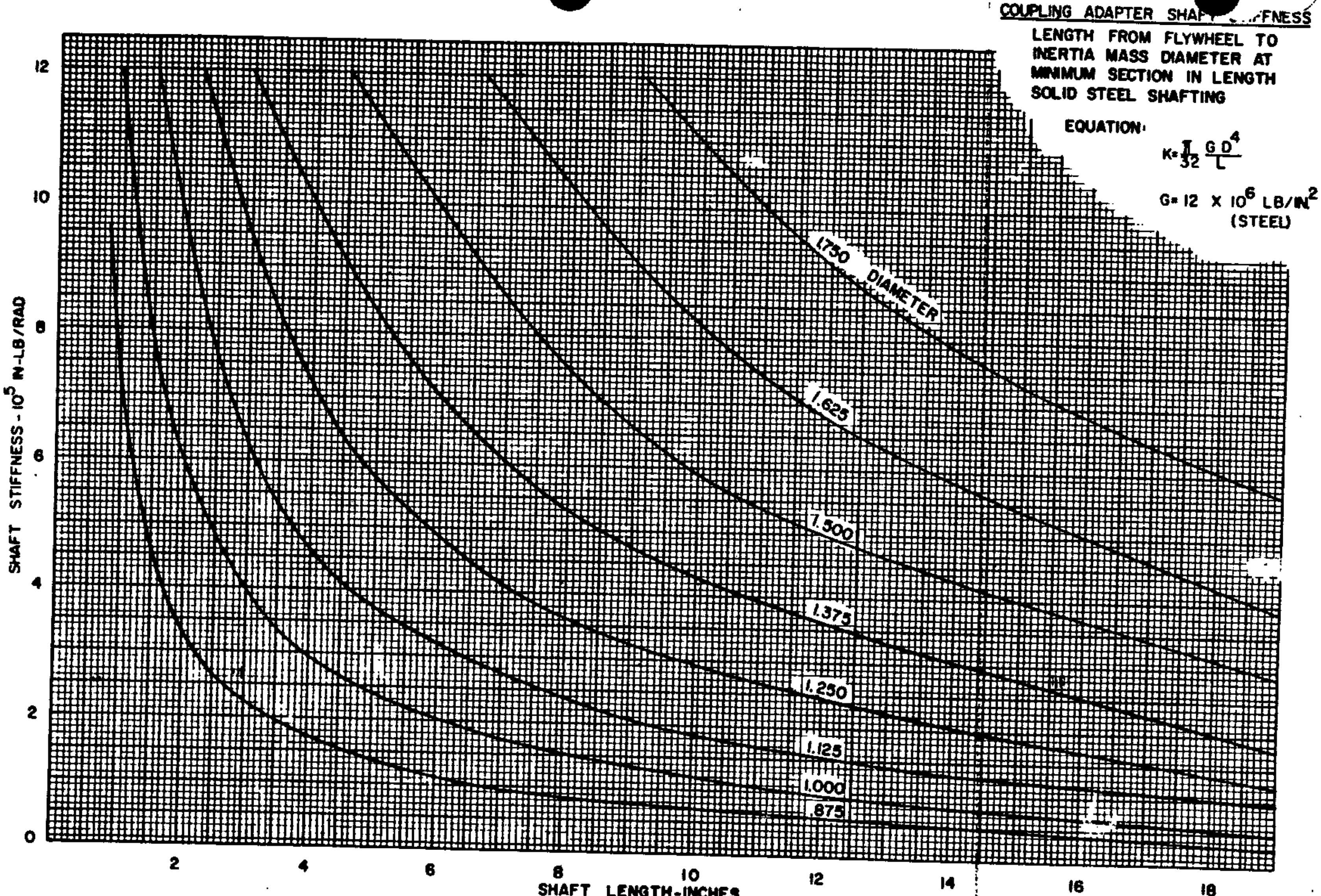


FIGURE 19
COUPLING ADAPTER SHAFT STIFFNESS

X-1849

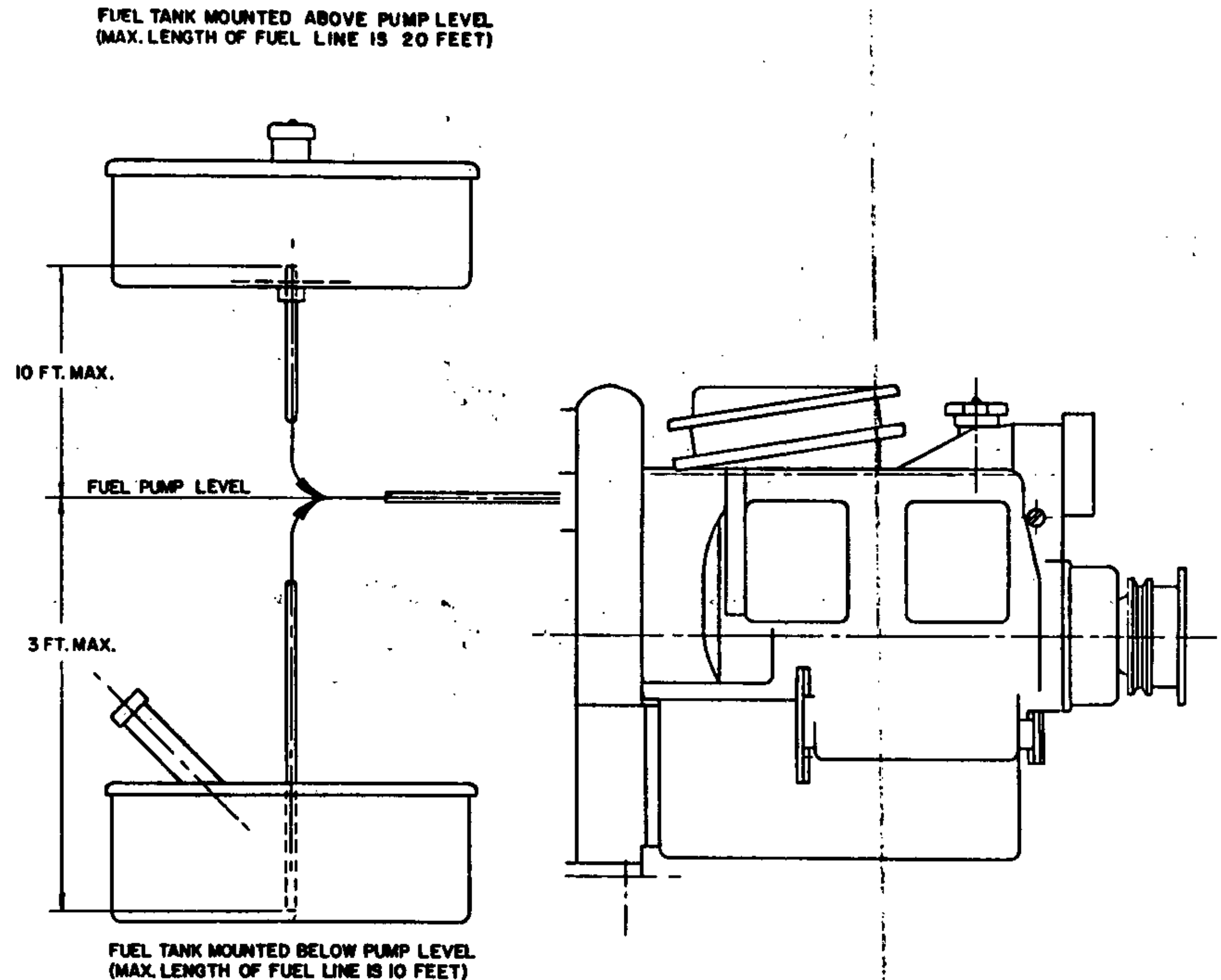


FIGURE 20
MAXIMUM LIMITS FOR FUEL TANK LOCATIONS

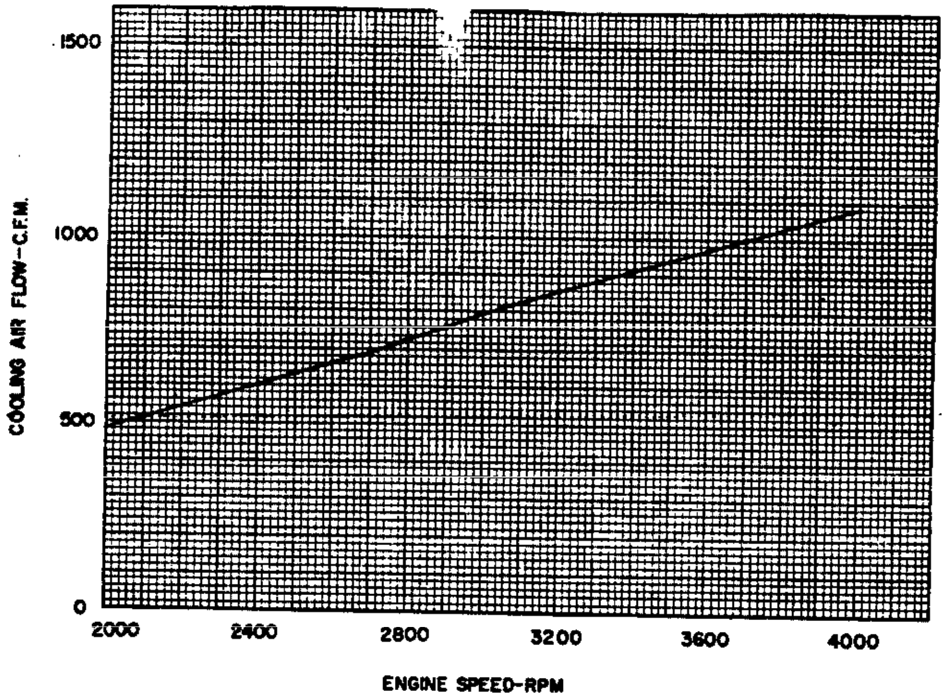


FIGURE 21

COOLING AIR CAPACITY

X-1851

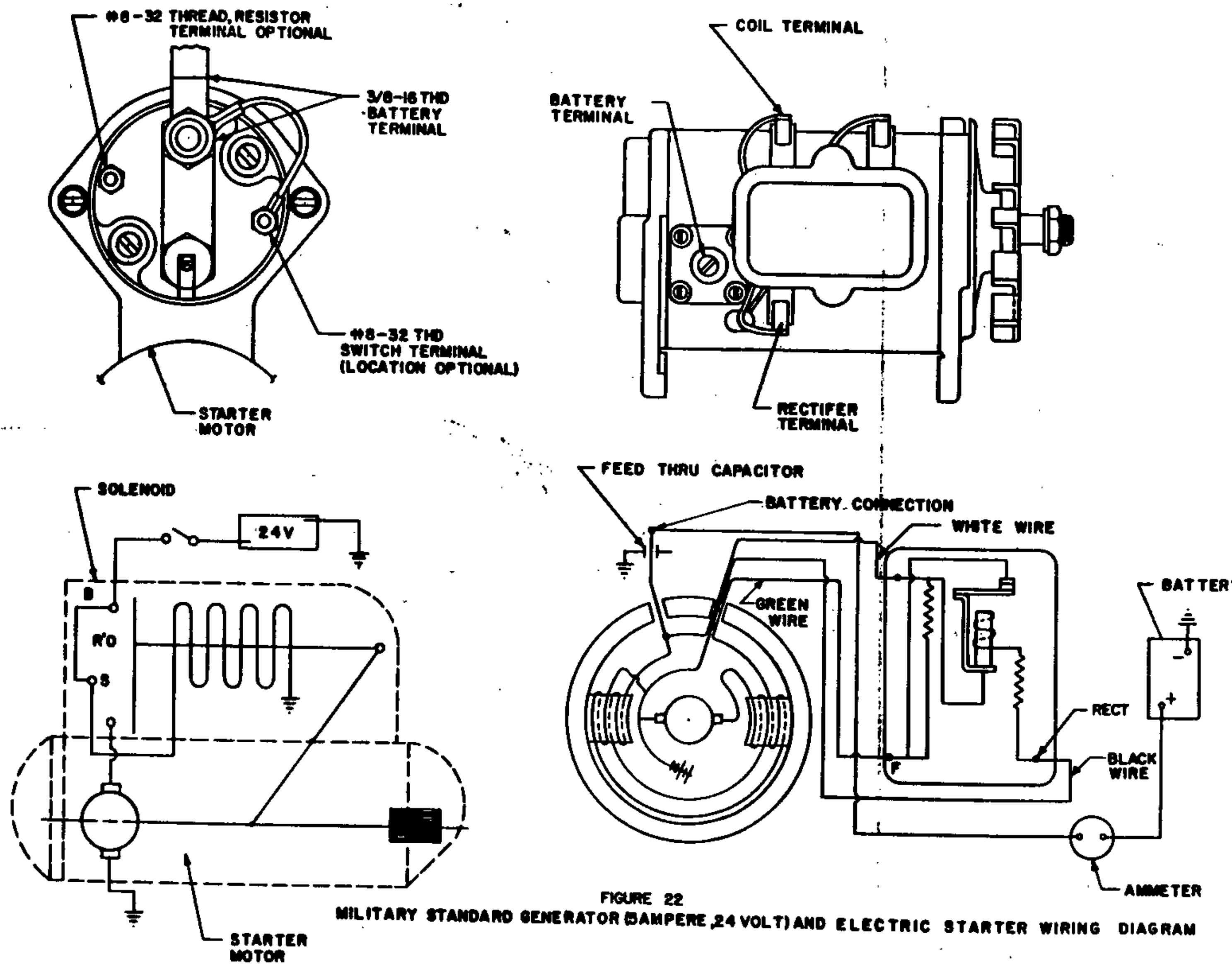


FIGURE 22
MILITARY STANDARD GENERATOR (5AMPERE, 24 VOLT) AND ELECTRIC STARTER WIRING DIAGRAM

X-1852

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

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3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
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a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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