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MILITARY SPECIFICATION

STARTER, ENGINE; ELECTRICAL MOTOR

(SHIPBOARD USE)

This specification is approved for use by the Naval Sea Systems Command and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers electrical motor engine starters for application in starting internal combustion engines aboard surface ships and for starting internal combustion motor boat engines.

1.2 Classification. Starters shall be of the following types and classes as specified (see 6.2.1).

Type I - For applications requiring a torque limiting clutch.
Type II - For applications not requiring a torque limiting clutch (direct drive).
Class 1 - Positive drive solenoid.
Class 2 - Inertia drive.

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

FF-B-171 - Bearings, Ball, Annular (General Purpose).
HH-I-536 - Insulation Sheet, Electrical, Natural Muscovite Mica.
HH-I-538 - Insulation, Electrical, Pasted-Mica.
QQ-C-390 - Copper Alloy Castings (Including Cast Bar).
QQ-I-666 - Iron, Malleable, Ferritic, for Castings.
QQ-S-763 - Steel Bars, Wire, Shapes, and Forgings Corrosion-Resisting.
QQ-T-390 - Tin Alloy Ingots and Castings and Lead Alloy Ingots and Castings (Antifriction Metal) for Bearing Applications.

MILITARY

MIL-M-14 - Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-S-890 - Steel: Forgings and Bars for Hulls, Engines and Ordnance (Heat Treated).
MIL-S-901 - Shock Tests H. I. (High Impact), Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917 - Electric Power Equipment, Basic Requirements for (Naval Shipboard Use).
MIL-E-2036 - Enclosures for Electric and Electronic Equipment Naval Shipboard.
MIL-C-2212 - Controllers, Electric Motors, AC or DC, and Associated Switching Devices, Naval Shipboard.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, D.C. 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

MILITARY (continued)

MIL-P-15024/5 - Plates, Identification.
MIL-P-15037 - Plastic-Sheet, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin.
DOD-B-15072 - Batteries, Storage, Lead-Acid, Portable; General Specification For (METRIC).
DOD-B-15072/2 - Battery, Storage, Lead-Acid, Portable Type BB-253/U (6V-SBMD-205Ah) (METRIC).
DOD-B-15072/6 - Battery, Storage, Lead-Acid, Portable Type BB-257/U (6V-SBMD-130Ah) (METRIC).
MIL-E-16298 - Electric Machines Having Rotating Parts and Associated Repair Parts: Packaging Of.
MIL-I-24092 - Insulating Varnish, Electrical, Impregnating Solvent Containing.
MIL-I-24137 - Iron Castings, Modular Graphitic (Ductile Iron) and Nodular Graphitic (Corrosion Resisting, Austenitic, Low Magnetic Permeability) (For Shipboard Application).

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I Environmental and Type II Internally Excited).
MIL-STD-749 - Preparation and Submission of Data for Approval of Nonstandard Parts.

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

B438 - Copper-Base Sintered Bearings (Oil Impregnated).

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 First article. The first starter of each design, type, class, and size produced under a contract or order shall be tested as specified in 4.3 (see 6.4).

3.2 Material. Minimum requirements for materials to be used shall be as specified in table I. All steel and iron shall be corrosion resistant in accordance with MIL-E-917. Reclaimed materials shall be used to the maximum extent possible.

TABLE I. Minimum material requirements.

Item	Material	Remarks
Armature cores	Steel	Nonaging low hysteresis
Ball bearings	------	FF-B-171
Ball bearing caps and cartridges	Steel Malleable iron Nodular graphitic iron	QQ-I-666, Grade I MIL-I-24137
Brush holders	Steel Nodular graphitic iron Brass	------
Brush studs	Steel	------

TABLE I. Minimum material requirements. (continued)

Item	Material	Remarks
Commutators: V-rings and shells	Steel	MIL-S-890, class B or C
End brackets	Steel Malleable iron Nodular graphitic iron	QQ-I-666, Grade I MIL-I-24137
Frame	Steel Nodular graphitic iron	MIL-I-24137
Insulation between commutator bars	Mica	HH-I-536 and HH-I-538
Insulation varnish	Grade CA	MIL-I-24092
Segments, commutator	Copper	Hard drawn rolled or forged
Shafts	Steel	MIL-S-890, Alloy No. 1
Sleeve bearing	Bronze Babbit, antifriction metal	QQ-C-390 or ASTM B438 QQ-T-390
Springs	Steel	QQ-S-763
Yoke	Plastic material	MIL-P-15037 Laminated, type GME, MIL-M-14 Molded

3.3 Ambient temperature. The rating of the equipment shall be based upon an ambient varying from 0° Celsius (C) to 50°C.

3.4 Soldering. Any necessary soldering shall be in accordance with MIL-E-917.

3.5 Design and construction.

3.5.1 Ratings. Starter motors shall be in accordance with figures 1 through 6 and table II. For applications where the use of standard motors is not practical, nonstandard may be used subject to acceptance by the procuring activity in accordance with procedures specified in MIL-STD-749. Where nonstandard motors are used they shall conform to the extent practical with figures 1 through 6 and table II.

3.5.1.1 Voltage. The rated voltage of the motors shall be in accordance with table II.

TABLE II. Rating of standardized starters 0°C.

Motor type	Nominal battery voltage	Navy battery class SBMD	Maximum cranking amperes	Minimum r/min at pinion	Minimum torque at pinion
					lb-ft
AA	12	130AH	700	1250	8.0
A	12	205AH	1,100	800	28
B	24	130AH	700	1400	22
	30	130AH	700	2000	22
C	24	130AH	700	1000	30
	24	205AH	1,100	1300	30
	30	130AH	700	1450	30
	30	205AH	1,100	1900	30
D	30	205AH	1,100	2300	45
	36	205AH	1,100	2700	45
E	30	205AH	1,100	1150	90
	36	205AH	1,100	1350	90
F	30	205AH	1,100	1050	100
	36	205AH	1,100	1250	100

See note at top of next page.

NOTE: It is the intent in ordering motors that the engine manufacturer shall furnish the motor manufacturer with all pertinent information which is necessary for the selection of a motor of the proper size. Such information shall include the approximate starting torque to turn over the engine and the approximate speed and torque at which the engine starts to fire under cold starting conditions.

3.5.1.2 Speed. The motor shall be of the varying speed type. The speed of the motor shall be in accordance with the values specified in table II. The motor selected for use with a particular engine shall be capable of cranking the engine at a speed of at least 125 percent of the engine starting speed at the beginning of the duty cycle specified in 3.5.6 and at least 100 percent of engine starting speed at the end of the duty cycle.

3.5.1.3 Torque. The torque of the motors shall be in accordance with the values specified in table II. The motor selected for a particular engine shall be capable of developing the torque necessary to crank the engine at starting speed for the duty cycle specified in 3.5.6.

3.5.1.4 Current. The rated current of the motor shall be the current drawn by the motor at rated speed and torque. The maximum current shall not exceed the values shown in table II. The motor shall also have a 50°C current rating. This rating shall be the current drawn by the motor during the duty cycle test at 50°C.

3.5.2 Navy standard batteries. The motor shall be designed to operate with Navy standard class BB-257/U and BB-253/U batteries as specified in DOD-B-15072, DOD-B-15072/2 and DOD-B-15072/6. The characteristics of these batteries while operated for 7 duty cycles as specified in 3.5.6 based on a temperature of 0°C specific gravity of 1,275, are shown in table III. The motor design should allow for an additional 5 percent of battery terminal voltage drop in the connecting cable.

TABLE III. Battery characteristics 0°C.

Discharge rate (amperes)	Percent of nominal (2v per cell) battery terminal voltage			
	BB-257/U		BB-253/U	
	Start	Finish	Start	Finish
500	81.6	76.3	87	84.2
700	75.8	64.5	82.9	78.3
900 1/	----	----	79.2	72.5
1,100 1/	----	----	75.4	62.9

1/ Not applicable to BB-257U.

3.5.3 Temperature limitation. Motors shall be designed so that the maximum temperature immediately following the last running period of the 7th duty cycle specified in 3.5.6 shall not exceed the values specified in table IV.

TABLE IV. Maximum permissible temperature of motors.

Field winding (thermocouple or thermometer method).....	145°C.
Armature winding (thermocouple method).....	145°C.

3.5.4 Dielectric strength. The motor shall be subjected to a dielectric test of 750 volts, 60 Hertz (Hz) alternating current for a period of 1 minute. The insulation shall show no evidence of burning, charring, loosening, cracking, smoking, rupture or other damage.

3.5.5 Overspeed. The motor shall be capable of operating for 5 seconds under no load with the maximum battery voltage applied to the motor terminals.

3.5.6 Duty cycle. The motor shall be capable of operating at minimum speed and torque, under cold starting conditions, for a duty cycle consisting of seven consecutive cycles of 30 seconds on and 2 minutes off. Cold starting conditions are as follows:

(a) The engine shall have been at rest, with the oil drained out of the crankcase, for not less than 6 hours.

(b) Cold water of temperature not exceeding 35°F shall be circulated through the engine cooling system for 1 hour prior to the test.
(c) Immediately before the test, the engine crankcase shall be filled with lubricating oil at 35°F.

3.5.6.1 Insulation resistance. The insulation resistance of starting equipment at the end of the duty cycle test shall be not less than 1 megohm.

3.5.7 Enclosure. Motors shall be spraytight or dripproof construction in accordance with MIL-E-2036 as specified, (see 6.2.1). Motors shall be furnished with open terminals.

3.5.8 Shaft. Alloy steel, number 1 in accordance with MIL-S-890 as shown in table I or other steel of equivalent physical properties, shall be used for the shaft. After completion of the duty cycle test there shall be no distortion of the shaft at the keyway or breakage of the key.

3.5.9 Commutator assembly. The motor commutator shall be secured rigidly to the shaft so as to prevent either rotational or axial motion of the commutator assembly relative to its supports. Commutator connections shall be welded or brazed.

3.5.10 Armatures. The spacers used for ventilation shall be mechanically rigid, and shall be secured so as to prevent their coming loose due to vibration in service. In the assembly of the cores, care shall be taken to remove all burrs or projecting laminations in the slot portion of the core which may result in injury to the coils. The laminations shall be clamped together in such a manner as to insure that the assembled core is "tight" at the top of the teeth. Keys shall be provided to prevent rotation of the armature core on the shaft. Provisions shall be made to prevent axial displacement of the armature core along the shaft. A pin through the shaft is not an acceptable means of preventing axial displacement. Welding may be used in conjunction with other means to prevent axial displacement.

3.5.11 Bearings. Except as otherwise specified, (see 6.2.1) all internal bearings for motors having gear reducers shall be ball bearings in accordance with FF-B-171 and all other bearings shall be sleeve bearings of material in accordance with QQ-C-390 or QQ-T-390.

3.5.12 Brush rigging.

3.5.12.1 Brush holders. Brush holders shall be so designed that the brushes will not bind in the brush holders and that sufficient spring pressure will be maintained over the entire wearing range of the brush to insure proper brush contact under all normal conditions of brush and commutator wear. Means shall be provided to prevent loosening and shifting of brush holders under vibration and spring pressure.

3.5.12.1.1 Accessibility. Brush holders shall be mounted such that removal of inspection covers, bands, etc. shall permit brushes to be easily removed for examination and brush spring tension can be easily measured.

3.5.12.1.2 Alinement. Brush holders shall be so mounted and alined that the brushes are parallel to the shaft and do not extend beyond the edge of the commutator.

3.5.12.2 Terminal screw. A separate terminal screw shall be provided for securing the brush shunt terminal lugs to the brush holder.

3.5.12.3 Springs. Springs shall not be depended upon to carry current. Care shall be taken to preclude the possibility of the brush spring pressure finger abrading the brush pigtails.

3.5.12.4 Brushes. Brushes shall be of a type that will give the maximum electrical performance for the application consistent with brush life. Brush pigtails shall be composed of copper strands protected by a coating of 90 percent lead and 10 percent tin. If the pigtail connection is of the tamped type, the connection shall be sealed so as to preclude the penetration of moisture.

3.5.13 Frame and armature marking. The manufacturer's serial, model, type, or part number shall be stamped in the solid metal of the magnet frame underneath (covered by) the main identification plate; the serial number of manufacturer's designation (model, type or part number) sufficient to completely identify the part shall also be stamped on the tooth surface of the armature lamination.

3.5.14 Circuit design. Engine starters shall be designed for operation on a two-wire, ungrounded system.

3.5.15 Connections and terminals.

3.5.15.1 Securing connections. All connections likely to become loosened by vibration shall be provided with efficient locking devices. Connections and leads shall be secured in a reliable manner to prevent their coming in contact with moving parts or being chafed by contact with stationary parts. Excess solder shall be removed from soldered connections.

3.5.15.2 Terminals. Terminal lugs or cupwashers for incoming and outgoing main power leads are not required to be furnished as a part of the engine starter. Terminal lugs or cupwashers for pilot circuit leads, however, are required to be furnished with each motor starter. Sufficient space shall be provided between the ends of the terminals and the inside faces of enclosures to provide ease in connections and maintenance of electrical connections to the equipment.

3.5.16 Creepage and clearance distances. The creepage and clearance distances shall be in accordance with MIL-E-917 except that for equipment rated not more than 36 volts, surface creepage of enclosed parts may be reduced to 1/4 inch.

3.5.16.1 Terminals shall have insulating washers providing at least 1/2-inch creepage between terminal and frame.

3.5.17 Assembly with engine. The design of the engine starters shall be such as to interface with the internal combustion engine for which they are intended. They shall have dimensions, mounting flanges, and pinions in accordance with figures 1 through 6 and shall have a minimum characteristics in accordance with table II.

3.5.17.1 Mounting flange. The mounting flange shall conform to the applicable figure.

3.5.17.1.1 The mounting flange and pinion housing shall rotate with respect to the solenoid and motor frame of class 1 starters.

3.5.17.1.2 The mounting flange and pinion housing shall rotate with respect to the motor frame of class 2 starters.

3.5.17.2 Drive.

3.5.17.2.1 Type I. The drive for type I starters shall consist of a pinion for meshing with the flywheel ring gear or engine crankshaft, a means for engaging and disengaging the pinion, and a torque limiting clutch. The drive shall be designed for specified rotation (see 3.5.17.5).

3.5.17.2.1.1 Clutch. The torque limiting clutch shall be adjusted to slip under the torque load specified on the applicable drawing (see 3.9).

3.5.17.2.2 Type II. The drive for type II starters shall consist of a pinion for meshing with the flywheel ring gear or engine crankshaft and a means for engaging and disengaging the pinion. The drive shall be designed for specified rotation (see 3.5.17.5).

3.5.17.2.3 Pinion. The pinion for starters with type A, B, C, D, E or F motors shall be eleven or twelve teeth, 6/8 pitch with 2.000 inch pitch diameter. The pinion for starters with type AA motors shall be twelve or thirteen teeth, 8/10 pitch with 1.625 inch pitch diameter.

3.5.17.3 Class.

3.5.17.3.1 Class 1. The pinion shall employ a positive drive for meshing with the flywheel ring gear. The pinion shall be actuated into mesh by a solenoid.

3.5.17.3.2 Class 2. The pinion shall employ an inertia drive for meshing with the flywheel ring gear.

3.5.17.4 The engine starter shall be designed for use with engines equipped with wet type clutches.

3.5.17.5 Direction of rotation. The direction of rotation of the output pinion shall be clockwise as viewed from the pinion end of the starter.

3.5.18 Inclined operation. The starter motor shall be capable of operating satisfactorily when either horizontal axis is inclined up to 15 degrees from normal operating position.

3.5.19 Endurance. When tested as specified in 4.8.9, there shall be no need for servicing or replacement parts. No malfunctions of the solenoid, its components or engaging linkages shall occur. Failure of the drive to overcome abutments shall not exceed seven percent of the total accumulated cycles at any stage of the test. The drive pinion shall not mill the flywheel, crankshaft, or mating gear used.

3.5.20 Shock. Motors shall be designed to withstand high-impact shock testing, grade A or B in accordance with MIL-S-901 as specified in 4.8.11 (see 6.2.1). Shock grade shall be the same as for the engine for which the motor is designed. The motor shall be shock tested as a separate unit. The procuring activity may require shock test of motor assembled with the engine in addition to or in lieu of shock test on the motor alone.

3.5.21 Vibration. When tested as specified in 4.8.10 components of the motor starter shall not be loosened or damaged.

3.6 Painting. Engine starters shall be finished and painted in accordance with MIL-E-917.

3.7 Identification plates. Identification plates shall be provided in accordance with MIL-P-15024 and MIL-P-15024/5, types A, B, C, D, H or J, except that plastic materials are not permitted. No aluminum shall be used except that anodized aluminum may be used for type H. Identification plates identical to those previously furnished to the Navy on starter motors under this specification are acceptable. The plates shall be installed and furnished as a part of the equipment for which they are intended. They shall be attached, with metal fasteners other than self-tapping screws, to a part of the equipment which will not ordinarily be renewed during normal service life and shall be located in a readily accessible position where they can be read at all times without danger to personnel.

3.7.1 Identification plate markings. The minimum data to be marked on the identification plates shall include the following items:

(a) Manufacturer's name or identification symbol, model and catalog number and serial number if available, and master drawing number. Unless otherwise specified in the contract, a nine digit Component Identification Number (CID) shall be provided. The Component Identification Number, preceded by the abbreviation "CID" shall be assigned by the Contracting Officer to identify a specific equipment furnished by a specific manufacturer (example: CID 340040116).

(b) Salient design characteristics: Motors - nominal battery voltage, r/min amperes and torque at 0°C rated output and amperes at 50°C rated output.

3.8 Motor controllers. Motor controllers shall be furnished in accordance with MIL-C-2212.

3.9 Technical data. The contractor shall prepare engineering drawings and technical manual information in accordance with the data ordering document included in the contract or order (see 6.2.2) and as specified in 3.9.1 through 3.9.2.

3.9.1 Drawings. In addition to the drawing content required by the data ordering document (see 6.2.2), the following unique features shall be included:

3.9.1.1 Motors.

(a) Manufacturer's name and catalog number or equivalent identification (sufficient for recording purposes) of the motor.
(b) A list of the exceptions, if any, to this specification and referenced specifications.
(c) Rating: voltage, maximum ampere, and minimum torque.
(d) Weight of motor (net).
(e) Finish, including method of treatment of enclosure for painting, color and applicable specification of paint.
(f) Method and procedure of impregnation of field and armature windings.
(g) A table of insulation indicating the location, the insulation material, the applicable specifications and remarks.
(h) Guaranteed performance curves.
(i) Outline of overall and principal dimensions.

(j) Wiring diagram indicating markings of all terminals of motor.
(k) Front view, side view, and sectional views as necessary showing mounting flange, identification plates with data to appear thereon, spacing of all terminals with their marking and any other pertinent data necessary for complete understanding of the drawing.
(l) Armature diameter and core length.
(m) Commutator diameter, length, wearing depth, depth of undercutting of mica segments, minimum clearance to ground.
(n) Brushes, original length, width, thichness, minimum length, number of brushes per stud, number of studs, range of brush spring tension and grade of brush and manufacturer.
(o) Table of armature winding data and insulation of coils including the following information:

(1) Number of slots.
(2) Number of commutator segments.
(3) Number of single coils.

(p) Cross section view of armature slot.
(q) Armature banding wire, number of turns and wire size, or where glass tape is used, identify tape, tape size, number of turns and method of wrapping tape.
(r) Table of field winding data for all fields, including the following information:

(1) Conductor size (of copper only).
(2) Conductor insulation - type and size.
(3) Conductors in parallel.
(4) Turns per coil.
(5) Feet of wire per coil.
(6) Pounds of wire per coil.
(7) Resistance per coil.

3.9.1.2 Motor controllers and master switches. Drawings for motor controllers and master switches shall be as required by MIL-C-2212.

3.9.2 Technical manual. The technical manual for the user engine will include technical information on the starter motor. The information required shall be in accordance with the specification for the user engine and shall include as a minimum.

(a) Drawing specified in 3.9.1.
(b) Assembly and disassembly instructions.
(c) Operating instructions.

3.9.2.1 Where the specification for the user engine does not specify technical manual information for the starter motor, the information required shall be the minimum information of 3.9.2.

3.10 Repair parts. Each item of repair parts shall be suitable for immediate replacement of originally installed part in the engine starter. The operation of the equipment in which such repair parts are installed shall be equal to the original. The word "set" as applied to any particular item in the list of repair parts shall mean the total number of such parts incorporated in the construction of one engine starter. Where a repair part as specified is not readily replaceable, a complete subassembly shall be furnished as a repair part. The contractor shall furnish repair parts as required by the data ordering document (see 6.2.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

(a) First article inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).
(c) Routine test (see 4.5).

4.3 First article inspection. First article inspection shall consist of the examination of 4.6 and tests specified in 4.8.

4.4 Quality conformance inspection. Each sample selected in accordance with 4.4.1.3 shall be subjected to the tests specified in 4.8.7 through 4.8.8.1 and 4.8.8.3. If any sample is found not to conform to this specification, the lot which it represents shall be rejected.

4.4.1 Sampling for quality conformance.

4.4.1.1 Lot. For purposes of sampling, a lot shall consist of all engine starters of the same design, type, class and size offered for delivery at one time.

4.4.1.2 Sampling for visual and dimensional examination. A random sample of starters or repair parts shall be selected from each lot in accordance with inspection level II of MIL-STD-105. The acceptable quality level (AQL) shall be 1.0 percent defective for major defects and 2.5 percent defective for minor defects.

4.4.1.3 Sampling for tests. A random sample of starters or repair parts shall be selected from each lot in accordance with inspection level S-4 of MIL-STD-105. The AQL shall be 2.5 percent defective.

4.5 Routine inspection. Each starter shall be tested in accordance with 4.8.2 through 4.8.6. Nonconforming units shall be individually rejected.

4.6 Examination. Each sample starter or repair part selected in accordance with 4.4.1.2. shall be examined for the defects as classified in table V.

TABLE V. Classification of defects.

Categories	Defects
Critical	None defined
Major	Design and construction
101	Design not as specified.
102	Material not as specified.
103	Dimensions affecting use or interchangeability.
104	Component missing, damaged or of improper type.
Minor	Finish
201	Not properly applied or throughly cleaned before painting.
	Marking
202	Incorrect, illegible or incomplete.

4.7 Test procedure. Starters shall be tested at an ambient test temperature maintained at 77°F ± 15°F. Starters shall be stabilized for one hour at this temperature before being subjected to testing. Tests shall be made with the starter powered by the Navy standard battery specified (see 3.5.2) or a source of supply whose voltage current characteristics duplicate those of the Navy standard battery (see 3.5.2). A variation of 10 percent in rated torque as indicated on the applicable drawing shall be allowed for each sample submitted for test. Calibration of test equipment shall be conducted at intervals sufficient to establish required accuracy. Records of calibration shall be made available to the Government. The Government may refuse to accept test results where accuracy of test equipment does not satisfy the following tolerances:

Instrument	Accuracy tolerance
Voltmeter DC	± 0.50 percent
Ammeter DC	± 0.50 percent
Prony brake	± 2.0 percent
Thermometers	± 1.0 percent
Tachometer	± 1.0 percent

4.8 Tests.

4.8.1 Weight. The weight of a starter and repair parts shall be taken and recorded.

4.8.2 Lubrication. The effectiveness of the lubricating system with the starter in its horizontal position shall be observed during the progress of the duty cycle test or by a special test, as the circumstances may warrant. Government approved lubricants similar to those required for service operation shall be used. There shall be no suction of lubricants into the electrical windings under any operating conditions.

4.8.3 Commutation.

4.8.3.1 The brush holders shall be equally spaced around the commutator; the brushes shall be sufficiently seated on the commutator to obtain the required electrical performance and the commutator itself shall have a smooth, uniformly colored surface. Thereafter during the progress of the tests, the brushes and the commutator shall remain untouched. The observation of commutation will not, in general, require any special tests as such, but will usually be made in conjunction with and during the progress of the duty cycle test.

4.8.4 Overspeed. Overspeed tests shall be made at maximum attainable speed under no load with maximum battary voltage applied to the motor terminals. The duration of the test shall be 5 seconds. The overspeed test may be made with the engaging mechanism assembled to the armature to ascertain that the mechanism functions satisfactorily.

4.8.5 *Dielectric tests.*

4.8.5.1 General. The dielectric test shall be made after all other tests have been completed. If the insulation resistance of the windings is known to be lower than specified, due to dirt or moisture or damage to windings, this shall be remedied before the application of the dielectric test voltage. The dielectric test shall be made upon the completely assembled machine and not upon individual parts; an exception is made in the case of repair parts which require dielectric tests.

4.8.5.2 Test voltage. The frequency of the testing voltage shall be not less than 60 Hz. It shall approximate a true sine wave. The testing voltage of 750 volts shall be applied continuously for a period of 1 minute.

4.8.6 Insulation resistance. The measurement of insulation resistance shall be made with all circuits of equal voltage above ground connected together. Circuits of groups of circuits of different voltage above gournd shall be tested separately. Test shall be made using a potential of 500 volts, direct-current. The temperature of the windings at the time of this measurement shall be recorded. Insulation resistance (hot) shall be taken immediately following temperature readings on duty cycle tests. Insulation resistance (cold) shall be obtained with the equipment at approximately the same temperature as the surrounding air.

4.8.7 Torque.

4.8.7.1 Cranking torque and speed. The starter shall be mounted on a test stand to simulate actual mounting in use. Torque shall be measured at the pinion. A continuous direct load shall be applied for no longer than five seconds. Readings shall be taken at a minimum of five points from the performance curve shown on the applicable drawing. When necessary, additional readings may be taken to determine conformance to the applicable curve. Between readings, a minimum of five minutes cooling time to permit the frame temperature to return to room temperature shall be allowed. Alternate methods for accomplishing this test may be used providing they have been approved by the Government.

4.8.7.2 Slipping torque (type I). When mounted as specified in 4.8.7.1 and with prony brake locked, the starter shall be energized by setting the voltage low and increasing it slowly until the clutch slips. Breakaway torque (highest reading reached before slippage) must not exceed the pound feet specified in the applicable drawing. The clutch shall be slipped for three seconds after the breakaway point and the torque reading taken within the following two seconds. Three successive engagements shall be made with an off time between engagements of not less than one minute.

4.8.7.3 Stalling torque (type II). When mounted as specified in 4.8.7.1, the stalling torque and current of the starter shall be measured at the applicable voltage as shown on the applicable drawing. Readings shall be taken within five seconds.

4.8.8 Duty cycle.

4.8.8.1 General. The duty cycle test shall be made with the starter powered by the Navy standard battery specified or a source of supply whose voltage current characteristics duplicate those of the Navy standard battery. The duty cycle test shall consist of seven cycles, each cycle consisting of 30 seconds ON and 2 minutes OFF. The starter shall be loaded with a dynamometer or similar equipment and mounted as in 4.8.7.1.

4.8.8.2 First article test. The duty cycle test for first article shall be run twice. During the first run the starter shall be loaded so as to simulate minimum torque and speed at 0°C ambient. The maximum temperature of the armature and field as measured immediately following the last cycle shall not exceed the 145°C shown in table IV. The starter shall be cycled a second time at 50°C ambient at no less than minimum torque and speed. The temperature measured immediately following the last cycle shall not exceed 145°C.

4.8.8.2.1 Starters submitted for first article duty cycle test shall be furnished with built in thermocouples for measuring the temperature of the armature and field. A minimum of 2 thermocouples for the armature and 2 for the field shall be supplied.

4.8.8.3 Quality conformance tests.

4.8.8.3.1 The duty cycle test for a quality conformance test shall be run once. The starter shall be loaded so as to simulate minimum torque and speed at 0°C. The maximum temperature of the armature and field as measured immediately following the last cycle shall not exceed 145°C as shown in table IV.

4.8.8.3.2 Where it is impracticable to measure the armature and field temperature directly, a relationship between armature and commutator, and field and frame temperatures shall be established. With this relationship, the maximum armature and field temperature may be determined by measuring the commutator and frame temperatures respectively.

4.8.9 Endurance.

4.8.9.1 Type I. When mounted as specified in 4.8.7.1, the starter shall be subjected to 3,000 cycles of operation, with each cycle consisting of 30 seconds of operation under load followed by a five minute off time. The load shall be 75 percent of the slipping torque (see 4.8.7.2) as shown on the performance curve of the applicable drawing. The load shall be applied at the pinion through a device simulating actual mounting in use. An air velocity of approximately 1,500 linear feet per minute to force ambient air over and around the starter shall be used. The 3,000 cycles of operation shall be conducted at the following ambient air temperatures:

Number of cycles	Temperature
1,000	plus 160°F ± 5°F
1,000	minus 20°F ± 5°F
1,000	plus 77°F ± 15°F

Prior to operation at these temperatures, the starter shall have been stabilized at the temperature for 24 hours. During the last 500 cycles of the 3,000 cycles of operation, the longitudinal axis of the starter shall be positioned at an angle 15 degrees above and below the horizontal for 250 cycles each. After testing, the starter shall be subjected to the tests as specified in 4.8.7.1 and 4.8.7.3 to determine conformance to 3.5.19.

4.8.9.2 Type II. When mounted as specified in 4.8.7.1, the starter shall be subjected to 5,000 cycles of operation, with each cycle consisting of five seconds of operation under load followed by a one minute off time. The load shall be 75 percent of the stalling torque specified on the applicable drawing. The load shall be applied at the pinion through a device simulating actual mounting in use. An air velocity of approximately 1,500 linear feet per minute to force ambient air over and around the starter shall be used. The 5,000 cycles of operation shall be conducted at the following ambient air temperatures:

Number of cycles	Temperature
1,000	plus 160°F ± 5°F
1,000	minus 20°F ± 5°F
3,000	plus 77°F ± 15°F

Prior to operation at these temperatures, the starter shall have been stabilized at the temperature for 24 hours. During the last 1,000 cycles the longitudinal axis of the starter shall be positioned at an angle with the starter pinion 15 degrees above and below the hori-

zontal for 500 cycles each. After testing, the starter shall be subjected to the test as specified in 4.8.7.1 and 4.8.7.3 to determine conformance to 3.5.19.

4.8.10 Vibration. The starter shall be mounted to simulate actual mounting in use. The starter shall then be subjected to the vibration tests specified in MIL-STD-167-1, types I and II.

4.8.11 High impact shock.

4.8.11.1 General. The class HI shock tests shall be made in a laboratory or manufacturer's facility acceptable to the procuring activity (see 6.3). The test shall be type A or B tests as specified in MIL-S-901, and shall be made on a lightweight shock machine.

4.8.11.2 Mounting. The motor shall be mounted on the shock machine, in a manner which simulates typical shipboard installations.

4.8.11.3 Number of blows. The number of blows shall be as specified in MIL-S-901. The motor shall be tested, on alternate blows, in each of its principal operating conditions, i.e., running and standing.

4.8.11.4 Examination after shock test. Upon completion of the shock test, the motor shall be carefully examined and tested to determine the extent of any damage to the mechanical and electrical components.

4.8.11.4.1 Any noticeable increase of decrease in noise produced by the motor shall be investigated and its cause determined. However, if disassembly is required for this check, it shall be made during the test specified in 4.8.11.4.4.

4.8.11.4.2 The insulation resistance (cold) of conducting parts to ground shall be measured in accordance with 4.8.6 and the values shall not be less than 1 megohm.

4.8.11.4.3 The motor shall be operated to obtain approximately rated temperature of iron and windings, then disconnected from its source of power and a dielectric strength test should be made in accordance with 4.8.5 except that it should be made with an applied voltage equal to 65 percent of that specified by 4.8.5.2. No insulation failures shall result.

4.8.11.4.4 The motor shall be disassembled following checks specified in 4.8.11.4.1 and inspected thoroughly for damage. The extent of disassembly need be only to the point where the condition of the motor may be easily observed. The effects of the shocks and subsequent check tests on the structure, bearings and insulation shall be carefully observed and recorded.

4.8.12 Failure to pass test. The motor will be considered to have failed to pass the shock tests in the event that any of the following occur:

(a) Breakage of any parts including mounting bolts.
(b) Appreciable distortion of dislocation of any parts including mounting flange, poles, coils, brushes, and bearings.
(c) Failure under the tests of 4.8.11.4.2 to 4.8.11.4.4, inclusive.

4.9 Test reports. The contractor shall prepare test reports to be submitted to the procuring activity in accordance with the data ordering documents included in the contract or order (see 6.2.2) for the following.

(a) Quality conformance (see 4.4).
(b) Routine inspection (see 4.5).
(c) Vibration (see 4.8.10).
(d) Shock (see 4.8.11).

4.10 Repair parts. Each starter shall be tested in accordance with 4.8.1 through 4.8.11 as are applicable to that part. Nonconforming units shall be individually rejected.

4.11 Inspection of preparation for delivery. Preservation-packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.5.)

5.1 Preservation-packaging, packing and marking. Starters and repair parts thereto shall be preserved-packaged level A or C, packed level A, B or C as specified (see 6.2.1) and marked in accordance with MIL-P-16298.

5.2 Cushioning, dunnage and wrapping materials. Use of all types of loose-fill materials for applications such as cushioning, filler, stuffing and dunnage for material destined for shipboard use is prohibited. If cushioning is required, cellulosic material bound fiber, fiberboard, or transparent fexible cellular material shall be used.

6. NOTES

6.1 Intended use. The equipment covered by this specification is intended to provide a means of electrically starting internal combustion engines onboard ship.

6.2 Ordering data.

6.2.1 Procurement requirements. Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Type and class (see 1.2 and 3.5.19.2).
(c) Voltage (see 3.5.1.1).
(d) Standard type (see 3.5.1.1).
(e) Enclosure - spraytight or dripproof (see 3.5.7).
(f) When internal bearings for motors having gear reducers shall be ball bearings (see 3.5.11).
(g) Appropriate engine characteristics.
(h) Repair parts required (see 3.10).
(i) Level of packing, packaging, preserving and marking required (see 5.1).
(j) Grade of HI shock (see 3.5.20).

6.2.2 Data requirements. When this specification is used in a procurement which invokes the provision of the "Requirements for Data" of the Armed Services Procurement Regulations (ASPR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the ASPR are not invoked in a procurement, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

Paragraph	Data requirements	Applicable DID	Option
3.9.1	Drawings, Engineering and associated lists, level 2 (production prototype and limited production)	DI-E-7014	Design activity designation - by Contractor Drawing no. - by Contractor Delivery of hard copy and microfilm - Procuring activity
3.10	Provisioning parts list	DI-V-2078	4
4.9	Report, vibration	UDI-T-23762	------
4.9	Reports, equipment shock test	UDI-T-23753	------
4.9	Reports, test	DI-T-2072	------

(Copies of data item descriptions required by the contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Unless otherwise indicated the issue in effect on date of invitation for bid or request for proposal shall apply.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the procuring/purchasing activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item procured to this specification. This does not apply to specific data which may be required for each procurement regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 Class HI shock tests may be made in a laboratory or manufacturer's facility listed in NAVSEAINST 9491.1.

6.4 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as to those bidders offering a product which has been previously procured or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending procurement.

6.5 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are procured by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.6 Changes from previous issue. The symbol "#" is not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 2920-N358)

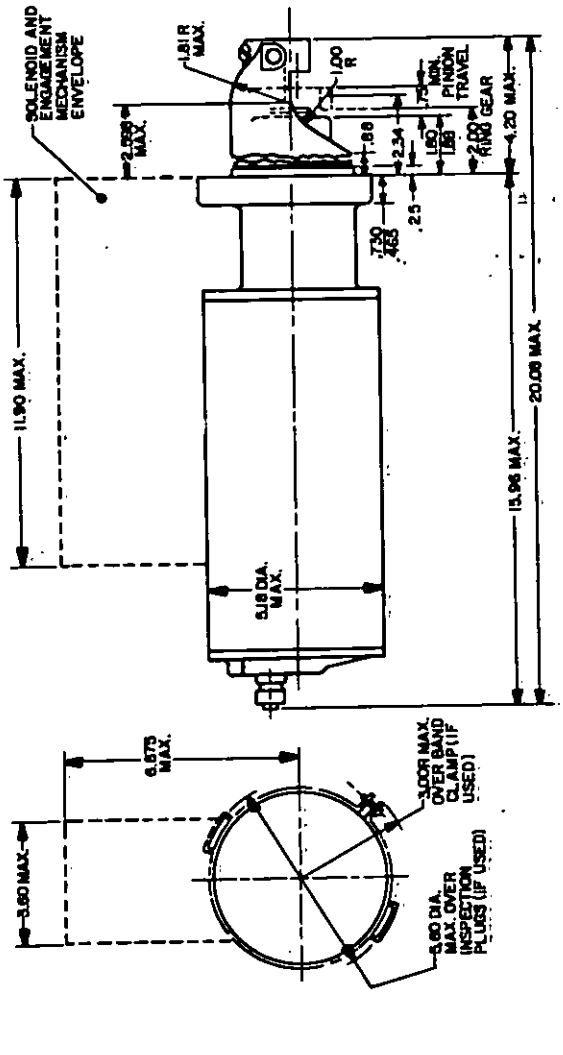
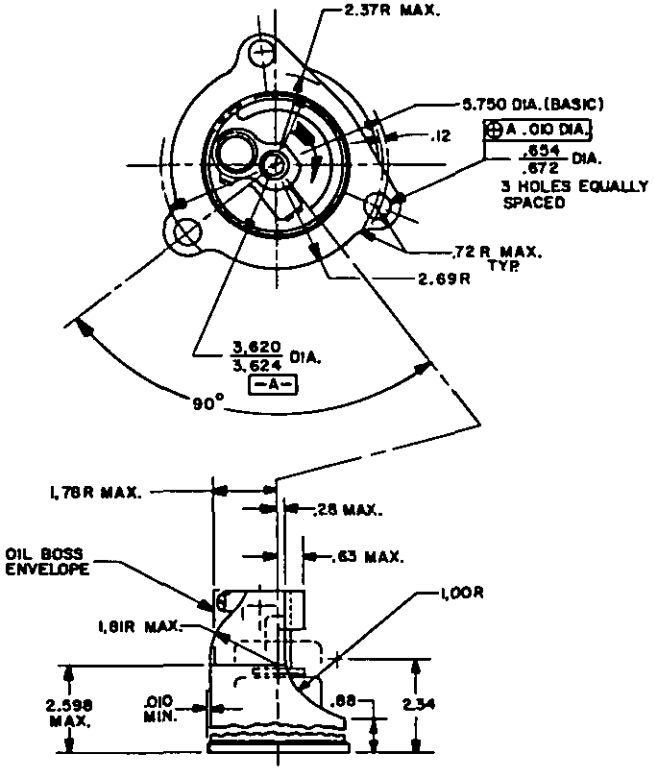


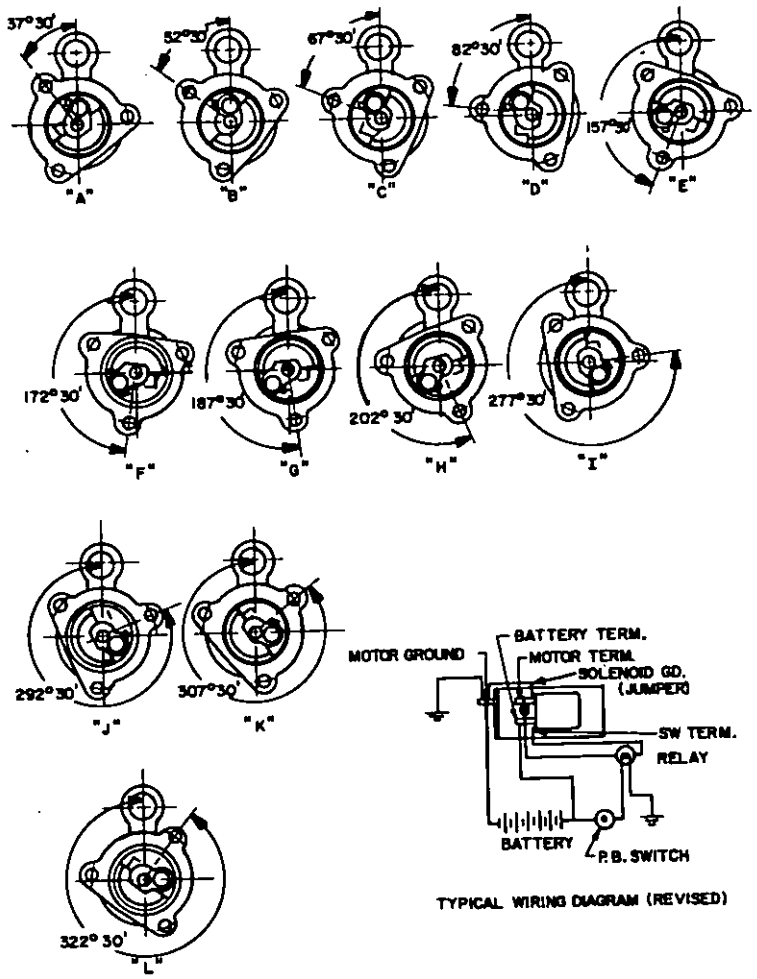
FIGURE 1 SHEET 1. Class 1 starter, Navy types A and B.

SH11213



SH11214

FIGURE 1 SHEET 2. Class 1 starter, Navy types A and B.

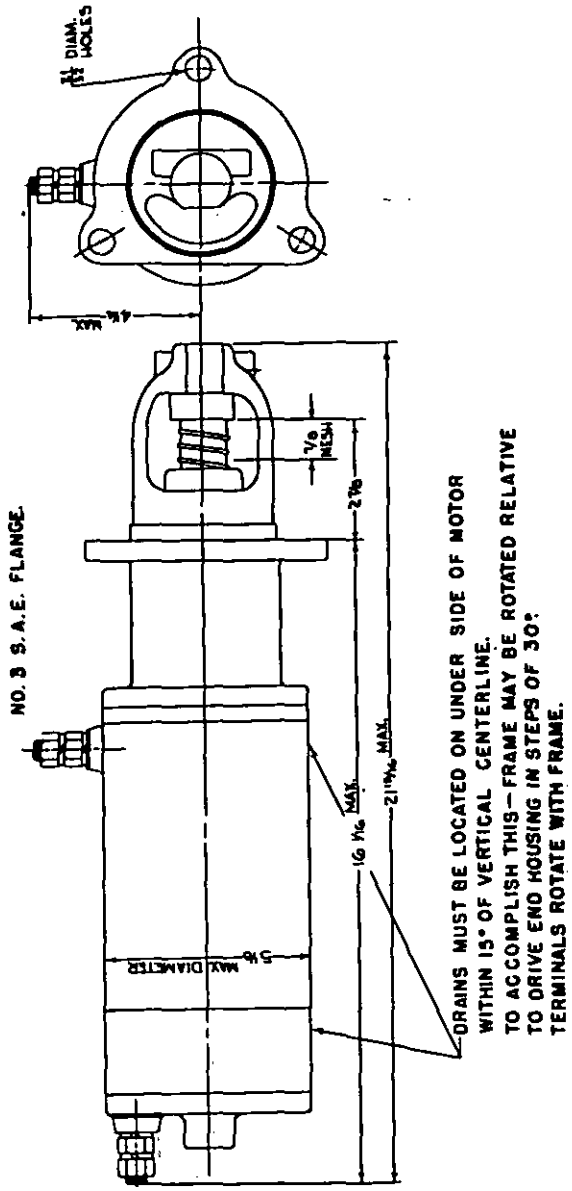


TYPICAL WIRING DIAGRAM (REVISED)

SH11215

MOUNTING FLANGE AND PINION HOUSING SHALL BE ADJUSTABLE TO ALL POSITIONS SHOWN HEREON. MOUNTING POSITIONS VIEWING DRIVE END OF MOTOR.

FIGURE 1 SHEET 3. Class 1 starter, Navy Types A and B.



SH11216

FIGURE 1 SHEET 4. Class 2 starter, Navy types A and B.

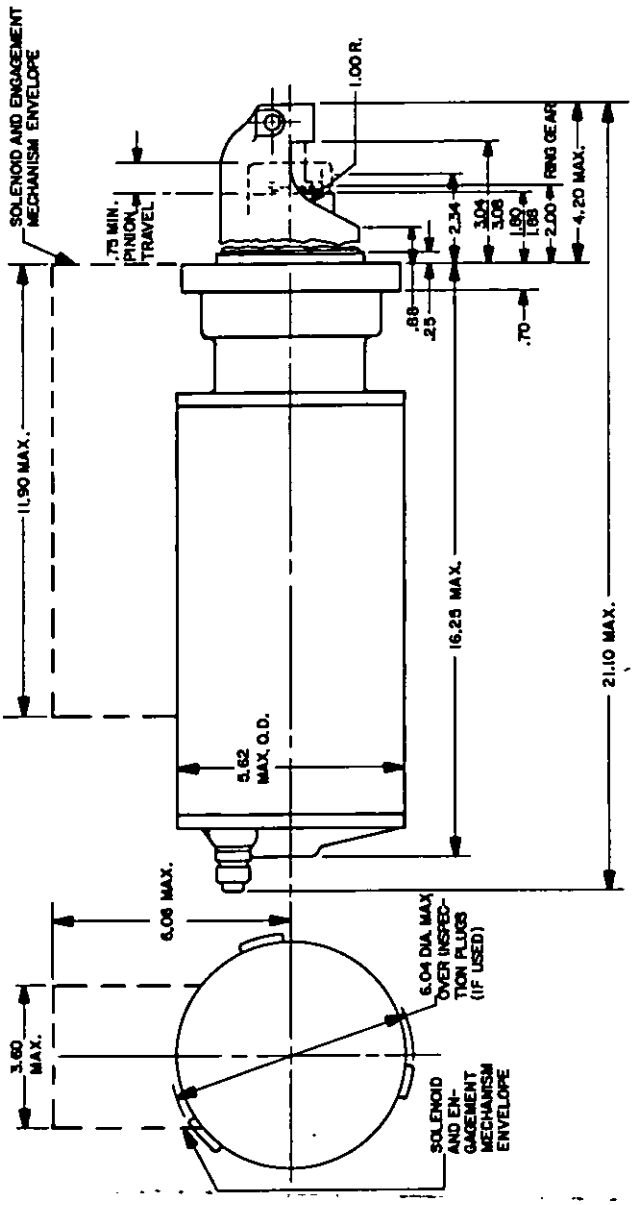


FIGURE 2 SHEET 1. Class 1 starter, Navy type C.

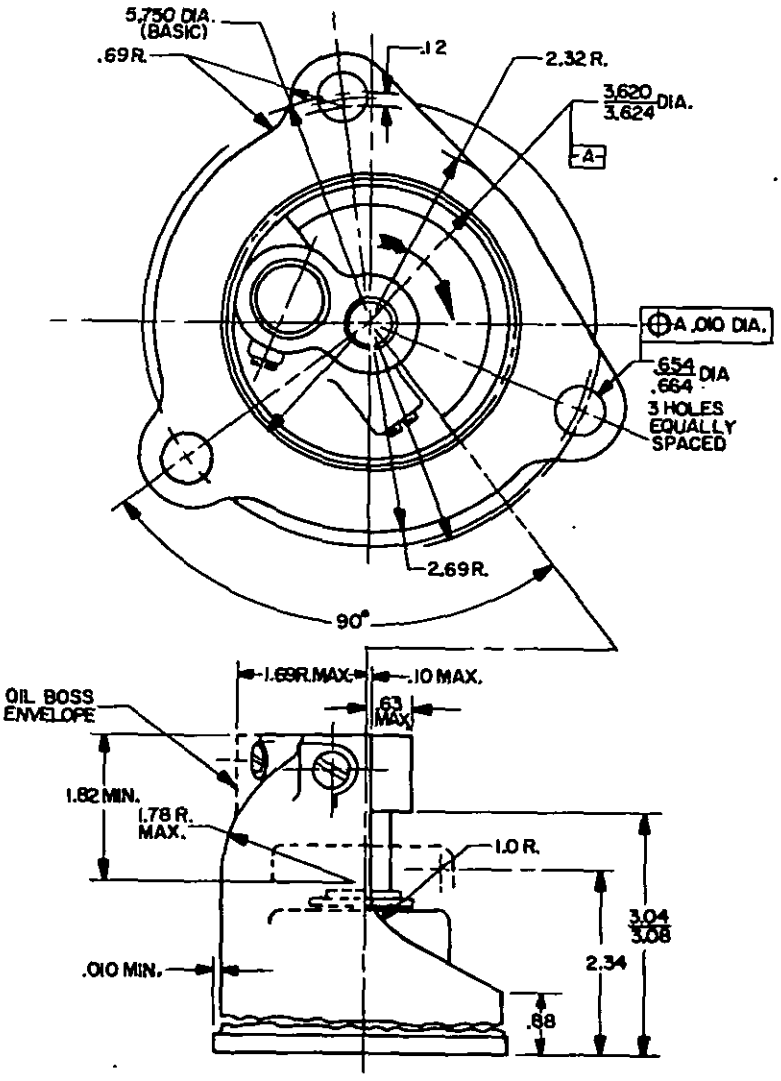
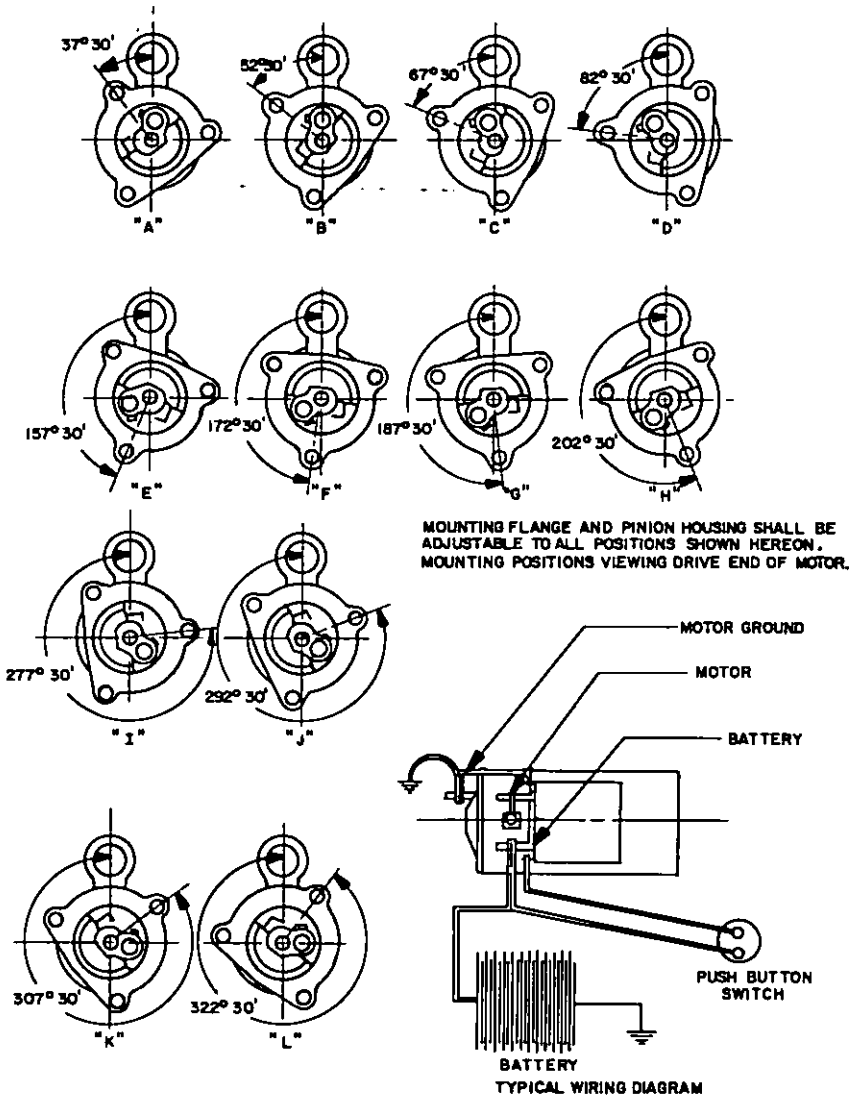


FIGURE 2 SHEET 2. Class 1 starter, Navy type C.



SH11219

FIGURE 2 SHEET 3. Class 1 starter, Navy type C.

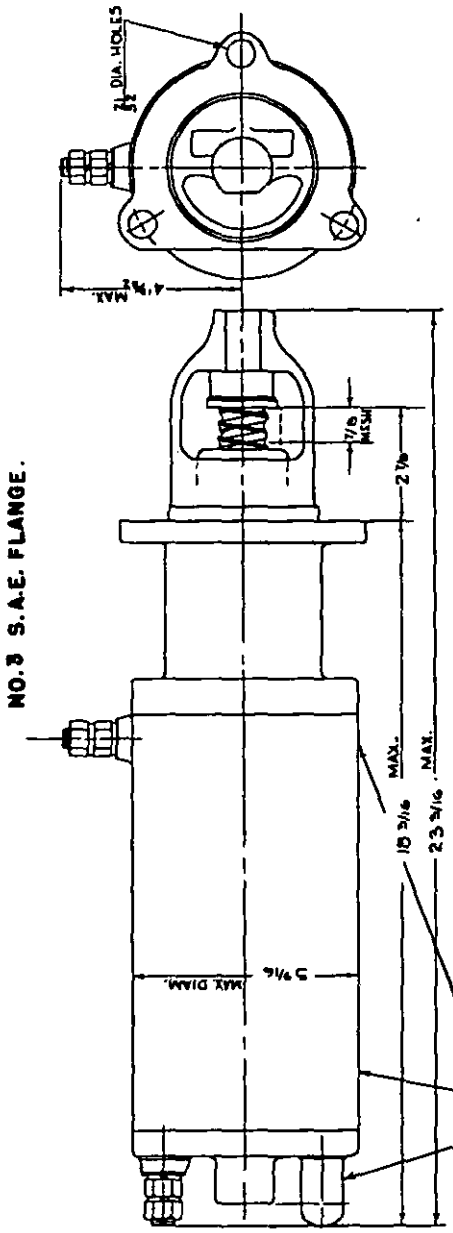


FIGURE 2 SHEET 4. Class 2 starter, Navy type C.

SH11222

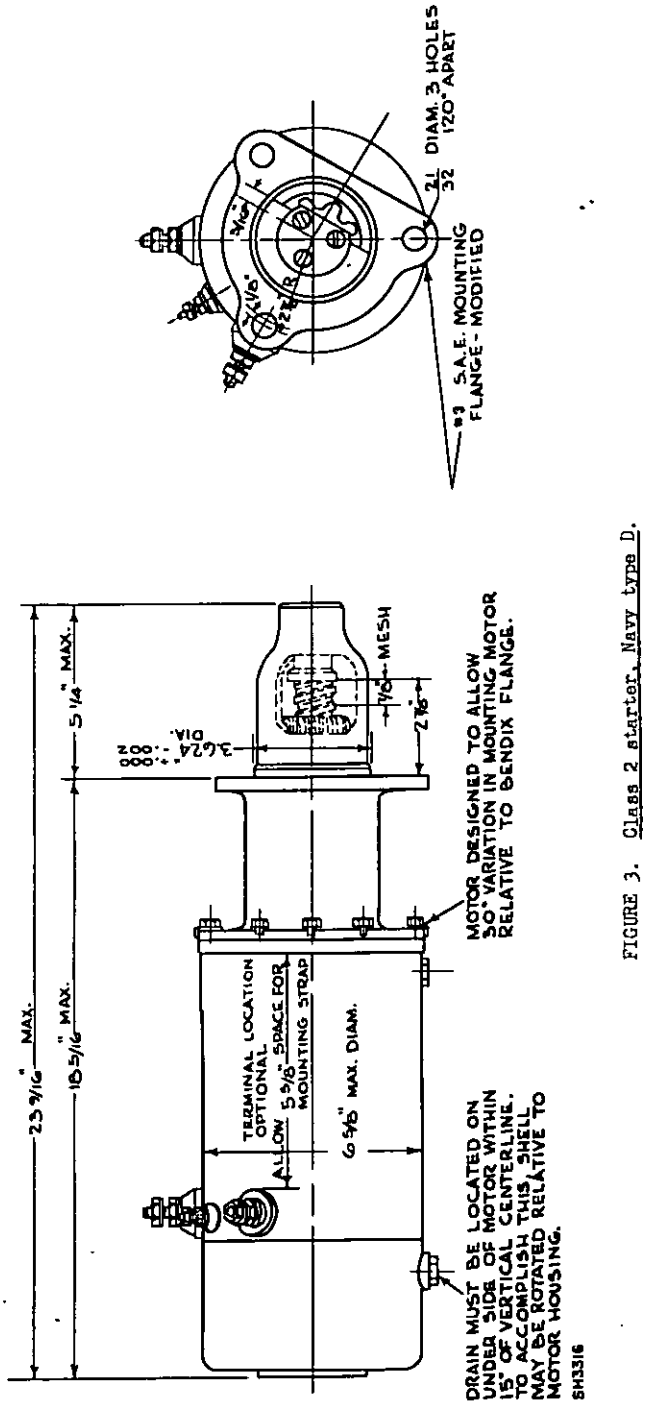


FIGURE 3. Class 2 starter, Navy type D.

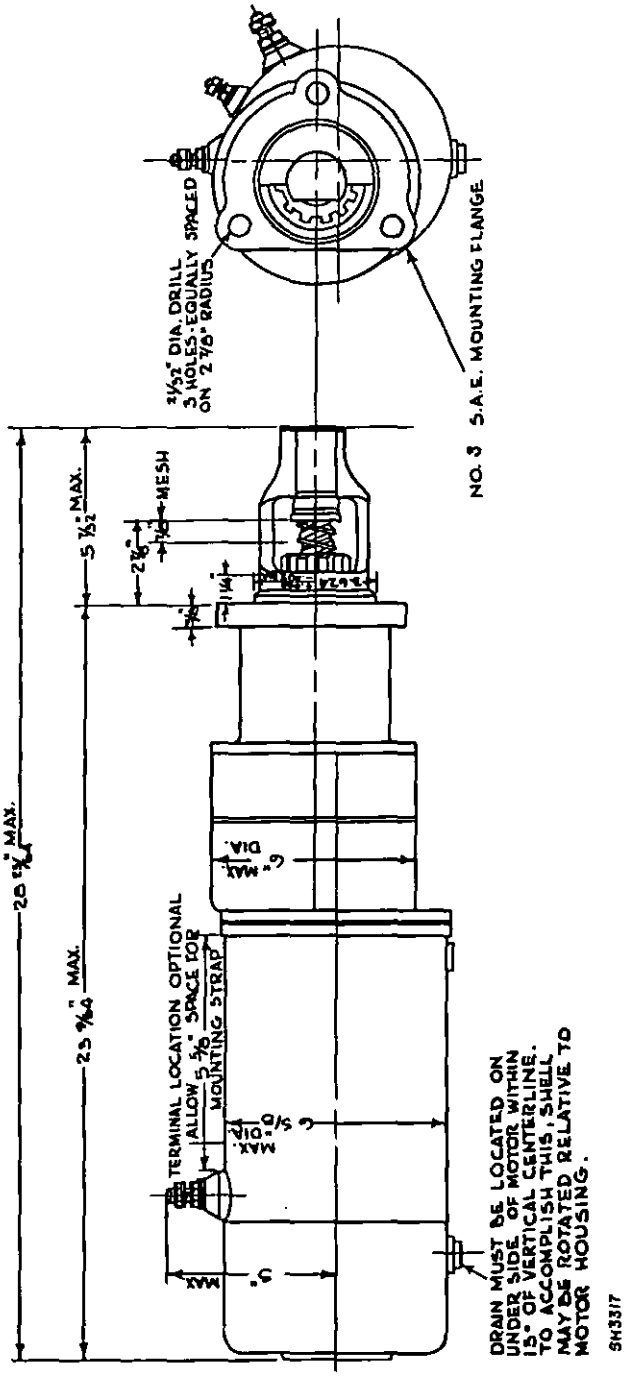
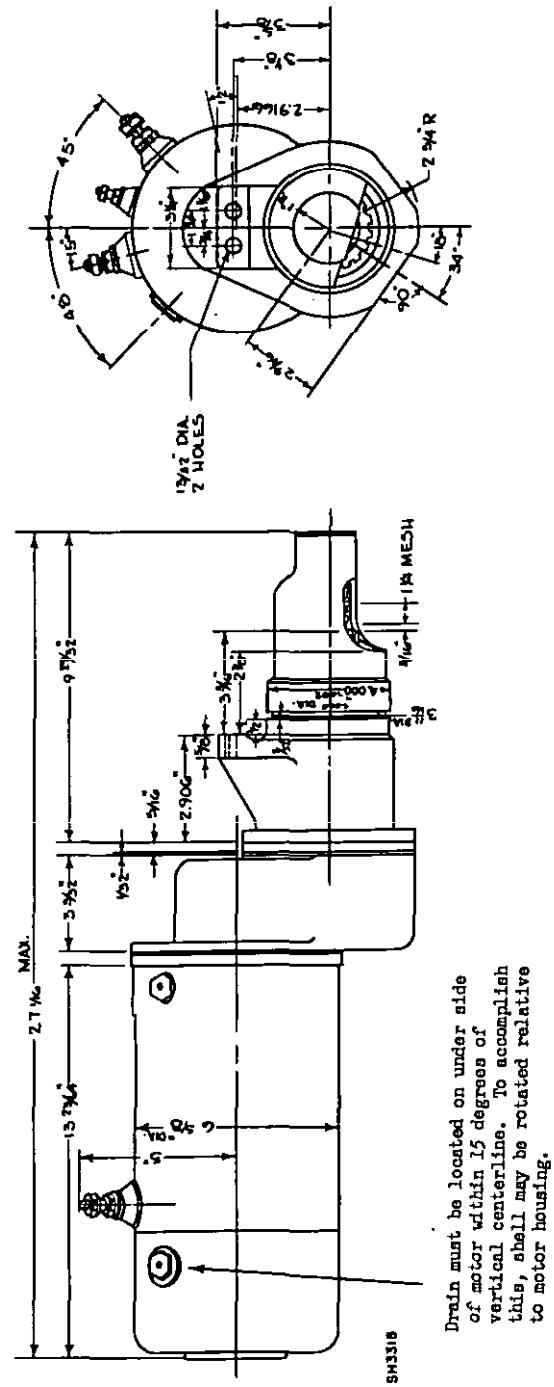


FIGURE 4. Class 2 starter, Navy type E.



Drain must be located on under side of motor within 15 degrees of vertical centerline. To accomplish this, shell may be rotated relative to motor housing.

FIGURE 5. Class 2 starter, Navy type F.

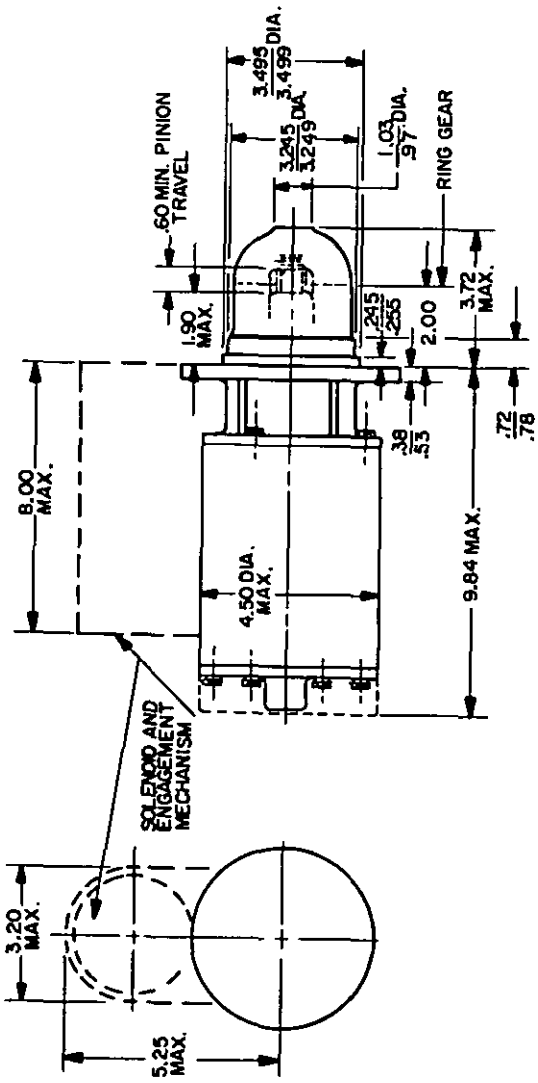
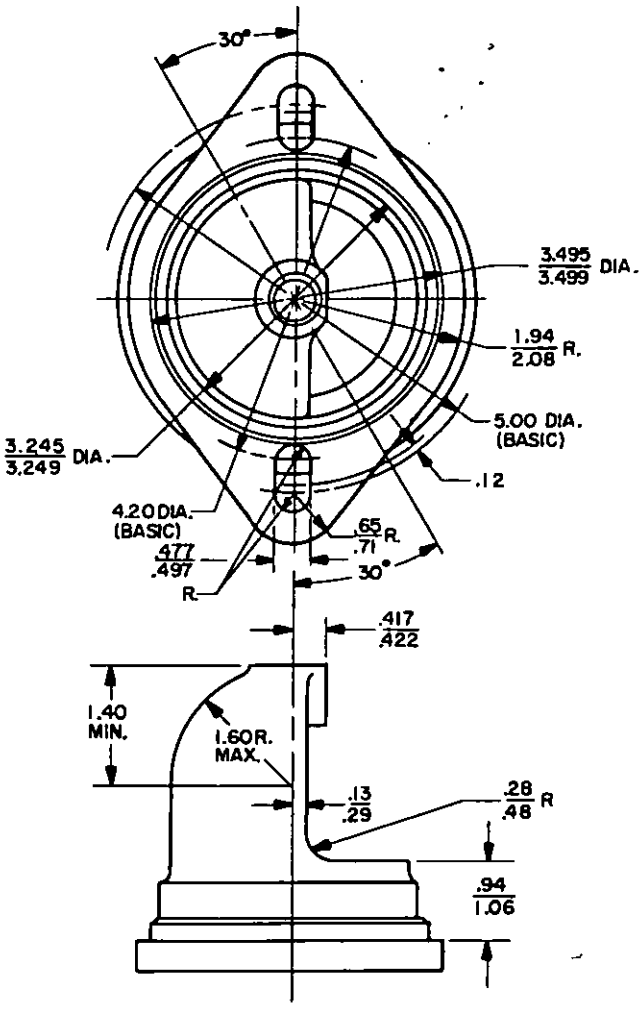


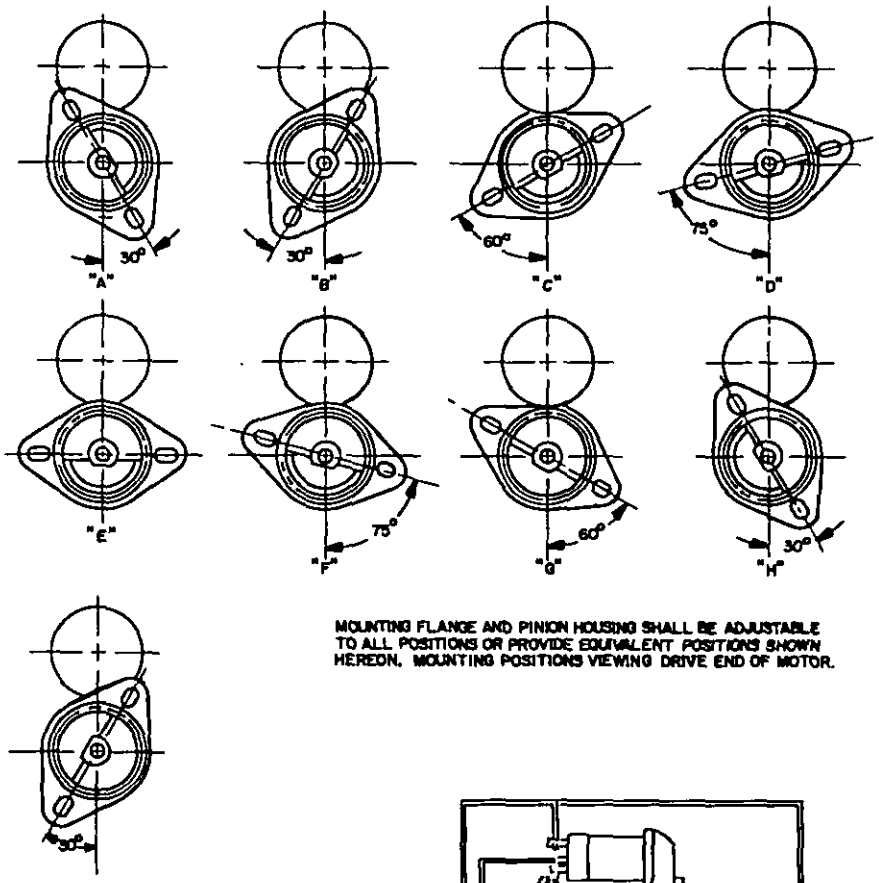
FIGURE 6 SHEET 1. Class 1 starter, similar to Navy type AA.

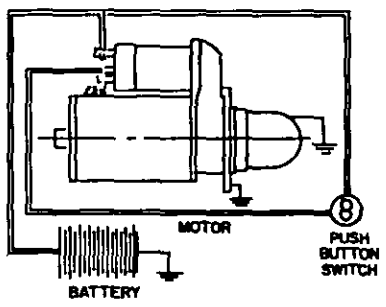


SH11222

SPECIAL FLANGE MOUNTING

FIGURE 6 SHEET 2. Class 1 starter, similar to Navy type AA.





SH11223

FIGURE 6 SHEET 3. Class 1 starter, similar to Navy type AA.

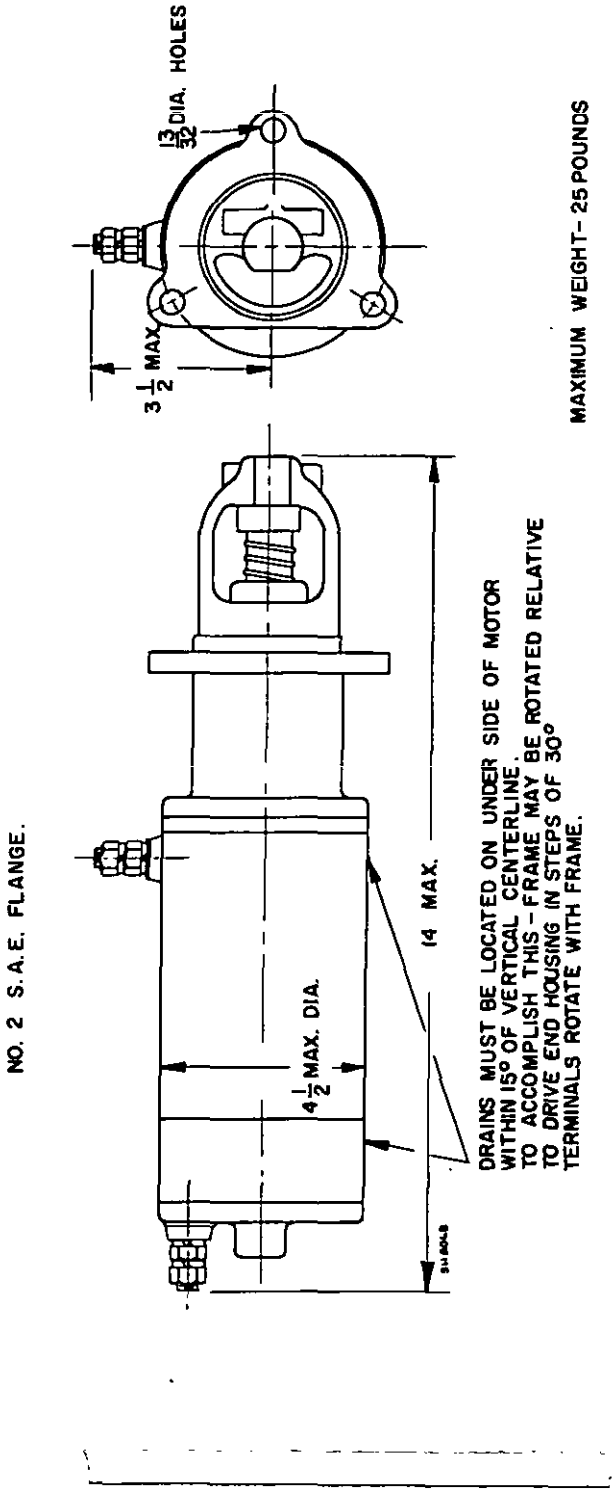


FIGURE 6 SHEET 4. Class 2 starter, Navy type AA.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

INSTRUCTIONS: The purpose of this form is to *solicit beneficial comments* which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document. DoD contractors, government activities, or manufacturers/ vendors who are prospective suppliers of the product are invited to submit comments to the government. *Fold on lines on reverse side, staple in corner,* and send to preparing activity. Comments submitted on this form do not constitute or imply authorization to waive any *portion* of the referenced document(s) or to amend contractual requirements. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to *form* and place both in an envelope addressed to preparing activity.

DOCUMENT IDENTIFIER AND TITLE

NAME OF ORGANIZATION AND ADDRESS

CONTRACT *NUMBER*

MATERIAL *PROCURED UNDER A*

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN *PROCUREMENT* USE?
   A. GIVE PARAGRAPH *NUMBER AND WORDING.*

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT *REQUIREMENT* CONSIDERED TOO RIGID

3. IS THE DOCUMENT RESTRICTIVE?

   ☐ YES ☐ NO *(If "Yes", in what way?)*

4. REMARKS

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REPLACES EDITION OF 1 JAN 66 WHICH MAY BE USED

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