SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS4167

REV. A

Issued 1988-09
Revised 1993-03
Reaffirmed 2004-01

Wrenches; Flare Nut, Crowfoot, 12-Point Nondistorting

1. SCOPE:

1.1 This SAE Aerospace Standard (AS) covers 12-point open box end crowfoot, flare nut, double open box end, combination box and open box end, and ratcheting open box end wrenches that are designed with the following requirements:

a. Nondistorting usage

b. Possessing the strength, clearances, and internal wrenching design to be used on hydraulic tube fittings that conform to the requirements of SAE J514.

c. Transmitting torque to tube fittings without bearing on the apex of fitting wrenching points.

Inclusion of dimensional data in this document is not intended to imply that all of the products described herein are stock production sizes. Consumers are requested to consult with manufacturers concerning lists of stock production sizes.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other documents shall be the issue in effect on the date of the purchase order.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 4118	Aluminum Alloy Bars, Rods, and Wire, Rolled or Cold Finish 4.0Cu - 0.70Mn - 0.60Mg - 0.50Si - (2017; -T4, T451) Solution Heat Treated
AS478	Identification Marking Methods
J514	Hydraulic Tube Fittings

2.1.2 ASME Publications: Available from The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

B46.1	Surface Texture
B107.4	Driving and Spindle Ends for Portable, Hand, Air, and Electric Tools
B107.6	Wrenches, Box, Open End, Combination, and Flare Nut (Inch Series)
B107.17M	Gages, Wrench Openings

2.1.3 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 4	Load Verification of Testing Machines
ASTM E 18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials, Standard Method of Test for
ASTM B 487	Measurement of Metal and Oxide Coating Thickness Examination of a Cross Section
ASTM B 499	Measurement of Coating Thickness by the Magnetic Method, Standard Test Method for
ASTM B 504	Measurement of Thickness of Metallic Coating by the Coulometric Method, Standard Test Method for
ASTM B 530	Measurement of Coating Thickness by the Magnetic Method: Electrodeposited Nickel Coating on Magnetic and Nonmagnetic Substrates, Standard Test Method for
ASTM B 568	Measurement of Coating Thickness by X-ray Spectrometry, Standard Test Method for
ASTM B 571	Adhesion of Metallic Coatings, Standard Test Methods for
ASTM A 754	Coating Thickness by X-ray Fluorescence, Standard Test Method for
ASTM B 748	Measurement of Thickness of Metallic Coating by Measurement of Cross Section with a Scanning Electron Microscope, Standard Test Method for

3. CLASSIFICATION:

3.1 This document covers a limited number of wrench opening sizes, as required, to accommodate the needs of SAE J514 and for wrench types that are commercially available in accordance with the requirements of this document.

3.2 Wrenches shall be of the following types, classes, styles, and designs. See Section 5.

3.2.1 Type I wrenches shall have a protective nickel-chromium finish in accordance with 4.8.2.

3.2.1.1 Class 1 - Crowfoot, Open Box End

a. Style A - 1/4 square drive
b. Style B - 3/8 square drive
c. Style C - 1/2 square drive
   (1) Design (a) - offset box
   (2) Design (b) - thin box

3.2.1.2 Class 2 - Flare Nut

a. Style A - double open box ends
   (1) Design (a) - straight heads
   (2) Design (b) - 15x heads
b. Style B - combination box and open box end
c. Style C - combination open end and open box end

3.2.2 Type II wrenches shall be a protective black oxide or phosphate finish in accordance with 4.8.3.

3.2.2.1 Class 1 - Crowfoot, Open Box End

a. Style A - 1/4 square drive
b. Style B - 3/8 square drive
c. Style C - 1/2 square drive
   (1) Design (a) - offset box
   (2) Design (b) - thin box

3.2.2.2 Class 2 - Flare Nut

a. Style A - double open box ends
   (1) Design (a) - straight heads
   (2) Design (b) - 15x heads
b. Style B - combination box and open box end
c. Style C - combination open end and open box end
d. Style D - single open box end
e. Style E - ratcheting open box end

4. REQUIREMENTS:

4.1 Illustrations:

4.1.1 The illustrations shown are descriptive and not restrictive, and are included for the convenience of requisitioning and purchasing officers. They are not intended to preclude the purchase of wrenches that are otherwise in accordance with this document.

4.2 Materials:

4.2.1 Unless otherwise specified, the materials used in the manufacture of wrenches shall be steel. The chemical composition and heat treatment shall be such as to produce wrenches conforming to the physical requirements specified. Powder metal or cast steel shall not be used.

4.3 Marking:

4.3.1 The wrenches shall be marked in a permanent manner with the country of origin and manufacturer's name or with a trademark so that the source of manufacture may be readily determined. In addition, the wrenches shall be marked in a permanent manner with the nominal opening size. Marking requirements shall be in accordance with AS478.

4.4 Female Drive Opening:

4.4.1 Female drive-opening dimensions for Class 1 wrenches shall conform to ANSI B107.4, except as noted in 4.4.1.1 or 4.4.1.2. The openings shall be broached or punched in a smooth and well-defined manner. Two sides of the opening shall be parallel to the longitudinal axis of wrench within ±3°.

4.4.1.1 All four faces of the female drive opening shall be recessed so that one of the recesses engages the spring-loaded steel ball on the corresponding male drive. If the length of engagement of the male tang is less than twice the dimension of Df in Table 9 of ANSI B107.4, the recess shall be central in the corresponding female drive opening within 0.010.

4.4.1.2 One or more of the faces of the female drive opening shall be drilled with a cross hole to engage the spring loaded steel ball on the corresponding male drive. If the length of engagement of the male tang is less than twice the dimension of Df in Table 9 of ANSI B107.4, the hole shall be centered within 0.010 in the corresponding female drive opening.

4.5 Edges and Corners:

4.5.1 All edges and sharp corners, capable of causing injury, not otherwise covered herein, shall have sharp edges removed by rounding, chamfering, or other means.

4.6 Internal Wrenching Configuration:

4.6.1 The internal 12-point wrenching configuration surfaces shall conform to Figure 1 and be finished in a smooth and well-defined manner (not smeared or torn). These openings, except for Style E wrenches, shall be chamfered on both sides to provide a lead-in for the working surfaces.

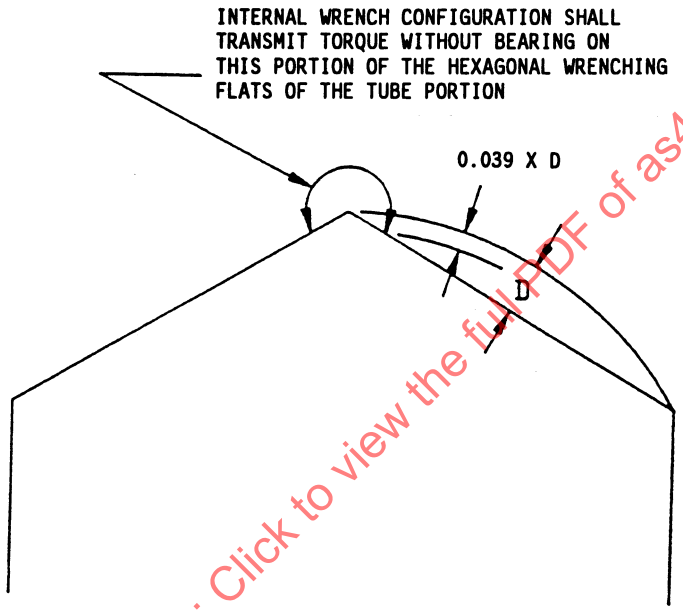


FIGURE 1 - Internal Wrench Engagement

4.6.2 Tolerance for box end, open box end, or both, openings shall be such as to ensure acceptance when gaged in accordance with requirements of ANSI B107.17M.

4.7 Hardness:

4.7.1 Unless otherwise specified, wrenches shall be hardened throughout to a Rockwell hardness of not less than 40 Rc nor more than 54 Rc. When grinding is necessary to prepare the test surface, the amount removed must not exceed 0.007 in on the surface contacted by the indentor. Hardness definitions, nomenclature, and procedures used can be found in ASTM E 18.

4.8 Surface Finish:

4.8.1 All surfaces shall be thoroughly cleaned, free from cracks, and essentially free from burrs, pits, nodules, and other detrimental defects. Areas ground, buffed, or finished by an equivalent method shall have a bright finish with a maximum surface roughness of 32 µin for Type I wrenches and a maximum surface roughness of 64 µin for Type II wrenches. Surfaces not ground or buffed shall have a surface conforming to good commercial practice and the surface roughness shall not exceed 250 µin.

4.8.1.1 Forge flash shall be removed from the periphery of the drive end for a minimum of 180° (90° on each side of the centerline of slotted openings on open box end(s) or longitudinal axis, or both, of the wrench on box end(s)) on the periphery of box and/or open box end, or both, portions of the wrench. Any remaining surfaces between the wrench end(s) shall blend smoothly with adjacent surfaces. External sharp edges shall be broken to a 0.015 in radius minimum, and shall not project more than 0.015 in from adjacent surfaces.

4.8.2 Nickel chromium plating on Type I wrenches shall be adherent, smooth, continuous, and free from pits, blisters, nodules, and any other defects that will interfere with their protective value and serviceability. Visible contact marks resulting from electroplating operations shall be confined to the interior of the wrenching and drive openings. The minimum thickness shall be 0.0002 in for nickel and 0.000007 in for chromium. One measurement of the nickel and one measurement of the chromium shall be made in each of the areas as specified in the applicable figure using one of the applicable ASTM Standards listed in 2.1.2. Plating adhesion shall be capable of withstanding the test specified in ASTM B 571 using one of the following methods:

a. Grind-Saw
b. Push
c. File
d. Burnishing

4.8.3 Black oxide or phosphate coating on Type II wrenches shall be a chemically produced oxide or phosphate coating followed with a coating of rust preventive oil.

4.9 Tests:

4.9.1 The load tests required herein are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting these tests.

4.9.2 Microinch measurements shall be made with a surface-measuring instrument using a 0.03 in roughness width cutoff. All surface roughness values shall be rated as arithmetical averages. Definitions and nomenclature used can be found in ANSI/ASME B46.1.

4.9.3 All wrenches shall be capable of meeting the aluminum mandrel test, as specified in the applicable tables, when performed in accordance with the following procedures. In addition, the box end on Class 2, Style B wrenches and the open end on Class 2, Style C wrenches shall achieve the applicable torque loads as specified in ANSI B107.6 for Type III wrenches.

4.9.3.1 Aluminum Mandrel Test: The open box end(s) on wrenches shall achieve the torque loads in Table 1 when subjected to the following: Mandrels constructed from aluminum, conforming to AMS 4118 and to Figure 2, shall be used. The wrench shall be placed on the mandrel and located centrally to the 0.140 in-long portion of the mandrel. See Figures 2 and 3. Care shall be exercised to maintain the face of the wrench parallel to the face of the mandrel during the test. Force shall be applied to the wrench to transmit the required test load between the wrench and torque tester. See Figure 2. This shall be done a total of three times on each mandrel, rotating the wrench 30° to the next gripping position of the wrench after each torque cycle. If the corners of the mandrel are deformed so that the test load values cannot be met, the wrench shall not comply with these requirements.

TABLE 1 - Aluminum Mandrel Test

Nominal Wrench Size (in) A		Torque Load (in-lb)	Nominal Wrench Size (in) A		Torque Load (in-lb)
3/8	(0.3750)	180	1 7/16	(1.4375)	1890
7/16	(0.4375)	260	1 1/2	(1.5000)	2025
1/2	(0.5000)	320	1 9/16	(1.5625)	2230
9/16	(0.5625)	380	1 5/8	(1.6250)	2430
5/8	(0.6250)	450	1 11/16	(1.6875)	2600
11/16	(0.6875)	560	1 3/4	(1.7500)	2850
3/4	(0.7500)	675	1 13/16	(1.8125)	2990
13/16	(0.8125)	775	1 7/8	(1.8750)	3400
7/8	(0.8750)	850	1 15/16	(1.9375)	3950
15/16	(0.9375)	960	2	(2.0000)	4500
1	(1.0000)	1050	2 1/8	(2.1250)	4500
1 1/16	(1.0625)	1175	2 1/4	(2.2502)	4500
1 1/8	(1.1250)	1300	2 3/8	(2.3750)	4500
1 3/16	(1.1875)	1410	2 5/8	(2.6250)	4500
1 1/4	(1.2500)	1525	2 3/4	(2.7500)	4500
1 5/16	(1.3125)	1640	2 7/8	(2.8750)	4500
1 3/8	(1.3750)	1750			

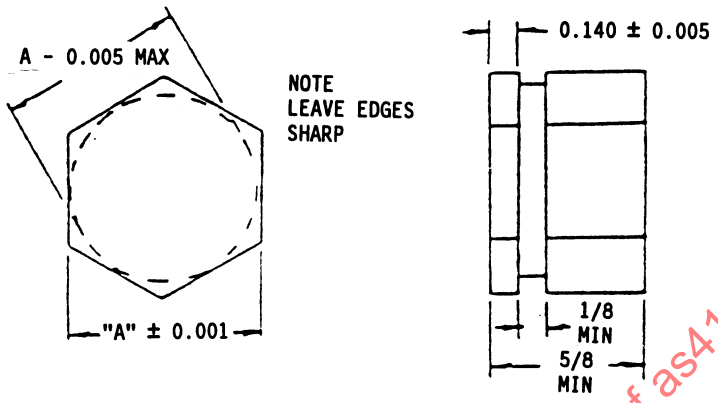


FIGURE 2 - Specimen for Aluminum Mandrel Test

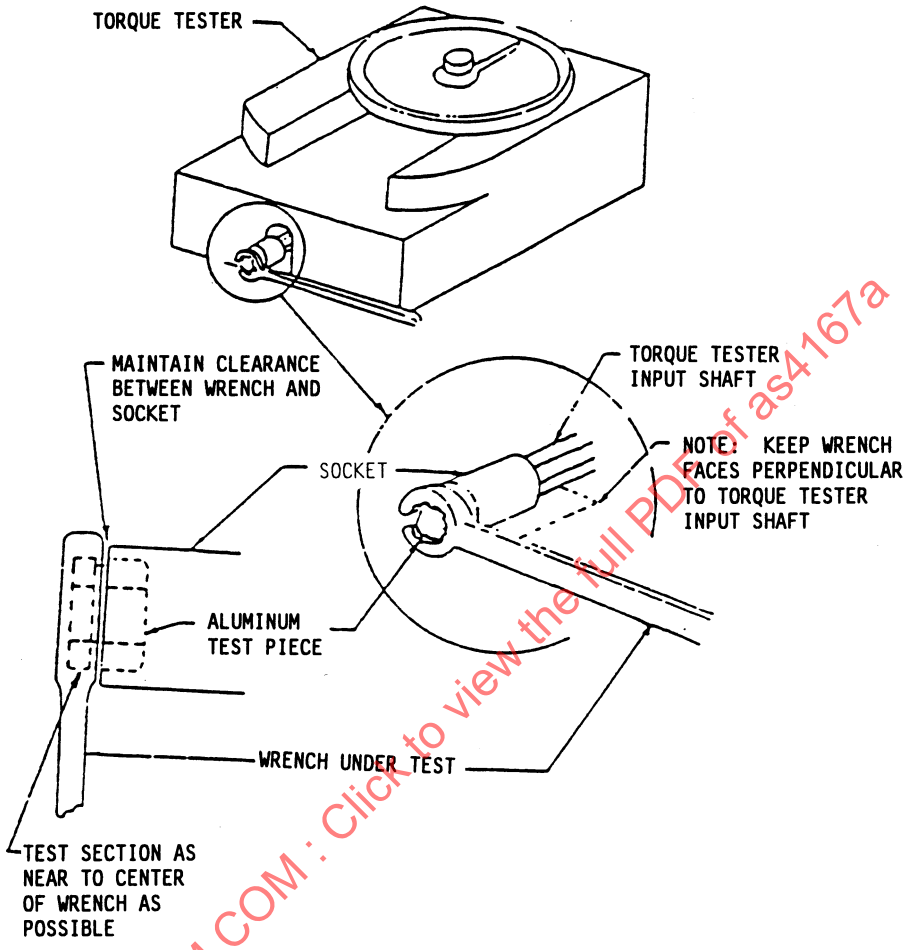


FIGURE 3 - Typical Test Setup for Aluminum Mandrel Test

4.9.4 Qualification Test: As a design and process qualification test the manufacturer shall maintain a record of compliance with the tube fitting distortion test of 4.9.4.1 for the open box end(s) of a sample tool. The test shall be required whenever the design or method of manufacture is significantly changed.

4.9.4.1 Tube Fitting Distortion Test: The open box end(s) on wrenches shall achieve the torque loads in Table 2 when subjected to the following: Place a socket of the same size as the open box end to be tested on a torque tester. See Figure 4. Insert into the socket the corresponding size Style "B" nut conforming to the requirements of SAE J514. A Class 2B, go and no-go thread gage shall be used. If the no-go end of the gage enters into the nut, it shall not bottom. The nut should be free of imperfections, and the go gage should turn freely the full length of the fitting. A light oil should be used on the threads for this test to minimize thread variables.

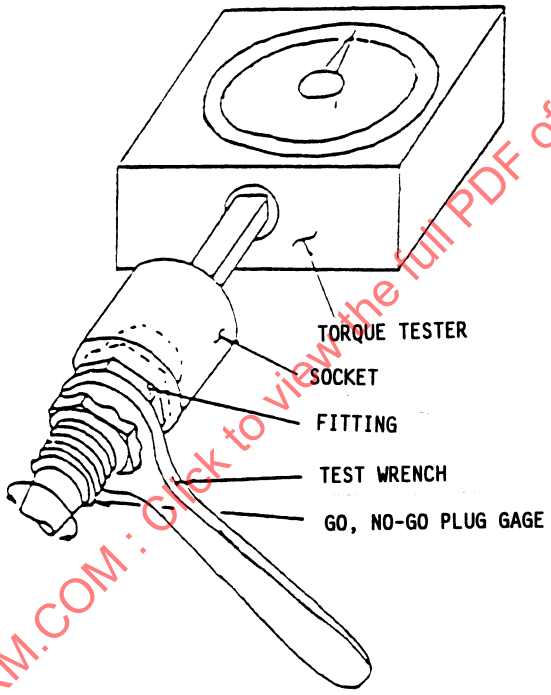


FIGURE 4 - Test Setup for Tube Fitting Distortion Test

4.9.4.1 (Continued):

After threading the gage to the bottom of the nut, the gage should be backed up one full turn. The wrench should be placed on the fitting with the center of the wrench as near to the center of the fitting as possible by inserting the nut only as far into the socket as is necessary to hold it securely when the torque is applied to it (approximately 1/8 in). The wrench shall then be brought up to one half the torque load specified for the wrench. This shall be done three times at one-half torque, rotating the wrench 30° to the next gripping position of the wrench, after each single torque cycle. (In the case of Style E wrenches, this shall be to the next ratcheting position.) Then while constantly rotating the thread gage by hand, clockwise and counterclockwise, through a short arc (1/16 to 1/8 turn), sufficiently to keep the gage in motion, the wrench should be brought up to the torque where the gage can no longer be turned by hand. This procedure should be repeated a total of six times, rotating the wrench 30° to the next gripping position of the wrench after each single torque cycle, as before. The three lowest torque readings, at which the thread gage can no longer be turned by hand, shall be averaged. This value shall be no lower than the values specified in Table 2.

TABLE 2 - Tube Fitting Distortion Test

Nominal Wrench Size (in)	Torque Load (in-lb)	Nominal Wrench Size (in)	Torque Load (in-lb)
3/8	240	11/16	410
7/16	250	7/8	600
9/16	330	1	720
5/8	360		

5. DESIGNATIONS:

5.1 Wrenches shall be designated by the following data in the sequence shown:

a. Type
b. Class
c. Style
d. Design, if applicable
e. Size

EXAMPLE: Type I, Class 1, Style B, Design (a), 5/8 in opening would be a chromium plated open box end crowfoot with a 3/8 in square drive and an offset box end having a 5/8 in internal wrenching configuration.

6. CLASSIFICATION DESCRIPTIONS:

6.1 Type I and II, Class 1, Design (a) and (b) wrenches shall be of the open box end crowfoot design having a female drive opening at one end and a slotted internal wrenching configuration at the other end.

6.1.1 Design (a) wrenches shall be similar to Figure 5 and conform to requirements of Table 3. The slotted portion of the internal wrenching configuration may be rotated up to 35° from wrench centerline.

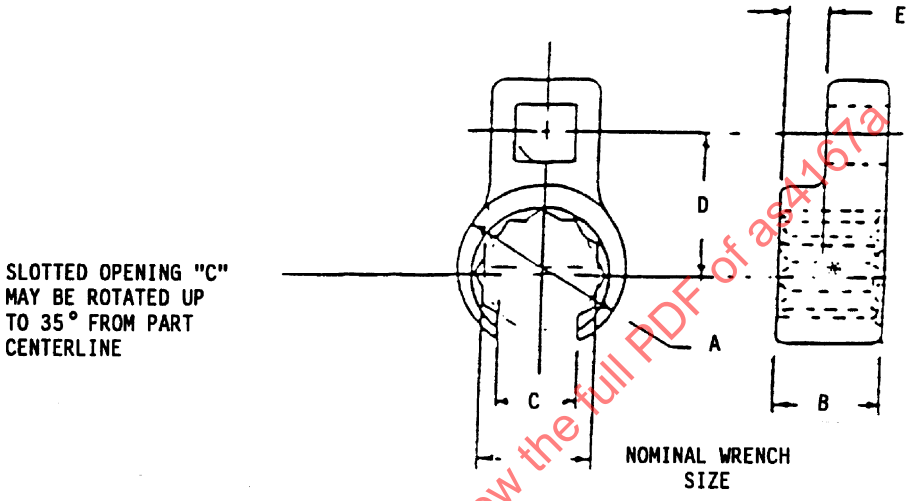


FIGURE 5 - Type I and II, Class 1, Style A, B, and C, Design (a) Open Box End Crowfoot

TABLE 3 - Type I and II, Class 1, Style A, B, and C,
Design (a) Crowfoot, Offset Box End

Nominal Wrench Size (in)	Style (Drive Size) (in)	Box End Diameter Max (in) A	Box End Thickness Max (in) B	Slotted Opening Min (in) C	Torque Center ±0.035 (in) D	Offset Min (in) E
3/8	A (1/4 Sq. Dr.)	0.625	0.531	0.193	0.500	0.156
7/16	A (1/4 Sq. Dr.)	0.719	0.594	0.255	0.547	0.219
1/2	A (1/4 Sq. Dr.)	0.813	0.594	0.317	0.594	0.219
9/16	A (1/4 Sq. Dr.)	0.875	0.594	0.343	0.625	0.219
5/8	B (3/8 Sq. Dr.)	0.984	0.750	0.406	0.719	0.280
11/16	B (3/8 Sq. Dr.)	1.078	0.750	0.442	0.766	0.280
3/4	B (3/8 Sq. Dr.)	1.172	0.781	0.442	0.813	0.313
13/16	B (3/8 Sq. Dr.)	1.250	0.781	0.531	0.859	0.313
7/8	B (3/8 Sq. Dr.)	1.344	0.813	0.531	0.925	0.344
15/16	B (3/8 Sq. Dr.)	1.422	0.813	0.578	0.954	0.344
1	B (3/8 Sq. Dr.)	1.500	0.844	0.656	1.000	0.344
1 1/16	B (3/8 Sq. Dr.)	1.578	0.844	0.755	1.032	0.344
1 1/8	C (1/2 Sq. Dr.)	1.688	0.938	0.755	1.140	0.344
1 3/16	C (1/2 Sq. Dr.)	1.763	0.938	0.755	1.188	0.344
1 1/4	C (1/2 Sq. Dr.)	1.844	0.938	0.890	1.219	0.344
1 5/16	C (1/2 Sq. Dr.)	1.906	1.000	0.890	1.265	0.344
1 3/8	C (1/2 Sq. Dr.)	2.000	1.000	1.015	1.297	0.407
1 7/16	C (1/2 Sq. Dr.)	2.062	1.063	1.015	1.328	0.407
1 1/2	C (1/2 Sq. Dr.)	2.125	1.063	1.015	1.360	0.407
1 9/16	C (1/2 Sq. Dr.)	2.203	1.063	1.015	1.406	0.407
1 5/8	C (1/2 Sq. Dr.)	2.281	1.063	1.130	1.469	0.407
1 11/16	C (1/2 Sq. Dr.)	2.375	1.063	1.265	1.515	0.469
1 3/4	C (1/2 Sq. Dr.)	2.438	1.063	1.265	1.531	0.469
1 13/16	C (1/2 Sq. Dr.)	2.529	1.063	1.265	1.578	0.469
1 7/8	C (1/2 Sq. Dr.)	2.625	1.125	1.265	1.625	0.530
2	C (1/2 Sq. Dr.)	2.781	1.125	1.515	1.703	0.530
2 1/8	C (1/2 Sq. Dr.)	2.904	1.188	1.515	1.812	0.590
2 1/4	C (1/2 Sq. Dr.)	3.094	1.188	1.515	1.875	0.590
2 3/8	C (1/2 Sq. Dr.)	3.250	1.250	1.630	1.969	0.657
2 5/8	C (1/2 Sq. Dr.)	3.562	1.312	2.015	2.125	0.719
2 3/4	C (1/2 Sq. Dr.)	3.719	1.312	2.015	2.219	0.719

6.1.2 Design (b) wrenches shall be similar to Figure 6 and conform to requirements of Table 4.

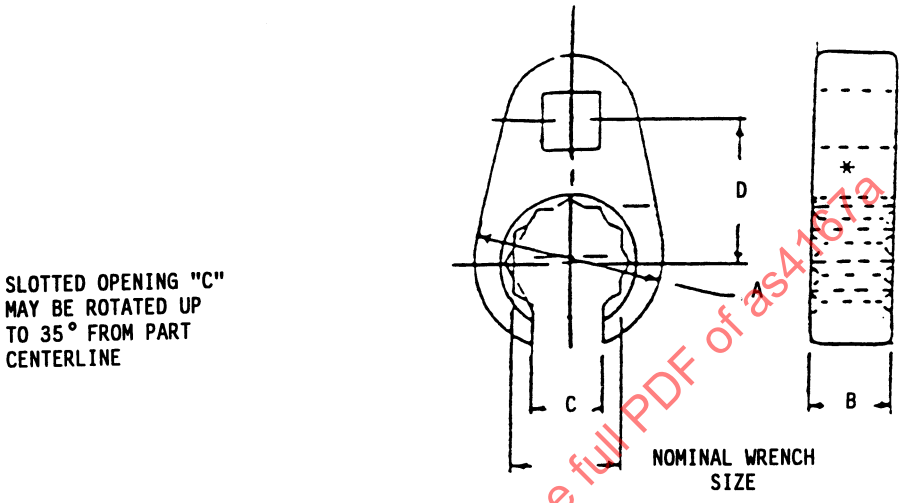


FIGURE 6 - Type I and II, Class 1, Style B, Design (b), Open Box End Crowfoot-Thin Box End

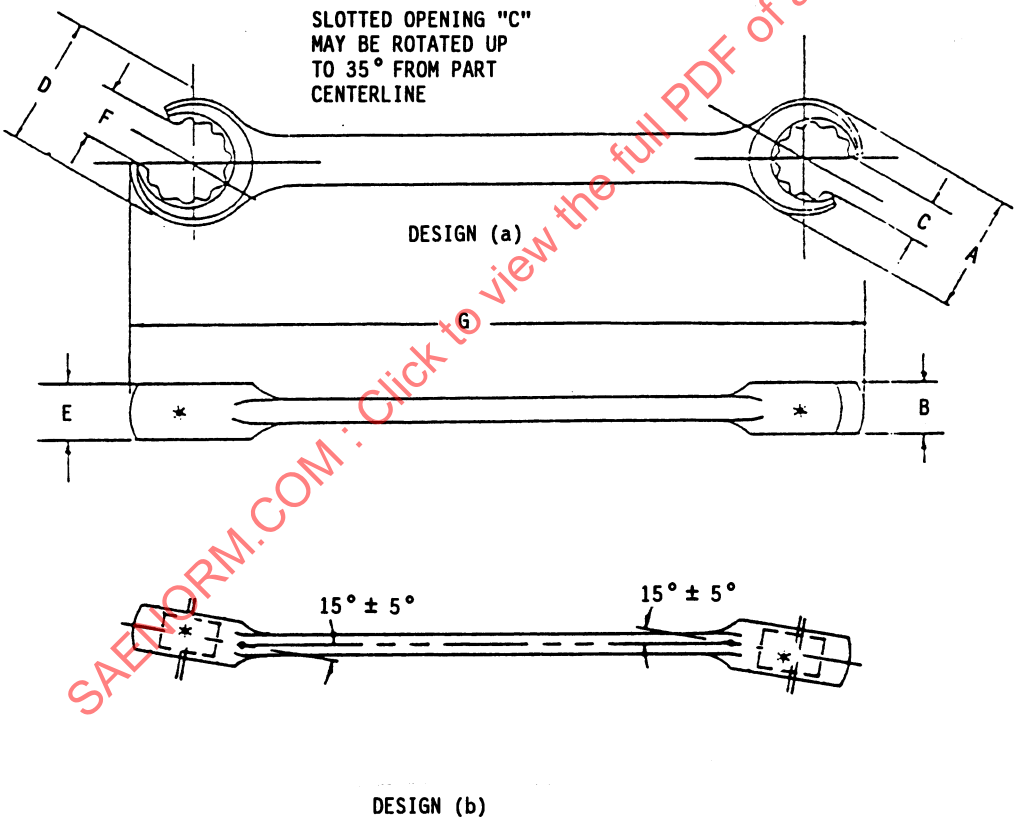
TABLE 4 - Type I and II, Class 1, Style B, Design (b), Crowfoot, Thin Box End

Nominal Wrench Size (in)	Style Drive Size (in)	Box End Diameter Max (in) A	Wrench Thickness Max (in) B	Slotted Opening Min (in) C	Torque Center ±0.030 (in) D
3/8	B (3/8 Sq. Dr.)	0.891	0.406	0.193	0.563
7/16	B (3/8 Sq. Dr.)	1.000	0.406	0.255	0.563
1/2	B (3/8 Sq. Dr.)	1.094	0.468	0.317	0.563
9/16	B (3/8 Sq. Dr.)	1.219	0.468	0.343	0.750
5/8	B (3/8 Sq. Dr.)	1.219	0.468	0.406	0.750
11/16	B (3/8 Sq. Dr.)	1.406	0.516	0.442	0.813
3/4	B (3/8 Sq. Dr.)	1.406	0.516	0.442	0.813
13/16	B (3/8 Sq. Dr.)	1.719	0.593	0.531	0.875
7/8	B (3/8 Sq. Dr.)	1.719	0.593	0.531	0.875
15/16	B (3/8 Sq. Dr.)	1.984	0.641	0.578	0.906
1	B (3/8 Sq. Dr.)	1.984	0.641	0.656	0.906

6.2 Type I and II, Class 2 wrenches shall be of the flare nut design, in accordance with one of the following styles:

6.2.1 Style A, double open box end wrenches shall have two slotted internal wrenching configurations, one located on each end of the wrench. They shall be similar to Figure 7 and conform to requirements of Table 5. The slotted portion of the internal wrenching configuration may be rotated up to 35° from the wrench centerline.

6.2.1.1 Design (a) wrenches shall have straight heads, design (b) wrenches shall have heads at a 15° angle to the wrench beam.



*NICKEL AND CHROMIUM PLATING TEST AREAS FOR TYPE I WRENCH.

FIGURE 7 - Type I and II, Class 2, Style A, Flare Nut Wrench, Double Open Box Ends

TABLE 5 - Type I and II, Class 2, Style A, Flare Nut, Double Open Box Ends

Nominal Wrench Sizes (in)	Small Box End Dia Max (in) A	Small Box End Thick. Max (in) B	Small Box End Slot Opening Min (in) C	Large Box End Dia Max (in) D	Large Box End Thick. Max (in) E	Large Box End Slot Opening Min (in) F	OAL Min (in) G
3/8 & 7/16	0.860	0.364	0.193	0.921	0.395	0.255	5.50
7/16 & 1/2	0.921	0.395	0.255	1.016	0.395	0.317	6.38
1/2 & 9/16	1.016	0.395	0.317	1.094	0.458	0.343	6.38
5/8 & 11/16	1.141	0.458	0.406	1.266	0.516	0.442	7.00
5/8 & 3/4	1.141	0.458	0.406	1.281	0.562	0.442	7.00
5/8 & 15/16	1.141	0.453	0.406	1.531	0.687	0.578	7.00
3/4 & 13/16	1.281	0.562	0.442	1.375	0.625	0.531	7.62
3/4 & 7/8	1.281	0.562	0.442	1.468	0.625	0.531	7.62
3/4 & 1	1.281	0.562	0.442	1.656	0.781	0.656	7.62
13/16 & 1 1/16	1.375	0.625	0.531	1.750	0.781	0.656	8.50
7/8 & 1	1.468	0.625	0.531	1.656	0.781	0.656	9.00
7/8 & 1 1/8	1.468	0.625	0.531	1.843	0.781	0.755	9.25

6.2.2 Style B, combination box and open box end wrenches shall be double ended with the same nominal size internal wrench configuration on each end. One end shall be of an open box design and the other end shall be a conventional box design. Wrenches shall be similar to Figure 8 and conform to requirements of Table 6.

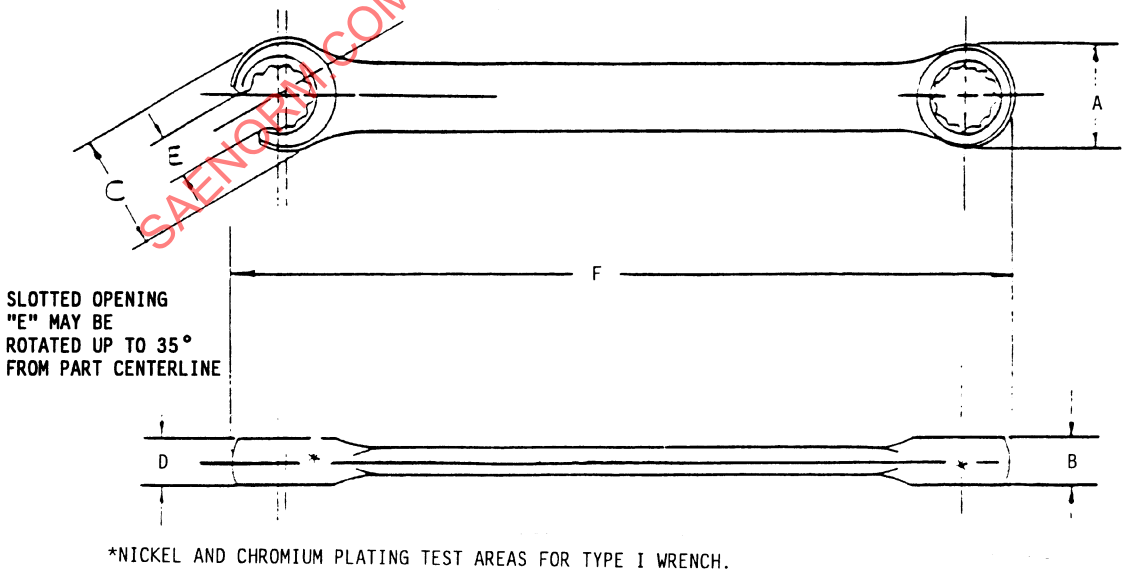


FIGURE 8 - Type I and II, Class 2, Style B, Flare Nut Wrench, Combination Box and Open Box End