

British Engineering Standards Association.

British Standard Specification for Aircraft Material.

MEDIUM CARBON STEEL BARS.

(Issued for and under the authority of the Ministry of Munitions,
Department of Aircraft Production).

NOTE.—The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to comprise all the necessary provisions of a contract.

**BRIGHT ROLLED OR DRAWN BARS
(Not to be used for Forgings or Stampings).**

1. **Manufacture.** The steel used for making the bars shall be of British manufacture, made by an approved maker on the Ministry of Munitions' list. The steel shall have been inspected and passed as complying with Specification S. 35.

2. **Chemical Analysis.** (a) The steel shall contain :—

	Bars up to $\frac{1}{2}$ in. diameter *	Bars over $\frac{1}{2}$ in. and up to 1 in. diameter *	Bars over 1 in. and up to 2 ins. diameter *	Bars over 2 in. diameter *
	Per cent.	Per cent.	Per cent.	Per cent.
Carbon between ...	0.15 & 0.25	0.20 & 0.30	0.25 & 0.35	0.30 & 0.45
Silicon not more than	0.30 per cent.			
Manganese between ...	0.50 & 0.90 " "			
Sulphur not more than	0.06 " "			
Phosphorus " "	0.06 " "			

(b) The contractor shall supply the analysis of the material when required to do so by the representative of the A.I.D. The representative of the A.I.D. may also select samples and have them analysed at the expense of the Government.

3. **Freedom from Defects.** (a) All bars shall be sound, straight, free from roaks, laps, cracks, twists, seams, and damaged ends, and shall have a workmanlike finish. They shall be uniform in quality, bright, clean, and within the stipulated margins of manufacture. The ends of the bars shall be cut by sawing, or in grooved shear blades which for round and hexagon bars shall be grooved not more than $\frac{1}{8}$ inch larger than the bars.

(b) Any bar may be rejected for faults in manufacture at any time, notwithstanding that it has been previously passed on analysis and physical tests.

4. **Dimensions.** The bars shall be made to the sizes given in Tables I and II.

5. **Margins of Manufacture.** The margins of manufacture shall be those given in Tables I and II.

6. **Mechanical Tests.** The bars shall comply with the following tests, which shall be carried out in the presence of the representative of the A.I.D., and to his satisfaction.

(a) **Tensile Test.** Test pieces turned from samples selected as specified in Clause 7 to the dimensions of the British Standard Test Piece C, or, if the bars are too small, turned to a similar form having the same geometrical proportions (suitable test pieces are shown in Figs. 1 to 6, Specification A. 4), shall give the

results shown in the Table below. At the option of the contractor samples may be tested in the full size of the bar from which they are cut, but the representative of the A.I.D. may require check tests to be made upon bars which have been turned to the size of the standard test piece.

	DIAMETER OR WIDTH ACROSS THE FLATS.		
	$\frac{5}{8}$ inch and under.	Over $\frac{5}{8}$ inch and under $1\frac{1}{2}$ inches.	$1\frac{1}{2}$ inches and over.
Ultimate tensile strength : Between	35 and 42 tons per sq. inch	35 and 42 tons per sq. inch	35 and 42 tons per sq. inch
Elongation not less than	12 per cent.	15 per cent.	15 per cent.
Reduction in area not less than	35 per cent.	40 per cent.	—
Elongation plus Reduction in area not less than	—	—	55 per cent.

(b) *Bending Test.* Test pieces shall be taken from bars of $\frac{3}{4}$ inch diameter (or width across the flats) or under and tested full size as rolled or drawn. For bars above $\frac{3}{4}$ inch diameter (or width across the flats) the test pieces may be the full size of the bar as rolled or drawn, or they may be turned down from the bar to a diameter of $\frac{5}{8}$ inch at the option of the contractor, but the representative of the A.I.D. may require check tests to be made upon bars which have been turned to a diameter of $\frac{5}{8}$ inch. The test piece shall withstand bending through an angle of 180° without showing signs of failure, the internal radius of the bend being equal to the diameter (or width across the flats) of the bar.

7. **Selection of Test Pieces.** (a) Where the material has been drawn in coils the bars cut from the same coil shall be bundled together.

(b) Where the representative of the A.I.D. is not satisfied that all the material of one size is from the same cast, or where the results of the physical tests are not found to be sufficiently uniform, the bars of each size shall be grouped in parcels of 100 bars for all sizes up to $\frac{1}{2}$ inch, or 50 for all sizes above $\frac{1}{2}$ inch up to 1 inch, or 20 for all sizes above 1 inch, and two samples, one for each of the above tests, shall be cut from the bar selected by the representative of the A.I.D. from each parcel.

(c) Where the representative of the A.I.D. is satisfied that all the material of one size has been produced from the same cast and the results of the physical tests are found to be consistently uniform, the number of samples may be reduced as follows:—For bars $\frac{1}{2}$ inch and under, one bar shall be selected from every 10 coils or from every 10 cwts.; for bars over $\frac{1}{2}$ inch up to 1 inch, one bar shall be selected from every ton; and for bars over 1 inch, one bar shall be selected from every 2 tons.

(d) If any test piece fails to fulfil the tests specified, the representative of the A.I.D. may at his discretion require the contractor to test in the same manner two other bars, to be selected from the same parcel by the representative of the A.I.D. If both the second samples should fulfil the tests the whole of the parcel from which the samples were selected will be accepted, except the bar from which the first piece was cut, but if either of them fail to pass the tests the whole parcel represented by the test pieces shall be rejected.

8. **Marking Accepted and Rejected Bars.** (a) All bars passed by the representative of the A.I.D. shall be marked as he may direct.

(b) Rejected bars and coils shall be suitably marked for identification and shall not be tendered again to any Government Department without written information being given to that Department or their Inspector regarding the previous rejection.

(c) The contractor shall not supply any bar or coil which has been previously rejected by any Government Department without giving written information to the representative of the A.I.D. about the previous rejection.

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9. **Facilities for Inspection and Testing.** (a) The representative of the A.I.D. shall have free access to the works of the contractor at all reasonable times while and where work on the contract is being performed; he shall be at liberty to inspect the manufacture at any stage and to reject any material which does not conform to the terms of this specification.

(b) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

(c) The contractor shall supply the material required for testing without additional charge, and at his own cost furnish and prepare the necessary test pieces and supply labour and appliances for such inspection and testing as may be carried out on his premises in accordance with this specification. Failing approved facilities at his own works for making the prescribed tests, the contractor shall bear the cost of carrying out the tests elsewhere.

TABLE I.

British Standard Steel Bars, Round and Square. (B.E.S.A. Report No. 32.)

1		2	1		2
Nominal Size of Bar. (Diameter or Width across Flats). Inches.		Bright Rolled or Drawn. Margin of Manufacture. Inch.	Nominal Size of Bar. (Diameter or Width across Flats). Inches.		Bright Rolled or Drawn. Margin of Manufacture. Inch.
.064 (16 S.W.G.)	- - -	<i>See Note.</i>	$\frac{3}{8}$ (.75)	- - -	<i>See Note.</i>
.080 (14 S.W.G.)	- - -		$\frac{7}{8}$ (.875)	- - -	
.104 (12 S.W.G.)	- - -		1	- - -	
.128 (10 S.W.G.)	- - -		$1\frac{1}{8}$ (1.125)	- - -	
$\frac{3}{16}$ (.1875)	- - -		$1\frac{1}{4}$ (1.25)	- - -	
$\frac{1}{4}$ (.25)	- - -		$1\frac{3}{8}$ (1.375)	- - -	
$\frac{5}{16}$ (.3125)	- - -		$1\frac{1}{2}$ (1.5)	- - -	
$\frac{3}{8}$ (.375)	- - -		$1\frac{5}{8}$ (1.625)	- - -	
$\frac{7}{16}$ (.4375)	- - -		$1\frac{3}{4}$ (1.75)	- - -	
$\frac{1}{2}$ (.5)	- - -		$1\frac{7}{8}$ (1.875)	- - -	
$\frac{9}{16}$ (.5625)	- - -		2	- - -	
$\frac{5}{8}$ (.625)	- - -		2 to 3, bright round	- - -	

NOTE.—The margins of manufacture are under revision.

TABLE II.

British Standard Steel Bars, Hexagon. (B.E.S.A. Report No. 32).

1		2	3.	4.
Nominal Size of Bolt.		Bright Rolled and Drawn.		
Whitworth.	Automobile.	Maximum Width across Flats.	Margin of Manufacture.	
Inches.	Inches.	Inches.	Inch.	
$\frac{1}{8}$	—	.338	<i>See Note.</i>	
$\frac{3}{16}$	—	—		
$\frac{1}{4}$	$\frac{5}{16}, \frac{9}{32}$.525		
$\frac{5}{16}$	$\frac{3}{8}$.710		
$\frac{3}{8}$	$\frac{1}{2}$.920		
$\frac{1}{2}$	—	1.100		
$\frac{5}{8}$	—	1.300		
$\frac{3}{4}$	—	1.480		
$\frac{7}{8}$	1	1.670		
1	—	1.860		
$1\frac{1}{8}$	—	2.050		
$1\frac{1}{4}$	—			

NOTE.—The margins of manufacture are under revision.

Additional Sizes required for British Standard Automobile Nuts and Bolt Heads.
(Suggested by the B.E.S.A., but not yet officially approved).

1.	2.		3.	1.	2.		3.
Nominal Size of Bolt, Automobile.	Bright Rolled or Drawn.		Margin of Manufacture.	Nominal Size of Bolt, Automobile.	Bright Rolled or Drawn.		Margin of Manufacture.
	Maximum Width across Flats.				Maximum Width across Flats.		
Inch. 1 1 1/4 1 1/2 1 3/4 1 7/8 2	Inch. ·445 ·600 ·820 0-10		Inch. <i>See Note.</i>	Inch. 3/4 1 1/8 1 3/8 7/8 1 5/8	Inches. 1-200 1-390		Inch. <i>See Note.</i>
2 B.A. 4 B.A.	·338 ·2						

NOTE.—The margins of manufacture are under revision.

Additional Sizes required for Metric Nuts and Bolt Heads.
(See Air Board Specification A. 2).

Nominal Size of Bolt, Metric.	Bright Rolled or Drawn.	
	Maximum Width across Flats.	Margin of Manu- facture.
3 mm. - - - -	0·188 inch.	<i>See Note.</i>
6 mm. - - - -	0·406 „	

NOTE.—The margins of manufacture are under revision.

This Specification was adopted by the Sectional Committee on Components of Aircraft and Aircraft Engines on 7th January, 1919, and approved on behalf of the Main Committee on 29th January, 1919.

NOTE.

Owing to the cessation of hostilities this Specification has not been issued.

SPECIFICATION
FOR
MEDIUM CARBON STEEL BARS.

Part 2.—Hot Rolled Bars.

(Hot Rolled Bars are suitable for Forging or Stamping.)

1. **Manufacture.**—The steel used for making the bars is to be of British manufacture, made by an approved maker on the Ministry of Munitions' list.

2. **Chemical Analysis.**—(a) The steel is to contain—

Carbon	-	-	-	between 0.25 and 0.40 per cent.
Silicon	-	-	-	not over 0.30 "
Manganese	-	-	-	between 0.40 and 0.85 "
Sulphur	-	-	-	not over 0.06 "
Phosphorus	-	-	-	" 0.06 "

(b) The Contractor is to supply the analysis of every cast to the Inspector. The Inspector may also select samples and have them analysed at the expense of the Government.

3. **Freedom from Defects.**—(a) All the bars are to be sound, straight, free from roaks, laps, cracks, twists, seams, and damaged ends, and are to have a workmanlike finish. They are to be uniform in quality, within the stipulated margins of manufacture, and capable of being turned and screwed satisfactorily and taking a good finish.

(b) Any bar may be rejected for faults in manufacture at any time notwithstanding that it has been previously passed on analysis and physical tests.

4. **Sections.**—Round, square, and hexagon bars are to be regarded as standard, other shapes as special.

5. **Margins of Manufacture.**—The margins of manufacture for standard bars are to be those given in Tables I. and II., which correspond with those given in the British Standard Specification No. 32. The margin of manufacture for special bars is to be $\pm 2\frac{1}{2}$ per cent. on the weight per foot run, calculated on the assumption that a bar 1 foot long by 1 square inch section weighs 3.4 lbs. No margins are specified for standard or special bars which are to be used for stampings.

6. **Heat Treatment.**—(a) All the bars are to be normalised.

(b) *Normalising.*—The bars are to be heated in a furnace to a temperature between 840° and 880° C., and kept there till they have reached a uniform temperature throughout. They are then to be removed from the furnace and allowed to cool in still air.

7. **Mechanical Tests.**—(a) The bars are to comply with the following tests, which are to be carried out in the presence of the Inspector and to his satisfaction.

(b) *Tensile Test.*—Test pieces turned from samples selected as specified in Clause 8 to the dimensions of the British Standard Test piece C shown in Fig. 1, or, if the bars are too small, turned to a similar form having the same geometrical proportions (suitable test pieces are shown in Figs. 1 to 6), must give results not less than the following:—

Ultimate tensile strength	-	-	-	35 tons per square inch.
Yield point	-	-	-	20 " "
Elongation	-	-	-	20 per cent.
Reduction of area	-	-	-	40 "

(c) *Bending Test.*—Bend test pieces are to be taken from bars of $\frac{3}{4}$ inch diameter (or width across the flats) or under, and tested full size as rolled. Above $\frac{3}{4}$ inch diameter (or width across the flats) the test pieces are to be turned down from the bars to a diameter of $\frac{5}{8}$ inch.

(d) The test piece must withstand being doubled over cold until the internal radius is equal to the diameter (or width across the flats) of the test piece and the sides are parallel, without developing any cracks.

8. *Selection and Preparation of Test Pieces.*—(a) The bars of each size are to be indiscriminately grouped in parcels of 100 bars for all sizes up to $\frac{1}{2}$ inch, or 50 bars for all sizes above $\frac{1}{2}$ inch up to 1 inch, or 25 bars for all sizes above 1 inch, and two samples, one for each of the above tests, are to be cut from the bar selected by the Inspector from each parcel. These samples are to be marked as directed by the Inspector before they are cut off. The samples are not to be further annealed, hammered, or otherwise treated before they are tested.

(b) If any test piece fails to fulfil the tests specified, the Inspector may, at his discretion, require the Contractor to test in the same manner two other bars to be selected by the Inspector from the same parcel. If the second samples should fulfil the tests the whole parcel from which the samples were selected will be accepted, except the bar from which the first piece was cut.

9. *Marking accepted and rejected Bars.*—Rejected bars are to be marked for identification to the satisfaction of the Inspector, and are not to be tendered again to any Government Department without written information being given to that Department or their Inspector concerning the previous rejection. Every bar passed by the Inspector is to be marked as he may direct.

10. *Inspection.*—The Contractor is not to supply any bars which have been previously rejected by any Government Inspection Department without giving written information to the Inspector about the previous rejection. The Inspector is to have free access to the works of the Contractor at all reasonable times; he is to be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this specification.

11. *Facilities.*—The Contractor is to supply the material required for testing without additional charge, and at his own cost furnish and prepare the necessary test pieces and supply labour and appliances for such inspection and testing as may be carried out on his premises in accordance with this specification. Failing approved facilities at his works for making the prescribed tests, the Contractor is to bear the cost of carrying out the tests elsewhere.

TABLE I.

British Standard Steel Bars, Round and Square. (E.S.C. Report 32.)

Nominal Size of Bar.		Hot Rolled.		Nominal Size of Bar.		Hot Rolled.	
(Diameter or Width across Flats.)		Margin of Manufacture.		(Diameter or Width across Flats.)		Margin of Manufacture.	
1.		2.		1.		2.	
Inches.		Inches.		Inches.		Inches.	
1	(.25)	+	.010	1 $\frac{1}{4}$	(1.125)	+	.015
1 $\frac{1}{8}$	(.3125)	+	.010	1 $\frac{1}{2}$	(1.25)	+	.015
1 $\frac{1}{4}$	(.375)	+	.010	1 $\frac{3}{4}$	(1.375)	+	.020
1 $\frac{3}{8}$	(.4375)	+	.010	1 $\frac{1}{2}$	(1.5)	+	.020
1 $\frac{1}{2}$	(.5)	+	.010	1 $\frac{3}{4}$	(1.625)	+	.020
1 $\frac{3}{4}$	(.5625)	+	.010	1 $\frac{1}{2}$	(1.75)	+	.020
1 $\frac{7}{8}$	(.625)	+	.010	1 $\frac{3}{4}$	(1.875)	+	.025
1 $\frac{1}{8}$	(.75)	+	.010	2		+	.025
1 $\frac{1}{4}$	(.875)	+	.010	2 to 4, black square		+	.030
1 $\frac{3}{8}$		+	.015	2 to 6, black round		+	.025

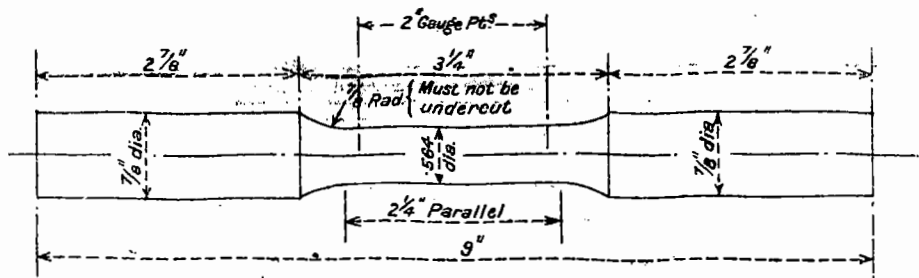
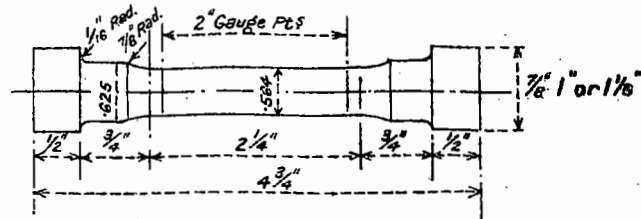


Fig. 1.



Note. When the ends are 1" or 1 1/8" dia. the shoulder shown .625" dia. may be increased in dia. if desired.

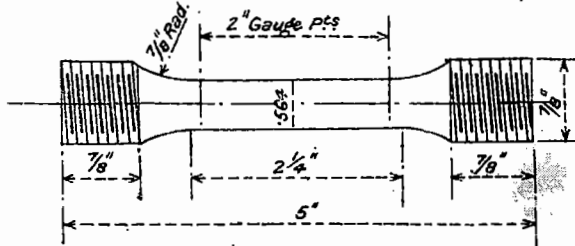


Fig. 2.

HALF SIZE

TENSILE TEST PIECE FOR BAR MATERIAL FROM 5/8" DIAM. TO 7/8" DIAM.

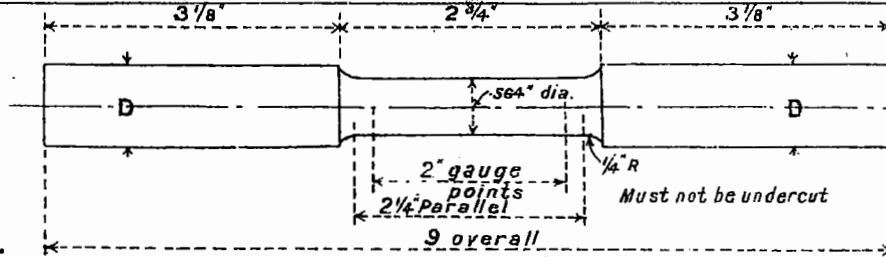


FIG. 3.

HALF SIZE.

NOTE:—The ends are to be turned, in order to ensure that they are concentric with the specimen but "D" should be kept as large as possible.

TENSILE TEST PIECE FOR BAR MATERIAL FROM 15/32" DIA. TO 39/64."

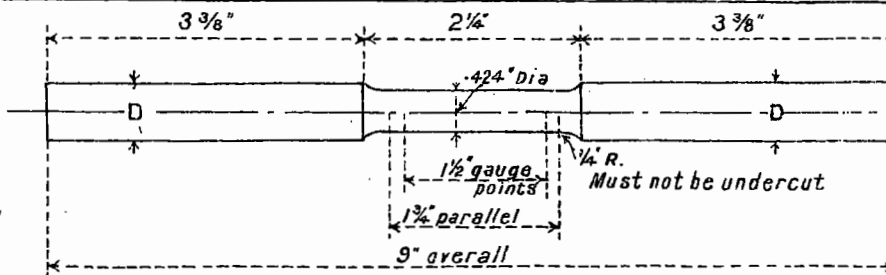


FIG. 4.

HALF SIZE.

NOTE:—The ends are to be turned, in order to ensure that they are concentric with the specimen, but "D" should be kept as large as possible.

TENSILE TEST PIECE FOR BAR MATERIAL FROM 9/32" DIA. TO 29/64."

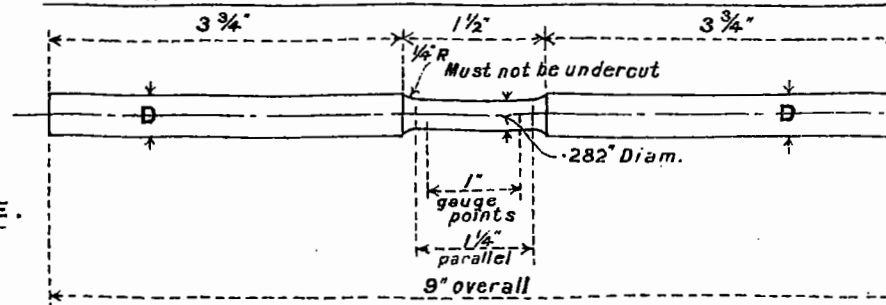


FIG. 5.

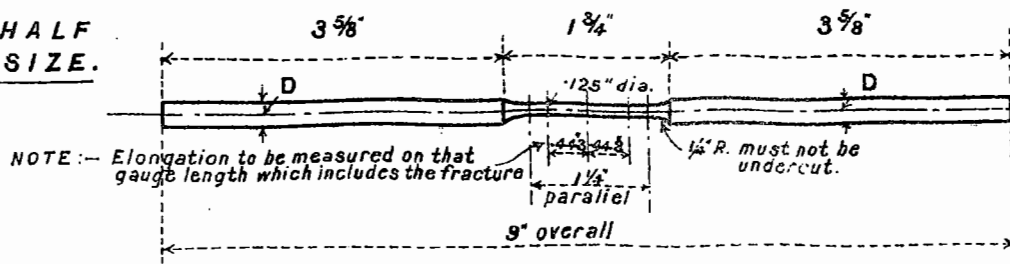
HALF SIZE.

NOTE:—The ends are to be turned, in order to ensure that they are concentric with the specimen but "D" should be kept as large as possible.

TENSILE TEST PIECE FOR BAR MATERIAL FROM 7/32 DIA. TO 7/64.

FIG. 6.

HALF SIZE.



NOTE:— Elongation to be measured on that gauge length which includes the fracture
 NOTE:— The ends are to be turned, in order to ensure that they are concentric with the specimen, but "D" should be kept as large as possible.

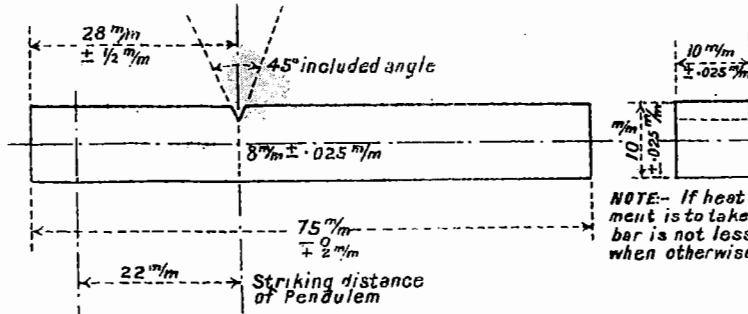
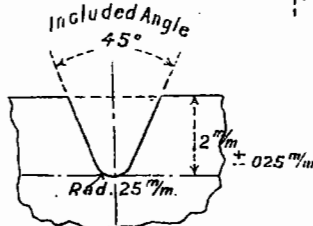


FIG. 7.

NOTE:— If heat treated, the treatment is to take place when test bar is not less than 3/8" dia. except when otherwise specified.



Check with wire N° 25 S.W. G. — .02" dia.
 ENLARGED VIEW OF NOTCH.

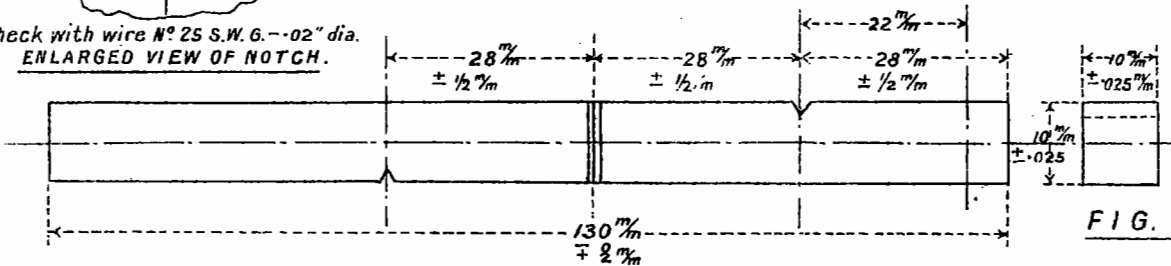


FIG. 8.

Alternative Izod impact specimen with 3 notches instead of one

FULL SIZE.

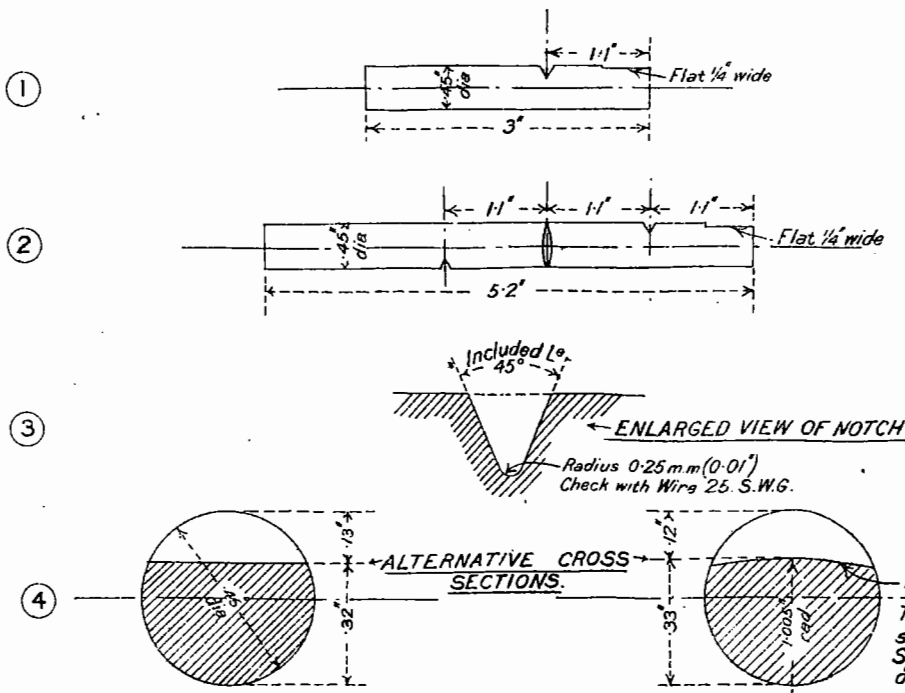


FIG. 9.

1.005" radius.
 This notch to be cut by mounting specimen in an eccentric mandrel, specimen being 0.9" from centre of mandrel.

TABLE II.

British Standard Steel Bars, Hexagon. (E.S.C. Report 32.)

Nominal Size of Bolt.		Hot Rolled.		
		Minimum Width across Flats when left Black.	Minimum Width across Flats with Allowance for Grinding.	Margin of Manufacture.
Whitworth.	Automobile.	3.	4.	5.
1.	2.	3.	4.	5.
Inches.	Inches.	Inches.	Inches.	Inches.
1/8	—	.318	.348	+ .010
1/4	5/16, 3/8	.505	.535	+ .010
3/8	7/16	.690	.720	+ .010
1/2	9/16	.900	.930	+ .010
5/8	—	1.080	1.115	+ .015
3/4	—	1.280	1.315	+ .015
7/8	1	1.460	1.500	+ .020
1	—	1.650	1.690	+ .020
1 1/8	—	1.830	1.870	+ .020
1 1/4	—	2.020	2.060	+ .020
1 1/2	—	2.190	2.235	+ .025
1 3/4	—	2.380	2.425	+ .025
2	—	2.550	2.595	+ .025
2 1/8	—	2.730	2.775	+ .025
2 1/4	—	2.990	3.035	+ .025
2 3/8	—	3.120	3.165	+ .025
2 1/2	—	3.300	3.350	+ .030
2 3/4	—	3.510	3.560	+ .030
3	—	3.710	3.760	+ .030
3 1/2	—	3.850	3.900	+ .030

TABLE II.—continued.

Additional Sizes required for British Standard Automobile Nuts and Bolt Heads. (Suggested by the E.S.C., but not officially approved.)

Nominal Size of Bolt, Automobile.	Hot Rolled.		
	Minimum Width across Flats when left Black.	Minimum Width across Flats with Allowance for Grinding.	Margin of Manufacture.
1.	2.	3.	4.
Inches.	Inches.	Inches.	Inches.
1/4	.425	.455	+ .010
3/8	.580	.610	+ .010
1/2	.800	.830	+ .010
5/8	.990	1.025	+ .015
3/4	1.180	1.215	+ .015
7/8			
1	1.370	1.410	+ .020
1 1/8			