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SUPERSEDING

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MILITARY SPECIFICATION**SHOT PEENING OF FERROUS METAL PARTS**

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 This specification covers shot peening of ferrous metal parts for the purpose of increasing the fatigue strength of the piece.

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS**FEDERAL**

- QQ-M-151 —Metals, General Specification for Inspection of
- RR-S-366 —Sieves, Standard for Testing Purposes

STANDARDS**MILITARY**

- MIL-STD-105 —Sampling Procedures and Tables for Inspection by Attributes

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

3. REQUIREMENTS

3.1 **Shot peening intensity.** Unless otherwise specified on the drawing, or in the contract, the intensity value (see 6.2) of the blast of peening used in the manufacture of a part shall be as specified in table I for the thickness involved.

TABLE I. Shot peening intensity.

| Thickness, inches | Intensity ¹ |
|---|--------------------------|
| $\frac{1}{16}$ to $\frac{1}{8}$, inclusive | .003A to .009A |
| Over $\frac{1}{8}$ to $\frac{3}{8}$, inclusive | .007A to .014A |
| Over $\frac{3}{8}$ | .012A, min. ² |

¹ The suffix letter A indicates that the values have been determined by the use of test strip A (see fig. 1).

² Test strip A is used for arc heights up to 0.024A. For greater peening intensity test strip C should be used (see fig. 2).

3.2 Shot and shot size.

3.2.1 **Shot.** The shot used shall be made from cast iron, cast steel, or cut steel wire. Cut wire shot, if used, shall be preused or otherwise conditioned to eliminate sharp edges.

3.2.2 **Size.** Unless otherwise specified, the nominal size of shot charged into the machine shall be at the option of the contractor and shall be as specified in table II (cast sizes) or III (cut wire sizes), as applicable.

3.2.2.1 Unless otherwise specified, when fillet surfaces are designated as critical areas, the nominal shot size shall not be greater than one-half the fillet radius. For slots or other apertures, through which shot must pass to peen shielded critical areas, the nominal shot diameter shall not be greater than $\frac{1}{4}$ the diameter or width of such aperture.

3.2.2.2 **Uniformity.** The shot shall be maintained in the machine so that not more than 20% of the particles by weight shall pass through the screen size specified in

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Table IV for the size of shot used. No shot shall be coarser than that shown in Table II or III as applicable for the size of shot used.

3.3 Coverage. All surfaces on which peening is required shall be peened to complete visual coverage except that, where a surface on which peening is required is obstructed and it is impossible to obtain complete visual coverage, the amount of visual coverage shall be as specified on the drawings or in the contract.

3.3.1 Unless otherwise specified, the variation in boundaries of areas to be peened, when limited, shall be -0 to $+1/8$ inch.

3.3.2 Complete visual coverage is defined as a uniform and complete denting or obliterating of the original surface of the part or work piece as determined by unaided visual inspection. In case of disagreement as to the extent of coverage, a referee method may be specified by the contracting officer.

3.3.3 Requirements necessitating the special examination of peened surfaces by methods involving magnification or surface reproduction for comparison with arbitrary standards for coverage, shall be specified on the applicable drawings or contract. Inspection procedure and percentage of work to be so inspected shall be detailed on contract or drawing.

3.4 Workmanship

3.4.1 Masking. Areas of the part or work piece which are designated in the contract

TABLE III. *Cut steel wire shot size classification.*

| Shot no. | Wire diameter, inches | Length of ten pieces, inches ¹ | Weight of fifty pieces, grams ² |
|----------|-----------------------|---|--|
| CW-62 | .0625 ± .002 | .620 ± .040 | 1.09 to 1.33 |
| CW-54 | .054 ± .002 | .540 ± .040 | .72 to .88 |
| CW-47 | .047 ± .002 | .470 ± .040 | .48 to .58 |
| CW-41 | .041 ± .002 | .410 ± .040 | .31 to .39 |
| CW-35 | .035 ± .001 | .350 ± .030 | .20 to .24 |
| CW-32 | .032 ± .001 | .320 ± .030 | .14 to .18 |
| CW-28 | .028 ± .001 | .280 ± .030 | .10 to .12 |
| CW-23 | .023 ± .001 | .230 ± .020 | .05 to .07 |
| CW-20 | .020 ± .001 | .200 ± .020 | .04 to .05 |

¹ Shot particles to be checked for length shall be mounted and ground and polished to expose a central longitudinal section. The combined length of ten random particles shall be within the tolerances shown in table III above.

² At the option of the contractor the particles may be weighed instead of mounted and measured as stated in note (1) above. When weighed, the total weight of fifty randomly selected particles shall be within the limits specified in table III above.

TABLE IV. *Uniformity of shot in machine.*

| Cast shot sizes | Cut wire sizes | Maximum 20% passing U. S. standard screen size |
|-----------------|----------------|--|
| 780 | — | 18 (.0394) |
| 660 | CW62 | 20 (.0331) |
| 550 | CW54 | 25 (.028) |
| 460 | CW47 | 30 (.0232) |
| 390 | CW41 | 35 (.0197) |
| 330 | CW35 | 40 (.0165) |
| — | CW32 | 40 (.0165) |
| — | CW28 | 45 (.0138) |
| 230 | CW23 | 50 (.0117) |
| 170 | CW20 | 70 (.0083) |
| 110 | — | 120 (.0049) |
| 70 | — | 170 (.0035) |

TABLE II. *Cast shot numbers and screening tolerances.*

| Shot no. | All pass screen | On screen (%) max | | On screen (%) min | | On screen (%) max | | (% max in pan |
|----------|-----------------|-------------------|-----|-------------------|-----|-------------------|-----|---------------|
| | | screen | max | screen | min | screen | max | |
| 780 | 7(0.111) | ----- | -- | 10(0.0787) | 85 | 12(0.0661) | 12 | 3 |
| 660 | 8(0.0937) | ----- | -- | 12(0.0661) | 85 | 14(0.0555) | 12 | 3 |
| 550 | 10(0.0787) | ----- | -- | 14(0.0555) | 85 | 16(0.0469) | 12 | 3 |
| 460 | 10(0.0787) | 12(0.0661) | 5 | 16(0.0469) | 80 | 18(0.0394) | 11 | 4 |
| 390 | 12(0.0661) | 14(0.0555) | 5 | 18(0.0394) | 80 | 20(0.0331) | 11 | 4 |
| 330 | 14(0.0555) | 16(0.0469) | 5 | 20(0.0331) | 80 | 25(0.028) | 11 | 4 |
| 280 | 16(0.0469) | 18(0.0394) | 5 | 25(0.0280) | 80 | ----- | -- | -- |
| 230 | 18(0.0394) | 20(0.0331) | 10 | 30(0.0232) | 75 | 35(0.0197) | 12 | 3 |
| 170 | 20(0.0331) | 25(0.028) | 10 | 40(0.0165) | 75 | 45(0.0138) | 12 | 3 |
| 110 | 30(0.0232) | 35(0.0197) | 10 | 50(0.0117) | 70 | 80(0.007) | 10 | 10 |
| 70 | 40(0.0165) | 45(0.0138) | 10 | 80(0.007) | 70 | 120(0.0049) | 10 | 10 |

or applicable drawing to be free of any shot peening marks shall be suitably masked or otherwise handled to protect such surfaces from the blast stream or subsequent damage. When it is impractical to mask or otherwise protect areas designated to be free from shot peening marks, material affected by the shot peening may be machined off provided sufficient stock has been left on the part to permit such material to be removed and still comply with the dimensional requirements shown on the applicable drawing.

3.4.2 After shot peening and removal of protecting masks, all shot and shot fragments shall be removed from surfaces of articles. Only methods which will not erode or scratch surfaces shall be used.

3.5 Processing procedure.

3.5.1 Parts shall be within dimensional and surface finish requirements before peening, except in areas where peening is not required. All heat treatment, machining, grinding and polishing shall be completed before shot peening.

3.5.2 Unless otherwise specified, shot peening may be performed either before or after such manufacturing operations as involve plastic deformation inducing favorable residual stresses.

3.5.3 When manufacturing operations induce residual stresses which may be detrimental to service after peening, the part or work piece shall be given a suitable stress relief heat treatment prior to shot peening.

3.5.4 Shot peening of parts while under stress from an exterior force shall not be permitted unless conducted with permission of the contracting officer or designated on the drawings or in the contract.

3.5.5 No manufacturing operations which relieve stresses developed by peening or which develop detrimental residual stresses shall be permitted after shot peening.

3.6 Heat treatment. When peened parts are heated after shot peening as for baking of paint or protective coatings, embrittle-

ment relief after electroplating, or other strain relief heat treatment, they shall not be subjected to processing temperatures exceeding 475°F.

3.7 Magnetic particle or fluorescent inspection. When magnetic particle or fluorescent penetrant inspection is required, parts shall be subjected to such inspection before peening.

3.8 Protection from corrosion. Shot peened parts shall be protected from corrosion during processing and until final coating or packaging is complete.

4. QUALITY ASSURANCE PROVISIONS

4.1 Shot peening intensity.

4.1.1 Sampling. At least one intensity determination as defined in 4.1.3 shall be made to represent each machine for each two hours of continuous operation or fraction thereof where cast iron shot is used, and for each eight hours of continuous operation or fraction thereof where cast steel or cut steel wire shot is used. In all cases, at least one determination shall be made at the beginning and one at the end of each period of operation.

4.1.2 Test specimens. Two test specimens conforming in dimensions and mechanical properties to figure 1 shall be used for each intensity determination.

4.1.3 Test procedure. The test specimens selected in accordance with 4.1.1 shall be attached as shown in figure 4, to holders of the form and dimensions shown in figure 3, and mounted on a fixture or article and exposed to the blast stream in a manner and for a time which simulates conditions used for the articles. After exposure the test strips shall be removed from the holders and the amount of deflection measured with a micrometer gage, of the form and dimensions shown in figure 5, and the values compared with the requirements of 3.1. In using the micrometer gage the central portion of the unpeened side of the test strip shall be placed against the indicator stem of the gage.

4.2 Shot size and uniformity.

4.2.1 *Sampling.* At least one determination for shot size and uniformity shall be made in accordance with 3.2 (using type A or type C specimen as applicable) for each 2 hours of continuous operation where cast iron shot is used, and for each eight hours of continuous operation or fraction thereof where cast steel or cut steel wire shot is used. In all cases, at least one determination shall be made at the beginning and one at the end of each period of operation. Where cut wire shot is used, it shall be inspected for absence of sharp edges. (See 3.2.1.)

4.2.2 *Test procedure.* Tests for shot size and uniformity for compliance with the requirements of 3.2 shall be made using sieves conforming to Specification RR-S-366.

4.3 Inspection of shot peened articles.

4.3.1 *Shot peened coverage.* Articles shall be visually inspected for compliance with the coverage requirements of 3.3. Surfaces of articles shall be bare or coated with light transparent oil.

4.3.2 *Inspection lot.* Lots shall be formed by the inspector provided that not more than the output of one machine during one 8-hour work period may be included in a lot.

4.3.3 *Sampling.* Samples shall be selected in accordance with Standard MIL-STD-105, at inspection level III.

4.3.4 *Quality level.* Unless otherwise specified, acceptance and rejection of lots shall be in accordance with A.Q.L. 1.5 percent defective.

4.4 Rejection and retest.

4.4.1 *Rejection.* All parts shot peened between a last previous successful test and the first unsuccessful test or the time a machine is found to be unsatisfactory by virtue of failure of the test specimens to meet any of the requirements of this specification, as well as any parts shot peened after the test which indicated the failure, shall be rejected. Such parts may, at the option of the con-

tractor, be repeened once and resubmitted for inspection.

5. PREPARATION FOR DELIVERY

5.1 *Marking.* When specified, shot peened parts shall be marked in accordance with instructions from the purchaser.

5.2 *Packing.* When specified, peened parts shall be so packed as to insure acceptance by common or other carrier for safe transportation to the point of delivery at the lowest rate.

6. NOTES

6.1 *Intended use.* The shot peening is intended for use on ferrous metal parts which are subjected to repeated applications of stress such as axles, springs (helical and leaf), gears, shafting, landing gear parts and wing panels, etc.

6.2 Shot peening, to have the desired effect, requires that the specified intensity and coverage be achieved on critical areas, where high tension stresses or stress ranges are most likely to cause fatigue failures in service. Actual experience with service failures or fatigue tests may sometimes be required to discover or confirm the location of such areas subjected to critical stressing, as a result of any combination of service, design, and manufacturing conditions.

6.3 Shielded or partially shielded areas, walls of deep recesses, or other areas less accessible to the maximum effect of the blast stream will receive less peening as to intensity and coverage than more exposed or more favorably oriented areas.

6.4 The peening of very thin or small sections to high intensities should be avoided because of the distortion and high residual tensile stresses in the core material that may result from such peening. This is particularly true where the part has surfaces finished after heat treatment, or is used as a tension member.

6.5 Where special procedure is required, applicable drawings or contract must definitely designate such critical areas referred to

in 6.2 as required by section 3. This is particularly important in instances referred to in 6.3 where such less accessible and unfavorably oriented surfaces are, or contain, areas subjected to critical stressing.

6.6 Relatively simple shapes and many open-pitched helical spring designs may not require special mention as to critical areas since such areas are generally accessible for full peening effect when uniformly exposed to the blast stream.

6.7 Shot size selection. In selecting shot sizes consideration should be given to the following factors:

- (a) Shape of parts
- (b) Size of fillets or scratches (small shot to get into small fillets, etc.)
- (c) Finish (small shot for fine finish)
- (d) Intensity desired (see 3.1)
- (e) Abrasive effect

6.8 Intensity comparisons. For comparisons of the nominal intensity designations, type C test specimen deflection may be multiplied by 3.5 to obtain the approximate de-

flection of a type A specimen when shot peened with the same intensity. Test strip "A" is ordinarily used for arc heights up to 0.024 inch; for greater degrees of peening, test strip C is used. (See fig. 1 and 2).

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Custodians:

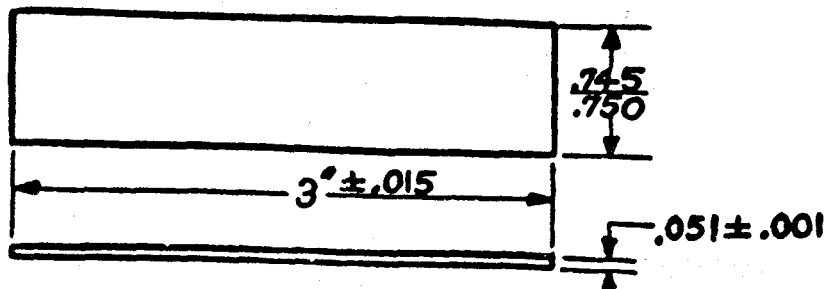
Army—Ordnance Corps
Navy—Bureau of Ordnance
Air Force

Other interests:

Army—C
Navy—Sh

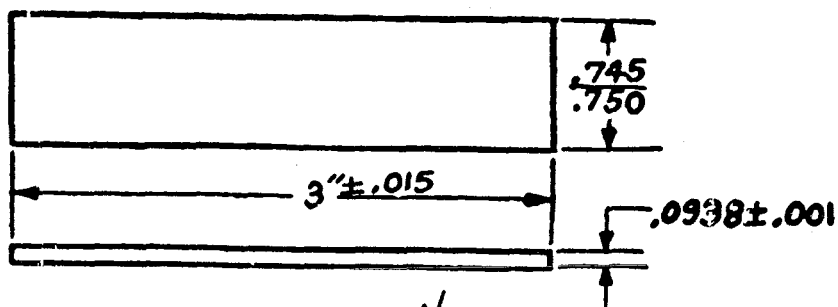
Preparing activity:

Army—Ordnance Corps



TEST STRIP A ✓

FIGURE 1.



TEST STRIP C ✓

FIGURE 2.

✓ **Test Strip Specifications**

Analysis of Stock - SAE 1070

Cold Rolled Spring Steel

Square Edge Number One (on 3" edges)

Finish - Blue Temper (or Bright)

Uniformly hardened and tempered to 44-50 RC

Flatness - $\pm .0015''$ arc height as measured on gage shown in Figure 5.

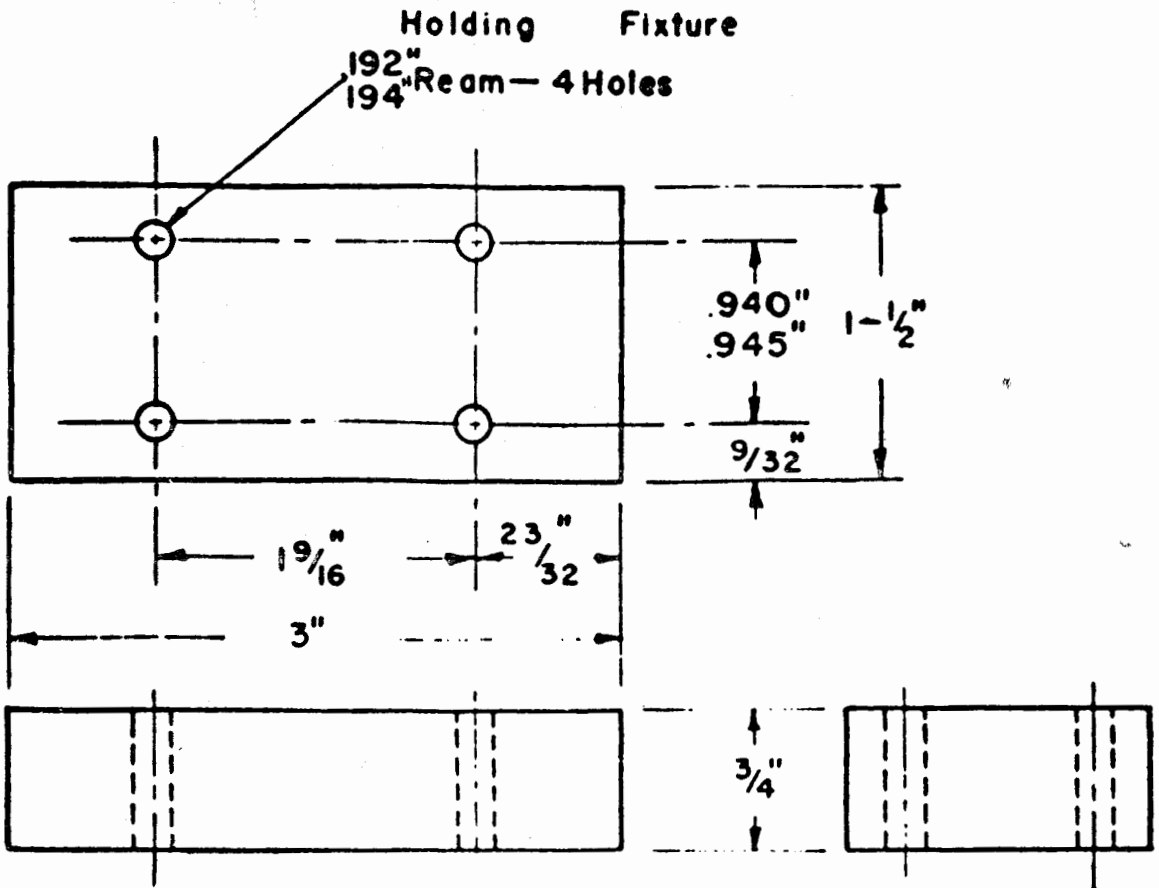


Fig. 3

Assembled Test Strip and Holding Fixture

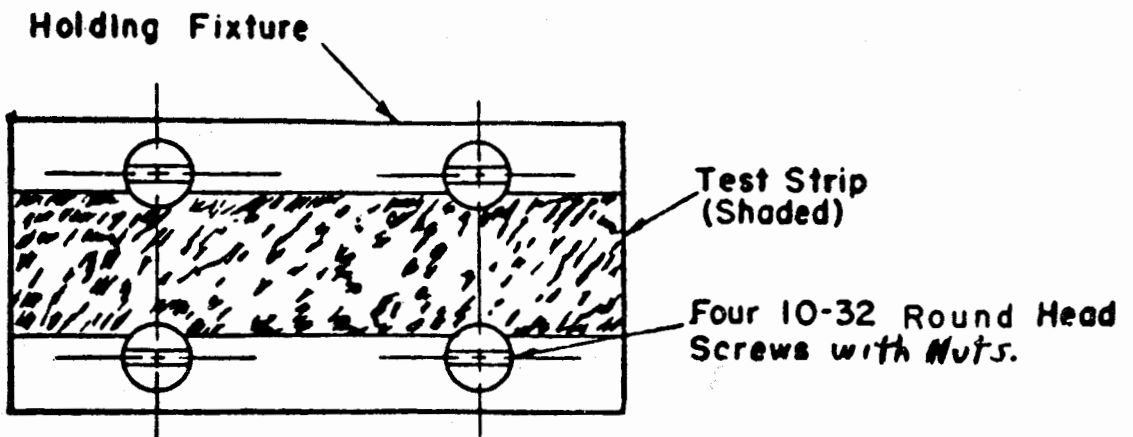
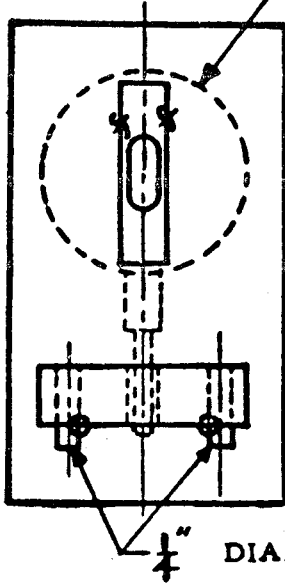
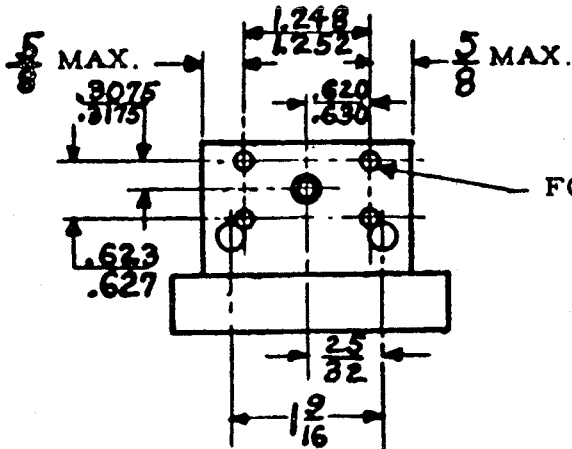
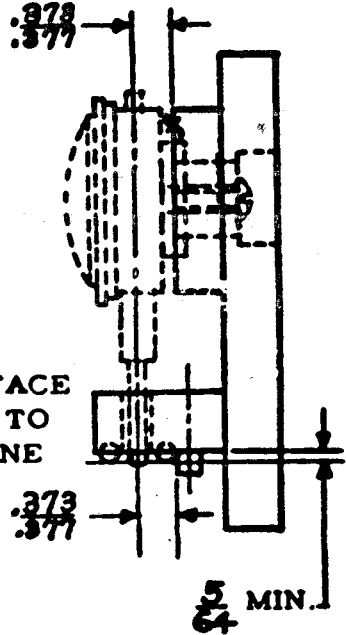


Fig. 4

DIAL INDICATOR, MAX. VALUE OF GRADUATION .001"
 COUNTER-CLOCKWISE BACK ADJUSTABLE BRACKET,
 LOW FRICTION JEWELLED BEARINGS, EQUIPPED WITH
 EXTENSION POINT.



CONTACT SURFACE
 OF ALL BALLS TO
 BE IN ONE PLANE
 $\pm .002$



FOUR 3/16" HARDENED STEEL BALLS

TEST GAGE
 FIGURE 5.