1990152

Volume 4

Issue 1

THE SHOT PEENER

Spring, 1990 INTERNATIONAL NEWSLETTER FOR SHOT PEENING—SURFACE FINISHING INDUSTRY

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THE ALMEN GAGE AND ALMEN STRIP

by Jack Champaigne

After the discovery that surface treatment by blast cleaning caused significant fatigue resistance improvement, John Almen devised a scheme to provide process consistency. Intensity of the shot blast stream was deemed to be a dominant variable to be controlled. Measurement of this intensity was made, by implication, with a test strip made of the same material as the valve springs being treated (SAE 1070 RC 45-50). By blasting, and therefore stretching, only one surface of the test strip the resulting curvature could be used as a measure of blast intensity.

By coincidence, Almen strip arc height in similar steel is equal to the depth of compression in the range of 0 to 9A. See Figure 1. This feature added merit to the use of the Almen strip as a control of the peening process. This relationship does not necessarily apply to other hardness ranges or to other metals.

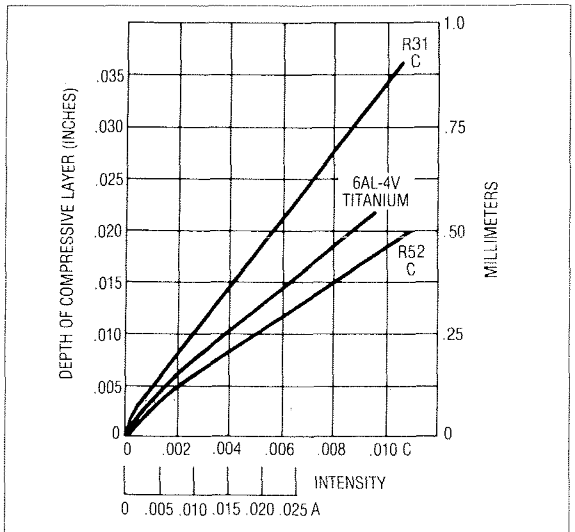

Fig. 1 Depth of Compression vs. Almen Arc Height, From **Shot Peening Applications,** Metal Improvement Co., pg. 6.

To assure an accurate intensity determination, several strips are exposed for increasingly longer times until no additional curvature occurs. The strip is said to be at saturation and this is a measure of the blast stream intensity.

John Almen's work led to issuance of U.S. Patent 2,350,440 in 1944. The gage he used, now referred to as Almen #1 gage, is similar to the present #2 gage except that instead of four round-balls supporting the strip, two knife edges were used. The Almen #2 gage was developed to accommodate the combination of span-wise and chord-wise curvature. See Figure 2.

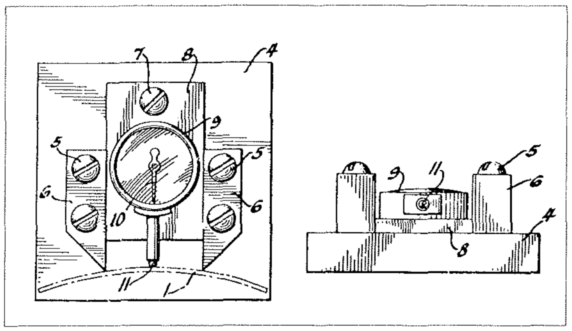

Fig. 2 Almen Gage from U.S. Patent. Elevation (left) and Side View.

The original test strip, 0.051" thick, was later supplemented with a strip of 0.031" thick referred to as the 'N' strip which led to naming the original strip the 'A' strip. Later, the 'C' strip, 0.0938" thick, was provided for very high intensity.

The performance relationship among the strips is shown in Figure 3. Generally the 'A' strip is used in the range of 4A to 24A.

The following steps describe the procedure of using the Almen strip to determine blast stream intensity.

1. Inspect the Almen test strip for conformity to applicable specifications. Generally, the chemistry, hardness and flatness are considered to be the dominate attributes.

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Performance Investigation

The Shot Peener has proposed a project to the National Center for Manufacturing Sciences to investigate Almen strip performance. Attributes to be studied include flatness, hardness, stress state, affect of oil on surface, affect of holding screw pressure, carbonization, etc. Any readers having additional suggestions should contact Jack Champaigne at (219) 256-5001.

The Almen Gage and Almen Strip *continued from page 1...*

2. Attach the strip onto a test block with four screws. Be sure the strip is held firmly and flat against the block (no shot between strip and block). The specifications for standard Almen blocks are shown in Figure 4.

3. Place the strip onto a fixture at a location that represents an area of interest of the actual part to be peened.

4. Expose the strip to the blast stream. Inspect the strip for coverage. Be sure blast stream targeting is correct. A helpful targeting tool is to use a surface coating, such as Dye Scan by Metal Improvement Co., which fluoresces under ultra-violet "black" light.

5. Remove the strip from the test block and measure its curvation on the Almen gage. The gage stem is placed against the non-peened surface. Be sure the gage has been zeroed using a zero block. The gage should be calibrated periodically, checking zero and span performance.

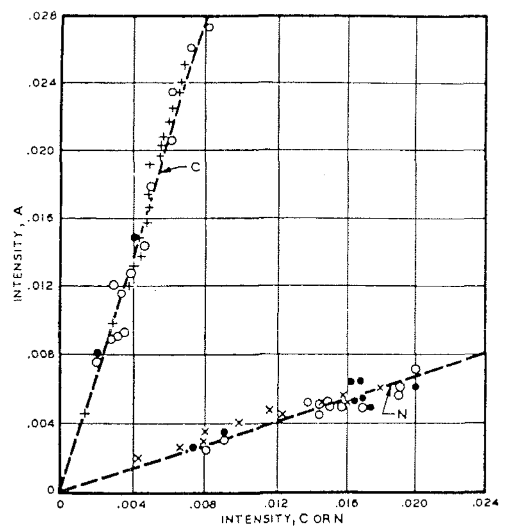

Fig. 3—Correlation of A, N, and C strips as checked on an Almen Gage No. 2.

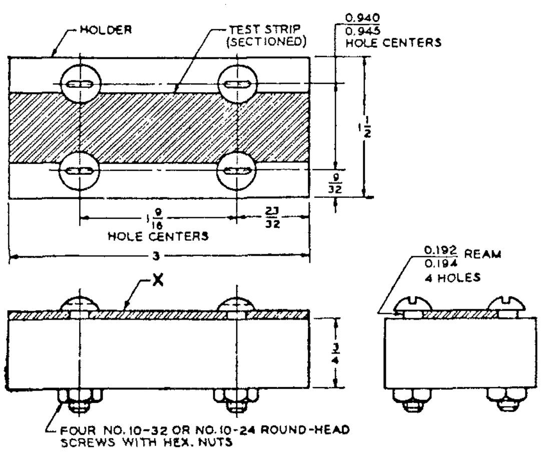

Fig. 4—Assembled Test Strip and Holder

6. Record the strip deflection, in thousandths of an inch, on a suitable graph.

7. Use additional strips at increasingly longer exposure times to develop the graph presentation.

8. When it can be determined that doubling the exposure time does not increase the arc height by more than 10%, then test strip saturation is achieved and the curvation, or arc height is the "intensity" of the blast stream.

ADDITIONAL COMMENTS

Periodic inspection of the Almen gage is required to preserve measurement accuracy. If the balls or stem are allowed to wear flat, the gage will not be accurate. Gage linearity should be verified on a regular calibration schedule.

The use of a zero block is important to maintain base line consistency. The practice of using the Almen test strip to zero the gage is not recommended. This practice encourages the use of non-flat strips where the difference reading is recorded. However, if the strips are archived and later remeasured, the true data is lost. Furthermore, non-flat strips are not likely to be stress-free and their performance may not be the same as flat, stress-free test strips.