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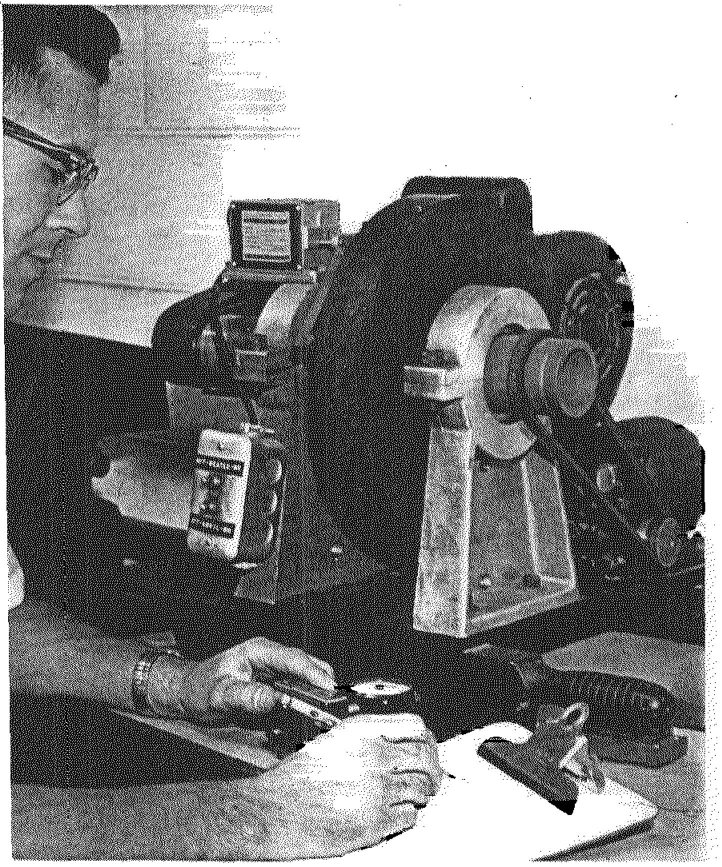

A Test for Blast Cleaning and Peening Media

By DAVID A. HALE

Simple in concept and operation, the Ervin Test Machine allows engineers to compare different blast media. "Essentially", says the author (photo above), "the machine duplicates the results of production blast cleaning or peening."

At our laboratory, we test and compare blast cleaning and peening media. The method we use, which calls for simple equipment, eliminates the necessity of "buying and trying" large quantities of many different types and sizes of media on a production basis. Furthermore, its use gives us more control than is possible on long-term production tests.

Using the Ervin Test Machine (Fig. 1) which we have devised, we require about a day to perform and analyze each test. About ½ lb of the medium is used, and results accurately predict effects in production machines. In fact, many customers not only rely on our test analyses, but also have purchased such machines to run quality control and comparison tests of their own.

Cleaning and Peening

Essentially, blast cleaning and peening differ only in results. In both, the shot strikes the part, transferring kinetic energy to it. With peening, the kinetic energy introduces compressive stresses into a surface. In contrast, the energy removes sand, scale and the like or etches the surface in a cleaning operation.

Machines and media used for peening can usually be employed for blast cleaning. The efficiency with which kinetic energy transfers from the moving shot to the workpiece is determined by the shot, provided that the characteristics of the peening machine and the workpiece load remain fairly constant.

Characteristics of Media

All types of media have three properties – hardness, mass and durability – which determine the efficiency of energy transfer and consequently, the economy of operation. Generally speaking, hardness and mass affect energy transfer and durability affects the consumption rate. However, all properties interact with one another, making the choice of the most effective and economical media a difficult task.

The Testing Machine

We developed the Ervin Test Machine (named for its developer) to compare blasting media for durability and efficiency of kinetic energy transfer. Modeled after an airless blast cleaning or peening machine, the machine consists of a throwing wheel, target and recirculating device which rotate together around a common centerline. The throwing wheel drives the material being tested against the target (an anvil or Almen test strip) at about

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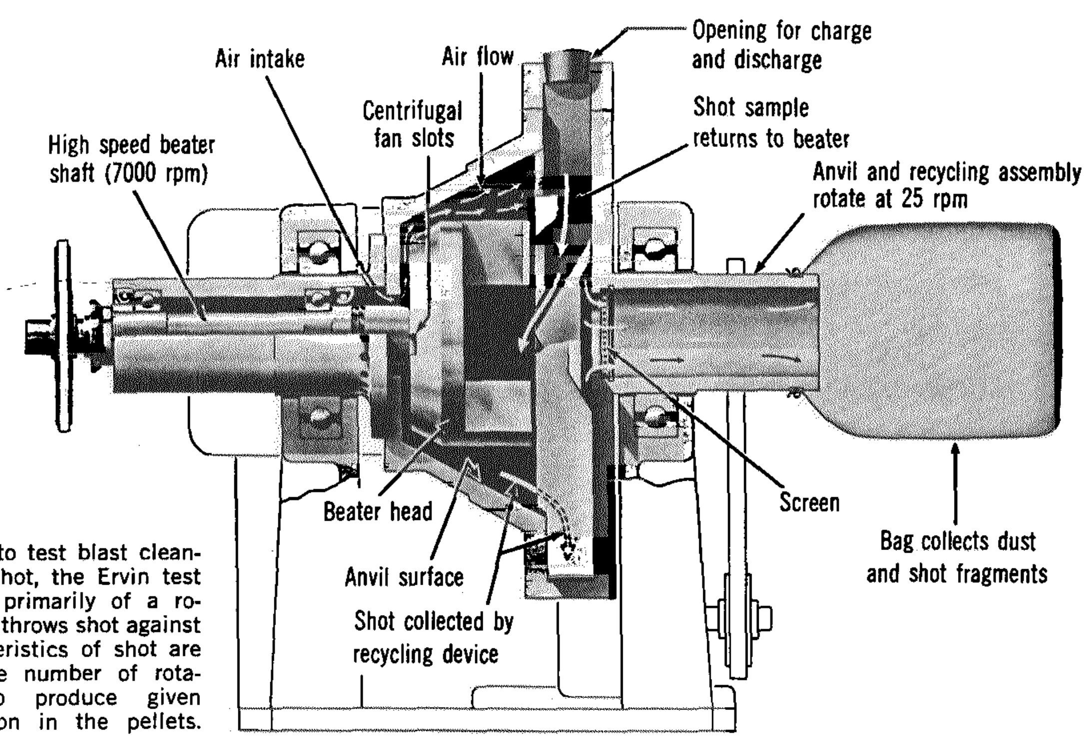

Fig. 1 — Designed to test blast cleaning and peening shot, the Ervin test machine consists primarily of a rotating wheel which throws shot against a target. Characteristics of shot are determined by the number of rotations needed to produce given degrees of attrition in the pellets.

200 ft per sec. Then, the material runs to the bottom of the recirculating device which picks it up and conveys it back to the center of the throwing wheel. A counter records the revolutions of the recirculating device; one revolution represents a complete pass of the medium through the throwing wheel. After a predetermined number of cycles, the machine shuts off automatically. Figure 1 shows the relationship of the working parts and the path of the medium.

Durability is determined by the number of passes against the anvil that are required to break the media to an unusable size. The effectiveness of kinetic energy transfer is determined with an Almen test strip; a section of the anvil is removed so that the strip and holder can be inserted. Several test strips are exposed to the blast from the throwing wheel for varying numbers of cycles, and the arc height and coverage are measured. The arc height at a given coverage is a measure of the effectiveness of kinetic energy transfer.

The testing machine essentially duplicates the results of production blast cleaning or peening. However, certain characteristics of production machines cannot be duplicated. For example, the angle at which the medium hits the workpiece is an important factor controlling energy transfer. In a batch-type of production machine, this angle varies slightly at different positions in the machine. For all practical purposes, however, this and other such variables can be treated as constants for a given machine.

Consequently, we can compare different materials under controlled conditions by this testing method. First, the performance characteristics of one type of media are determined in the production machine and by testing in the Ervin machine. Next, we ascertain how a suggested replacement material performs by testing it. Potential performance characteristics can then be predicted by comparing test results.

Testing for Durability

We determine durability by the "100% breakdown" test. In this test, 100 g of the material is placed in the machine and passed through the throwing wheel for a predetermined number of cycles. Considering the type and hardness of the medium, we select the number of cycles so that approximately 10 to 30% of the material will break down to an unusable size during one test run. The medium is then screened to remove unusable fines, and the remainder is weighed to determine the amount of loss. Then, we add more new material to make 100 g, and repeat the test until the accumulative loss for all runs is approximately 100%. This represents replacement of the original 100 g of material. The total cycle and loss figures are then interpolated mathematically to determine the number of cycles required to use up 100% of the starting material. Thus, the number of cycles indicates durability. Different media are compared by comparing the durability in cycles. Of course, we employ the same number of cycles for

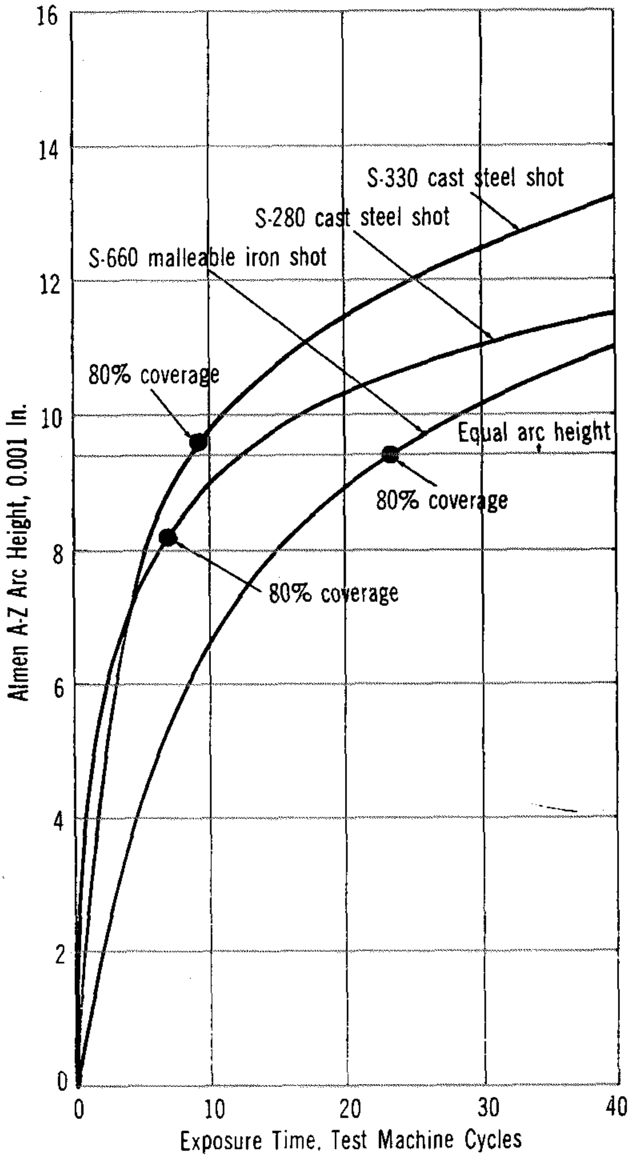

Fig. 2 — Tests of shot demonstrate that S-280 shot can replace S-660 malleable iron shot for blast cleaning thin structural members of heat treated steel. Compared to the latter, S-280 shot meets requirements by producing better than 80% coverage in much less than 22.8 cycles. In fact, the new shot will clean the members better (and with no more distortion) almost twice as fast.

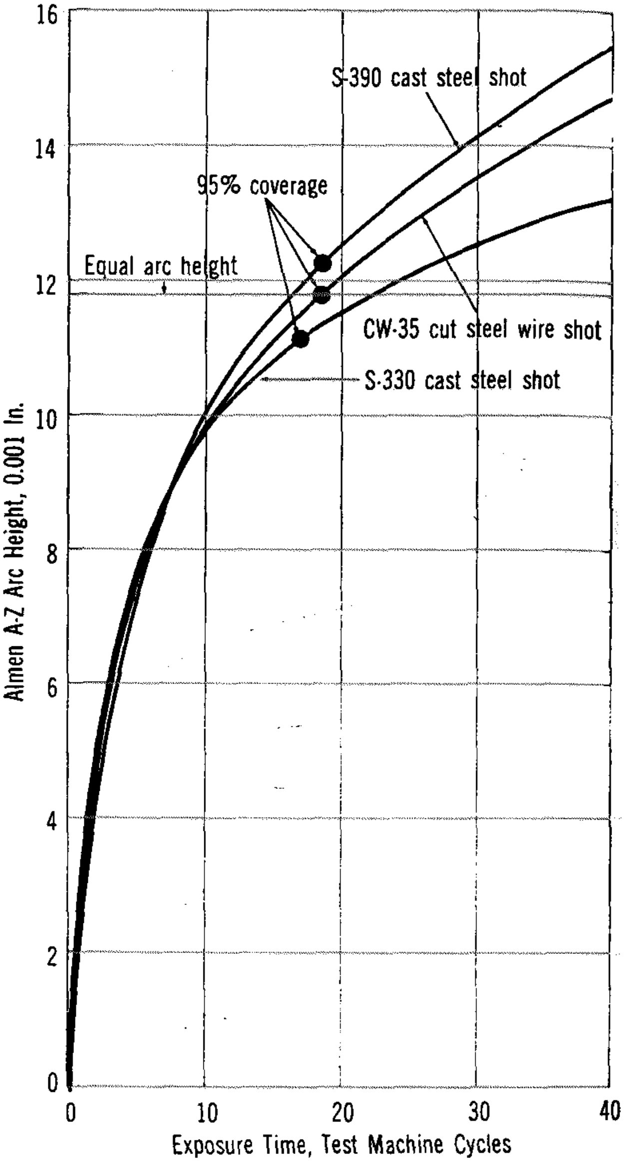

Fig. 3 — These results, determined through use of the Ervin test machine, led to the replacement of CW-35 shot with more economical S-390 shot for peening automotive leaf springs. It produced equal coverage with slightly greater arc height in less time.

each test run and the same size of screen to remove unusable fines to make the comparison valid.

To determine the efficiency of peening, we employ 50 g of the mix used in the last test run of the durability test and process several Almen strips. With the mix, we peen separate strips for 1, 2, 5, 10, 20, and 40 cycles, using a new strip for each test. Coverage is determined by measuring the area struck by the media. Also we measure the arc height of each strip, and plot it against exposure time in cycles. Comparison of these curves and coverage data for different materials give a relative rating of efficiency of energy transfer. Equal arc heights at equal coverage indicate equal energy transfer and thus equal peening or cleaning effects.

The test machine and procedure can be used to evaluate many factors related to the media and the production machine. These include velocity (which is controlled by impeller speed), average size (which is controlled by the machine separator setting), and the like.

For example, one of our customers was blast cleaning long, thin structural members of heat treated steel. He tried different types and sizes of shot. Some did not clean the work; others did, but peened the members, causing them to warp and distort which necessitated expensive straightening. Of the products he tried, S-660 malleable iron shot gave a tolerable distortion with approximately 80% coverage, all shot smaller than 0.0165 in. being removed as unusable. However, he wanted to clean the components with cheaper, more durable shot of cast steel that would cause no more distortion and clean at lower cost.

In the tests, we determined screen size distribution and hardness of new S-660 malleable iron shot. Then, durability was determined with the Ervin machine. Following this, we peened Almen A test strips with the operating mix at various exposure times. The arc height for each strip was measured, and the percent coverage determined on the strip exposed for 10 cycles. Finally, the number of cycles required for 80% coverage was ascertained according to the procedures set forth in SAE J-443.

According to our results, the S-660 operating mix required 22.8 passes to achieve 80% coverage. As Fig. 2 shows, this value corresponds to an arc height of 0.0093 in. Therefore, any shot that would satisfactorily replace the S-660 malleable iron shot in the production machine would have to produce 80% or better coverage at 22.8 cycles or less, and produce an arc height no greater than 0.0093 in. (The 80% minimum coverage at 22.8 cycles or less is required to produce parts which are cleaned as well in the same cleaning time or less, and arc height can be no greater than 0.0093 in. to insure that the replacement material does not produce more distortion than the S-660 shot.) Of course, the impact energy that distorts the part is the same impact energy that cleans it. Therefore, the arc height produced by the substitute material cannot be less than 0.0093 in. and still insure adequate cleaning. As a consequence, 0.0093 in. arc height is essential for the shot to do the job.

Past experience indicated that one of two sizes of cast steel shot, S-330 or S-280, would adequately replace the S-660 malleable iron shot. Therefore, we repeated the same procedure (testing for screening, hardness, durability, and peening efficiency) on S-330 and S-280 shot, and plotted the resulting data. Again referring to Fig. 2, at equal coverage (80%) S-330 cast steel shot produces 0.0097 in. arc height. Since this is greater than the 0.0093 in. arc height limit, S-330 cast steel shot was eliminated from consideration because it would produce too much distortion. However, S-280 cast steel shot produced an arc height of 0.0082 in. at 80% coverage, indicating no problem with distortion. At equal arc heights, 0.0093 in., coverages produced by S-660 and S-280 shot are 80% and 93.8%, produced at 22.8 and 12 machine cycles respectively. On this basis, the S-280 shot will clean parts better than S-660 shot, with no more distortion, and do it almost twice as fast.

A word of caution here. If substituted for the S-660 shot and run for the same cleaning cycle time in production, the S-280 will, according to Fig. 2, produce much more distortion. (Arc height at 22.8 cycles is 0.0105 in., much higher than the limit, 0.0093 in.) Hence, the cleaning cycle would have to be reduced to utilize the full potential of the replacement shot. Since S-280 cast steel shot is more than twice as durable as S-660 malleable iron shot, it is over four times as economical as S-660 shot. (We are considering only durability and rapidity of cleaning, not the difference in price; S-660 malleable iron shot is somewhat cheaper.)

Peening Leaf Springs

In the next example, we will consider a peening operation on automotive leaf springs. Here, the customer used SAE CW-35 cut steel wire shot with 95% coverage, all shot smaller than 0.0165 in. being removed as unusable. Arc height produced was in the middle of the range specified. Our job was to determine a size of cast steel shot that would do a comparable job of peening at lower cost. For the CW-35 shot, we ascertained size, hardness, durability, peening arc heights, and coverage. Arc height and exposure time data are plotted in Fig. 3. According to our calculations, 19.2 test machine cycles were required for 95% coverage; this produced an arc height of 0.0119 in. Consequently, a replacement shot would have to produce the same arc height at 95% coverage in the test machine to give production peening results equivalent to those of CW-35 shot. Since past experience indicated that one of two sizes of cast steel shot, S-390 or S-330, would be suitable, we ran tests of both. Again, Fig. 3 gives arc height and exposure time data.

Calculations demonstrated that CW-35, S-390 and S-330 shot produce 95% coverage at 19.2, 18.6, and 17.5 test machine cycles, respectively. However, S-390 and S-330 shot require 18 and 24 cycles, respectively, to produce an arc height of 0.0119 in. On the basis of these tests, C-390 shot was chosen to replace the CW-35 shot because it produced equal coverage with a slightly greater arc height (0.0122 compared to 0.0119 in.) in a little less time. Considering durability and rapidity of cleaning (but not initial price), CW-35 cut steel wire shot is worth 1.23 times as much as S-390 cast steel shot. However, S-390 shot is more economical because CW-35 shot costs 1.4 to 1.5 times as much.

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