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SHOTPEENING

by Fred K. Landecker
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The subject of shotpeening belongs in a sympo-
sium on “the reduction of mechanical wear”
because fatigue failures and breakages caused by
repeated use should be included in “wear.” Shot-
peening is a process that will give sensational
increases in fatigue life when applied to suitable
parts. It is beneficial to any part which is subject
to fatigue, shock, or impact. Some of the parts on
automotive equipment which show the greatest life
improvement are: springs of all kinds, gears, axle
shafts, crankshafts, and connecting rods.

In shotpeening we peilt a metal part with fine,
round shot by means of air pressure or centrifugal
force. This causes a plastic flow of the surface
layers and sets up a high residual compressive
stress in the surface. The depth of the layer which
is cold forged in this manner varies from 0.005 to
0.015 in., depending on material and intensity of
peening.

Shotpeening was formerly also called shotblasting. The term shotblasting is today usually ap-
plied to the cleaning process in which grit or
broken up shot is used to obtain abrasive action.
In contrast to this, it is important for shotpeening
that the shot used is round, as the corners of
broken shot will produce scratches which will act
as stress concentrations, and also it should be as
closely as possible of uniform size. The shot itself
fatigues and breaks up and must be separated con-
stantly while peening. The common steel shot sizes
used vary from 0.016 to 0.065 in. in diameter. The
smaller sizes have much wider applications because
the shot used should never be more than half the
size of the radius of the smallest fillet or corner.

We are able to measure the intensity of shot-
peening with a gage developed by J. O. Almen,
Research Laboratories, GMC, Detroit. With this
gage we use two sizes of standard steel strips,
which are bolted to a holding block and passed
through the same cycle of operation as the part to
be shotpeened. When these strips are shotpeened
on one side the compressive stresses developed in
the surface cause the strip to assume a curved
shape, as shown in Fig. 1. The curvature as read
on the dial indicator of the Almen gage (Fig. 2)
is a standard method of measuring peening inten-
sity. With this measurement we can accurately
duplicate and specify the desired peening intensity
at any time. It must be understood that the same
Almen intensity can be achieved in many ways,
and it is imperative that it is obtained by satura-
tion. Saturation is achieved when the part is uni-
formly and fully covered by peening to the desired
intensity. No advantage can be expected if this is
not accomplished. Fig. 3 shows two typical curves
which are found when plotting Almen arc height
over time of exposure. It can be seen that the
curves level out when the saturation point is
reached. It is important that the correct combina-
tion of variables, such as shot size, nozzle size, and
air pressure or wheel speed, is used, so that the
desired arc height is obtained on the level part of
the curve. If that is not achieved the part will have
spots which are not fully peened, and it is likely to
fail. Many reports on this subject tell about the
dangers of overpeening. In the author’s experience,
it is nearly impossible to overpeen, while, as has been shown, underpeening is a constant danger.

Under the auspices of the National Defense Research Committee, Mr. Almen's laboratories made many tests on shotpeening during the war. The case histories of these tests have been compiled in three books. Some of the charts from them will be presented here. Fig. 4 shows the test results of the valve rocker arms used in the GM truck engine. It can be seen that the four parts which were not peened had a life ranging from 17 to 57 hr, while the 12 peened ones were tested for 140 hr, at which time one rocker arm failed. The engine which was used for this test was run at a speed of 4000 rpm.

Test results on the fork type of connecting rod for the Rolls Royce engine built by Packard Motor Car Co. are shown in Fig. 5. This chart is especially interesting because it shows that shotpeening can save many man- and machine-hours by eliminating costly grinding and polishing operations. It is indicated that the rods which were shotpeened after rough finish outlasted many times over those which were polished.

Another way how shotpeening can save money to the manufacturer is proved in Fig. 6. This shows tests on carburized, low-speed sliding gears of a Fuller transmission. The two groups of bars on the left show the life comparison of unpeened and shotpeened gears made of SAE 4620 steel. The group on the right shows that the fatigue life of carburized shotpeened gears made of SAE 1020 steel is at least as high as that of the unpeened gears made of alloy steel. Considerable savings can be obtained when facts like these are kept in mind by the designing engineer.

Test results of another gear are shown in Fig. 7. This represents the fatigue life on final-drive ring
The Author

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Because the valves are very thin and had to be peened very lightly and because they were operated at a temperature above 500°F.

Fig. 10 is taken from a paper by O. J. Horger and C. H. Lipson. They report that shotpeening of straightened axles gives about three times the endurance limit of those not peened. This chart gives the S-N data on fatigue tests of rear-axle shafts. It indicates an endurance limit of 13,000 psi for the straightened, 20,000 psi for the not-straightened shafts that were not peened, and 43,000 for the shotpeened, production shafts.

These charts should give some idea of the tremendous increases in fatigue life which can be obtained by shotpeening steel. Shotpeening has been found to be just as effective on nonferrous metals. On some of these, as on magnesium and soft aluminum, it is necessary to use nonmetallic shot made of walnut shells, apricot pits, plastic, or glass. Shotpeening, as any work-hardening process, also produces a slightly harder surface. In some of the work-hardening metals as high manganese steel and inconel, the increase in skin hardness is quite substantial.

It was mentioned in the beginning that shotpeening sets up a residual compressive stress in the surface. Usually, we read about residual stresses only as harmful stresses. Residual stresses can also be used to our advantage and this is done very frequently, chemically by nitriding and carburizing and mechanically by shotpeening and surface rolling. To be valuable these residual stresses in the surface must be compressive because it has been proved frequently that a surface in compression will not fail. As practically all fatigue failures

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