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First International Conference on Shot Peening

Discussion by H.O. Fuchs
of "History of Shot Peening" by P.E. Cary

It may be useful to add a few words about the origins and early development of industrial shot peening.

Although the earliest publication (Foeppl, 1929) and the earliest patent application (Verwerk, 1934) were found in the German literature, it seems that the process first was applied in production and developed in the United States, without benefit of the German work.

Bush, Almen, Danse and Heiss (1962) recall that about 1928 the service life of valve springs was a subject of concern. Various methods of cleaning were tried. Danse at Cadillac and Heiss at Buick observed that springs cleaned by shot blasting were clearly superior. A change request by C.A. Chayne of Buick, dated 12-3-30, reads in part:

> "Note added: Shot blast with steel shot of 0.30 or less diameter.
>
> Cancel note: Wire brush springs all over to remove all abrasive
>
> Reason for change: To clean springs thoroughly - manufactucturer's request."

The process was used in production, but the reasons for its success were not understood. Zimmerli (1940a) reported on these early developments, from the spring makers viewpoint. In a summary of this paper (1940b) he starts by saying, "Shot blasting has done more to increase fatigue life of our small springs than any of the alloy steels ever used."

J.O. Almen, inventor of engines, transmissions, and many other devices, then devoted himself to the investigation of shot peening. He told me that he changed from inventing mechanical devices to the study of fatigue life improvement because he was tired of having his designs second-guessed by administrators. He soon proclaimed that residual stresses (self-stresses) were the cause of the improvement, that stresses could not be calculated from loads and geometry alone, and that fatigue cracks would not propagate unless tensile stresses were present. (Almen, 1951).

During the war, 1941 to 1945, shot peening spread from the automobile industry to the aircraft industry and others, largely through the missionary work of Almen whose efforts were supported by a government grant. He started the SAE committee on shot peening in 1943 and was its guiding spirit. In 1944 John Straub, one of Almen's assistants, transferred from General Motors to Wheelabrator Corporation to work on using their machines for shot peening applications.

Almen's views were unorthodox at the time, and strongly resisted by some academics. But they prevailed and were eventually legitimized through the development of fracture mechanics.

By 1950, twenty years after its beginnings, shot peening was well accepted and discussed in engineering handbooks. (Almen 1950, Horger 1964.)

Peen forming was developed about 1950 when Lockheed designed the Super-Constellation, using skins on which the stiffening stringers were integral parts of the skin, machined from a thick plate of aluminum. Forming such skins in presses is not practical. Borger (1955) conceived the idea of peen forming and Metal Improvement Company designed the machine and developed the process to peen form the the wing skins for Lockheed.

References

Almen, J.O. (1950). Shot peening. In C. Carmichael (Ed.) Kent's Mechanical Engineers' Handbook, 12th edition, Vol II, pp. 20-40 to 20-49.

Almen, J.O. (1951) Fatigue failures are tensile failures, Product Engineering Vol. 22 No. 9, pp. 101-124.

Borger, J.C. (1955), Method of cold forming sheets. U.S. Patent 2,701,408, filed Nov. 19, 1951.

Bush, G.F., J.O. Almen, L.A. Danse and J.P. Heiss (1962) How, when, and by whom was mechanical pretressing discovered. Report to Division XX of the Iron and Steel Technical Committee of Society of Automotive Engineers.

Foepp1, O. (1929) Das Druecken Der Oberflaeche von Bauteilen Aus Stahl. Stahl und Eisen, Vol. 49, pp. 575-577.

Horger, O.J. Ed (1965), ASME Handbook Metals Engineering - Design, 2nd edition.
pp. 134-155 Horger on Residual Stresses 177 refs.
pp. 258-263 Straub on Shot Peening 9 refs.
pp. 264-277 Horger on Cold Working 56 refs.

Vorwerk, P.O.F. (1934), Spring having its surface layers compacted, U.S. Patent 1,946,340, filed in Germany, 16 October 1929.

Zimmerli, F.P. (1940a) Shot blasting and its effects on fatigue life. Preprint No. 51, American Soc. for Metals, October 1940.

Zimmerli, F.P. (1940b), How shot blasting increases fatigue life, Machine Design, Vol. 12 No. 11, pp. 62-63.