PRODUCTION SHOT PEENING

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A GOOD example of the shot peening process set up on a mass production basis is afforded by the peening department at Cadillac Motor Co., Detroit, to set up residual compression in the surface fibers of connecting rods for the Allison aircraft engine.

It is generally accepted in the automotive and aviation industries now, largely as a result of work carried on over a period of years by the Research Laboratories Division of General Motors Corp. and others, that the residual surface compressive stress set up by shot peening greatly increases the fatigue life of parts in tension or torsional stress.

The compressed surface layer acts to offset the tension stresses induced by bending or torsional loads, so that fatigue cracks (which enlarge and cause failure) do not start until a great number of cycles of load stress have taken place.

Shot peened gears, for example, failed at 931,000 cycles, whereas similar gears not shot peened showed a normal life of 111,000 cycles. In his paper "Shot Blasting to Increase Fatigue Resistance," J. O. Almen, head of the Mechanical Engineering Department No. 1, Research Laboratory Division, General Motors Corp., reports as the result of this process: 310 per cent life improvement on transmission main shafts, 600 per cent on hypoid gears, and 520 per cent on U-joint crosses.

Department Built Around Conveyor System

At Cadillac, the shot peening equipment is located in an enclosed room, with an endless overhead monorail chain conveyor entering and leaving at one end. The exterior loop of the conveyor passes around benches where girls mask the connecting rods and where the shot peened rods are taken off the conveyor hooks ready for the next operation.

Two kinds of connecting rods are peened—blade and forked. The blade rod works inside the split (forked) rod, and it is masked by metal disks. Bolt holes are plugged. Such masking is necessary to confine the shot peening action entirely to the stressed areas, particularly the fillets. The blade rods are peened simply by passing them through the stream of metallic shot produced inside an American Wheelapeening table-machine. This machine has a number of round tables that revolve while under the rain of shot so that all surfaces are peened. A second pass with the rods reversed peens the opposite side. Two of these machines are used in the department.

Peening of the forked rod presents a more difficult problem. All surfaces and fillets except the inside of the fork are peened in the peening machines; the bearing surfaces, bolt holes and certain inside areas of the fork being masked, as shown in the illustrations. Forked rods are then mounted on special fixtures to hold the fork end upright while they are passing through the shot stream in a cabinet type Wheelapeening machine.

The operation of the cabinet-type machine is of special interest. The heart of the machine is a rapidly rotating bladed wheel, to which is fed a stream of chilled metallic shot. The blades throw the shot tangentially onto the work, in much the same manner as one would throw an object held loosely in the hand. A carrier passes back and forth under the shot stream, and on this is placed the fixture carrying the forked rod. Two access openings are provided so that the carrier can be loaded at either end of its travel. The spent shot is collected, elevated to the top of the machine, cleaned of dust and broken shot, and used over again.

Peening Transmission Gears

In a separate department, automotive transmission gears are shot peened for longer service life. Here is located an entirely different American cabinet type Wheelapeening machine which will shot peen a number of gears mounted on a spindle, in one pass under the shot stream. On the spindle also is a roller (Please turn to Page 131)
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which engages with other rollers inside the peening compartment to impart a rotary motion to the gear spindle. This combination of rotating and linear motion insures thorough peening of the roots of the gear teeth.

The intensity of shot peening, which is a function of wheel diameter, wheel speed, size of shot and hardness of shot was determined in advance by tests. Number of passes and speed of work through machine were selected to give thorough coverage. Through fatigue tests in a laboratory, the intensity of peening that produced the most satisfactory results was determined. The intensities tested were measured by the Almen gage, on which a dial reads the arc of curvature of a test strip, one side of which has been shot peened (the stretching of one surface of the strip causes the strip to become "dished" in shape). For example: If fatigue tests of a part show a maximum life at a peening intensity of 0.014-inch, the conditions that produce that intensity are standardized on the commercial peening process. The gage was invented by J. O. Almen.

Delivery Chamber
Blankets Fire

For foam fire protection on pressure type oil storage tanks, a foamite delivery chamber is said to provide an easy means of applying a blanket of fire-smothering foam to burning oil surfaces, and yet prevent release of tank pressure.

A glass diaphragm seals the inlet of the passageway to the tank, permitting the top plate of delivery chamber to be removed for painting or for diaphragm inspection without releasing any tank vapors. The diaphragm is glazed in a removable steel frame, and extra framed diaphragms may be kept in stock. Lip of frame gives support to resist tank vapor pressure. The diaphragm ruptures at a very low pressure from the upper side.

A deflector, permanently attached to the throat, is said to eliminate special baffle installations, discharge being deflected with a rotary motion against tank shell and down to the oil surface without undue disturbance of the liquid or foam breakdown.

A 6-inch adapter flange may be mounted over an opening cut in tank shell, or the tank manufacturer may furnish a studded flange for welding around the opening. If a chamber is to be installed later, a blind flange may be bolted over the opening.

Use of the Evertite delivery chamber is said to avoid the practice of using ordinary pipe connections discharging directly into the tank near the roof, which may result in the fire draft throwing much of the foam outside of the tank.

44 BILLET GRINDERS IN A ROW
SERVED WITH 9 TYPE D ROTO-CLONES

This picture, taken in one of America's leading steel mills, shows a pronounced absence of dust all along an impressive lineup of swing frame grinders. Dust is drawn into the individual booths by the rapid flow of air induced by the Roto-Crones and precipitated by their rotating impellers— at the rate of a ton a month per unit.

Roto-Crones has but one moving part and requires the very minimum of maintenance; is extremely compact and can be placed close to the equipment it serves — with resulting savings of space and piping and power. These advantages and its high dust separating efficiency have led the operators of this same plant to purchase 16 additional Roto-Crones for other dust collecting jobs. Consult with AAF engineers about your dust problem — there's no obligation. Send for Bulletin 272.
Shot Blasting Gears to Improve Fatigue Life

Shot blasting is being utilized in production at transmission plants of Chevrolet Motor Division to substantially increase the fatigue strength of gear parts.

Surface peening by means of shot is effectively carried out at Chevrolet's Toledo plant by means of a cleverly devised fixture which exposes all wear portions of the gear teeth to direct and right-angled blast in a closed chamber. This conforms to requirements outlined in recent papers by J. O. Almen, of General Motors Research Div., who specifies that the most effective use of the surface peening technique lies in directing the shot at 90 deg. angle to the surface at the ends and the roots of the gear teeth.

In the production procedure at Toledo, gears are mounted on an arbor which fits onto the open end of a Y-shaped fixture or yoke. Rubber belting slipped over this arbor is used to rotate the gears at a preselected speed. At the same time the entire fixture oscillates on its longitudinal axis, at a right angle to the arbor axis. This latter movement covers an arc of 45 deg. each way from horizontal. The entire fixture is mounted on a vertical arm which swings out to permit ready positioning of the gears, and then swings back into a standard Pangborn Roto-blast shot-blasting machine.

The showers of shot impose steady wear on the supports of this fixture necessitating replacements at regular intervals. Angle iron is used for the forward corners, this having been found the best wear-resistant material.

No. 26 chilled steel round shot of 0.025 to 0.035-in. diameter is used. A wheel of 13-in. diameter, turning at 3300 r.p.m., mounted above the gears, directs the shot at approximately 200 ft. per sec. The shot then drops through grating on the floor of the installation and is returned through a closed circuit to the im-peller wheel. The size of the shot is controlled by regular sift checks.

Installations for the shot blasting of gear parts in other Chevrolet plants utilize air pressure to produce a high velocity shot stream. Here the cabinet in which the parts are placed is usually mounted directly above a mixing chamber into which the shot is returned through open grates in the floor of the cabinet. In this chamber, air and shot are mixed and conducted through a rubber tube to a nozzle in the cabinet.

At Toledo, the shot blasting is utilized on first speed gears and first speed countergears of a 1½-ton truck transmission. The low-speed gears are mounted on the fixture three at a time, as illustrated, the countergears one at a time. Rotation of the pieces is at 22 r.p.m., actuated by a 1/4 hp. motor with speed-reducer and crank action. This motor also serves to swing the gears back and forth through the 90 deg. arc on the longitudinal axis.

The shot spray is left on for 30 sec. Research has established that a perfectly controlled cycle is 16 sec., but the longer period is specified to permit less expert supervision. A longer cycle than 30 sec. has been proved unnecessary.

The gears which are thus treated are of SAE 8820 steel, previously hardened. There is no subsequent grinding, for obviously any such operations following the shot-blasting would remove the surface and relieve the compressive stresses induced during the peening, thereby destroying the beneficial effect already achieved.

This installation first went into use in May, 1941. Before that time, dynamometer tests gave the gears a life of 2½ hr. at torque of 200 ft.-lb., the maximum engine torque in installed positions in engines being 170 ft.-lb. By use of the shot-blasting technique, these pieces now stand up for 40 hr. under the 200 ft.-lb. torque test.

This is the fixture devised by Chevrolet for its shot blasting of gears at Toledo. Three first speed gears are mounted ready to be moved into the chamber for peening treatment. At this point the rear arm of the fixture is nearly at the top of its 90 deg. arc. When shot blasting begins, it will swing downward while the arm in foreground rises, this oscillatory movement being actuated by the same motor which drives the rubber belting slipped over the arbor on which the gears are mounted.