HAMMER PEENING TREATMENT

Some of the cases in this report deal with a pre-stressing operation designated as hammer peening. A brief description of this method of peening follows.

Hammer peening is a method of cold working a surface. In certain cases it can be applied more readily than other cold working treatments such as shot peening and surface rolling. The process consists essentially of pounding the surface to be cold worked with a blunt nosed tool. The operation may be performed by hand with a ball-peen hammer or with variously shaped punches and a hammer; or by a pneumatically operated hammer. In general, the pounding is of sufficient severity to cause local plastic flow. All portions of the surface to be cold worked must be covered. This is usually judged by eye.

Frequently, special tools are made for special purposes. For example: for the hammer peening of oil holes, a tapered punch may be used or a series of punches of various amounts of taper may be used.

A special pneumatically operated hammer described in detail below was used in much of the hammer peening work reported here.

PNEUMATIC HAMMER PEENING TOOL

A commercial pneumatic hand grinder was modified. As shown in Fig. 164, an unbalanced weight was attached to the spindle. An adapter was added to house the unbalanced weight and to receive the hammer. A photograph of the assembled tool and hammer is shown in Fig. 165.

A centrifugal force of the unbalanced weight, as the spindle is rotated, causes a vibratory motion of the hammer which exerts a peening action when it is brought into contact with a work surface. The severity of the peening action exerted by the hammer depends on the amount of unbalanced weight attached to the spindle and on the speed of rotation of the spindle.

Various shapes of hammers are used to suit the conditions required. See Figs. 166, 167.

The tool is portable but requires a supply of compressed air for its operation.

APPLICATION

Hammer peening is well suited for peening holes. A hammer with a circular type head is used as shown in Fig. 166. The O.D. of the hammer head is made a few thousandths of an inch smaller than the diameter of the hole. The hammer is inserted into the hole as shown in Fig. 169 and then moved up and down several times in the direction of the hole axis. The process is continued until the surface of the hole has been thoroughly peened.

As shown in Fig. 168, fillets may be hammer peened. Wedge shaped hammers as shown in Fig. 167 are used. The hammer is moved back and forth along the length of the fillet until the fillet surface has been thoroughly covered by the peening action.

Hammer peening has been found to be a useful method of pre-stressing many machine parts in the field (see Fatigue Case 100).
PRE-SETTING TREATMENT

Pre-setting is a type of pre-stressing obtained by over-loading the part or specimen in the direction of the applied load beyond the yield point of the material that a permanent set results. This process may be used for parts which are loaded particularly in one direction in torsion or bending and is commonly used on springs. It is often referred to as pre-setting, pre-stressing, scragging, bull-dozing or pre-loading. In this process, the areas of high working stress become favorably residually stressed in compression. In operation, the actual stress is the algebraic sum of the residual stress and the load stress. Therefore, the true stress at the surface is less for the pre-set specimen or part than for the one which has not been pre-set.

To illustrate this phenomenon, Fig. 170 shows schematic diagrams of the stress distribution in a simple beam as altered by the pre-setting operation. If it is assumed that initially there is no residual stress in the specimen, the stress distribution would be as shown by A, Diagram 1. If a bending load is applied so that the maximum stress is lower than the yield point of the material, a stress distribution as shown by B, Diagram II, would be obtained. If this bending load is increased so that the stress near the surface exceeds the yield strength, plastic flow will occur and the stress distribution would be that shown by C, also Diagram II. Now, if the bending load is removed, the specimen will be found to take a permanent set and the specimen would be residually stressed as shown by D, Diagram III. The material near the surface on the top side of the specimen is residually stressed in tension and the material near the bottom side is residually stressed in compression. The beam is now “pre-set”. For a load now applied in the same direction, the stress distribution will be according to E shown in Diagram IV. Near the surface the actual stress will be less by the amount of the residual stress as illustrated by “X”, Diagram IV. For comparison, the dotted line shows the stress distribution for the beam if not “pre-set”. It can be seen that a substantial gain in the efficiency of the use of material can be made by the operation of pre-setting.

In the case of torsion loading a similar gain can be made by pre-setting. The treatment is used, for example, on torsion bar springs. Fig. 171 shows the schematic stress distribution diagrams illustrating the introduction of favorable residual stresses by pre-setting (or over-loading). Torsional stress is plotted vertically and the radius or
the bar horizontally. The circle indicates the diameter of the bar. The stress at Y is the yield stress of the material. If the bar is twisted but not to the point of yielding the torsional stress varies directly with the radius and the stress distribution is as shown by the dashed line B. If the bar is twisted so that the stress exceeds the yield strength of the material, the stress distribution is in accordance with the dotted line material beyond the radius corresponding with point R has yielded or has been plastically deformed while the core material has been stressed elastically. As the load is removed, the stress at any radius changes by an amount proportional to the radius. When the load is removed, it will be found that the bar has taken a permanent set or twist. The stress remaining in the bar must be in equilibrium and their distribution is shown by the solid line D or the shaded area. The material near the outside diameter which was up-set by yielding is now negatively residually stressed in torsion as shown by the amount X. The bar is now "pre-set".

After pre-setting if a twisting load is applied to the bar in the same direction as before, the stress distribution would be in accordance with the cross line E. This may be compared with the stress distribution shown by the dashed line B which is for the same load but applies to the bar before pre-setting. The stress at the surface is less for the pre-set bar than for the bar before pre-setting. It is less of the residual negative stress X which was introduced by the pre-setting treatment. It can be seen that a improvement in the utilization of material can be made by pre-setting loaded members in this manner.

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**Fig. 171 - Schematic stress distribution diagram showing the introduction of favorable torsional residual stress by pre-setting.**