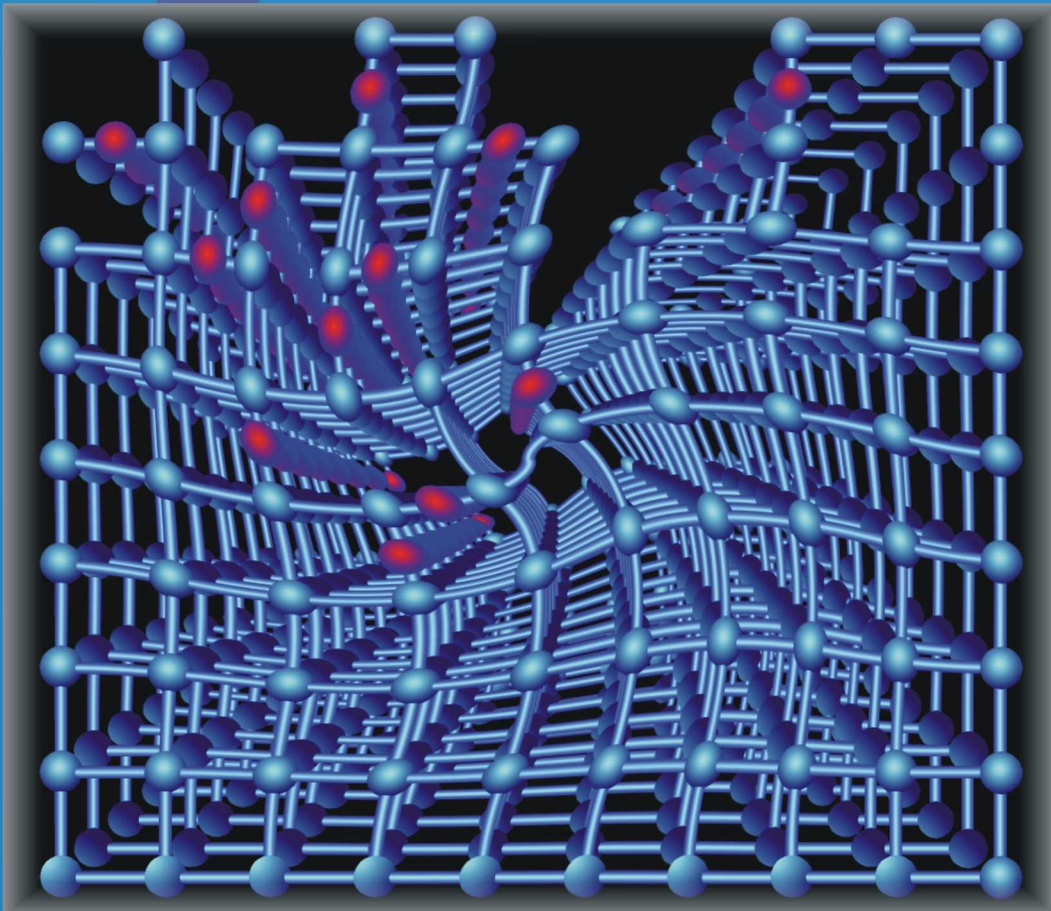


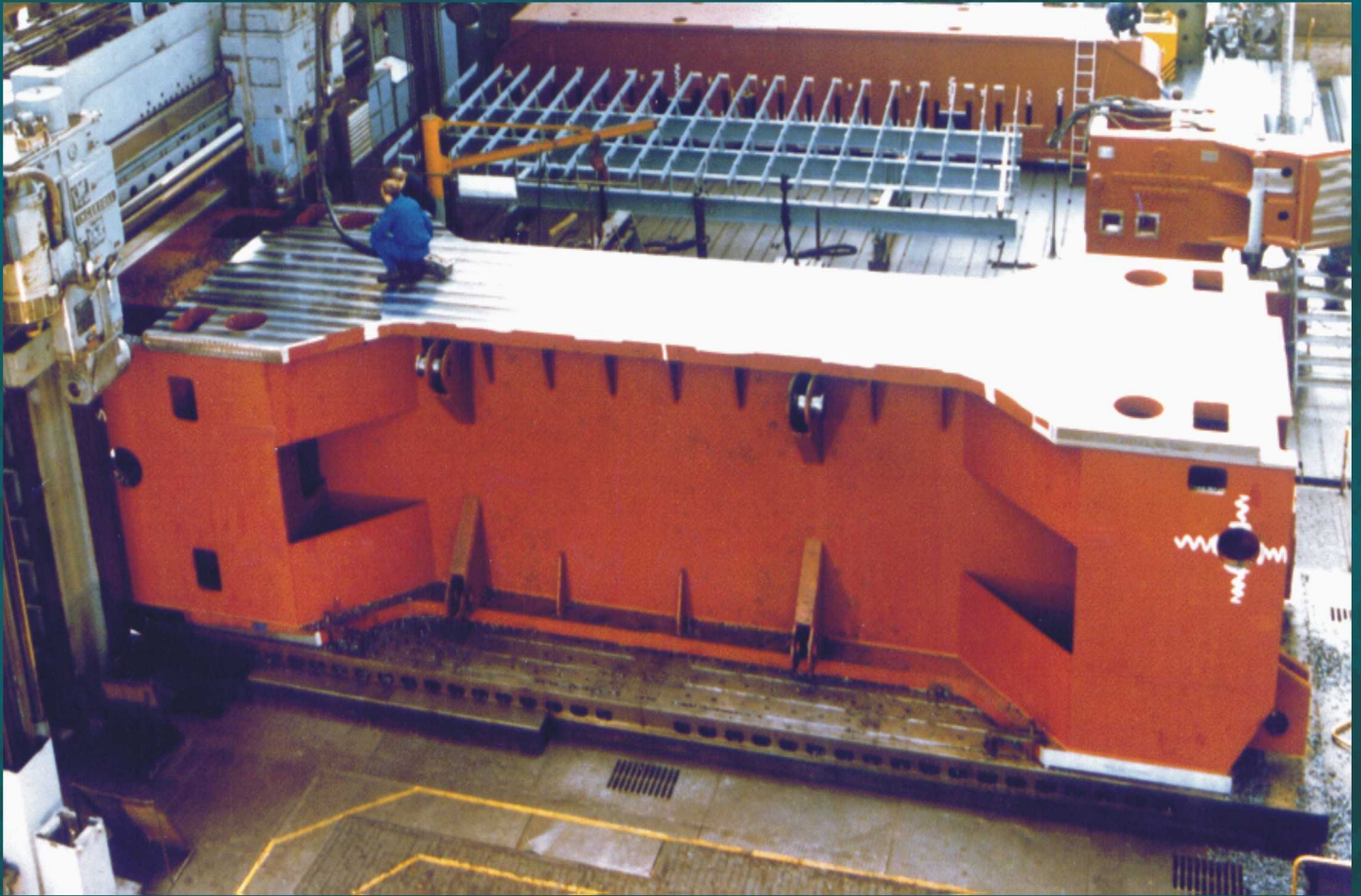
VIBMATIC 6000

The procedure for stress reduction
on welding and cast constructions



... dimensioned manufacturing without distortions

VSR means **V**ibration for **S**tress **R**eduction



What is the **VSR** process?

It is a metal physical process where the workpieces would be stabilized in their dimension.

By a specific vibration treatment with discrete frequency, lost workpieces from 100 kg up to 200 tons their critical incline, move during and after the mechanical work, so that no low tolerances could, or only with very high finishing expense, be kept.

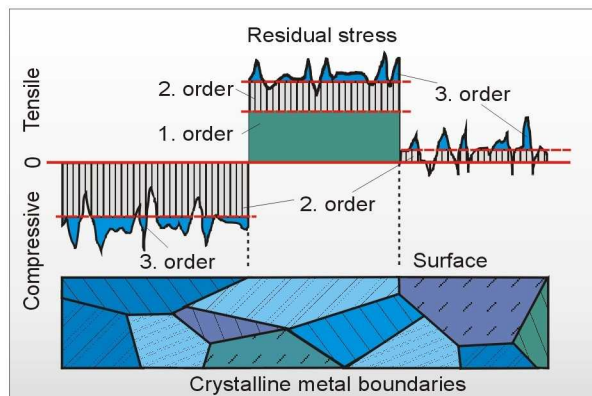
Therefore, one can justify the saved expense costs with the many advantages tied together in respect to replacing stress-relief annealing.

Hundred of such vibration systems are in use since 1975 worldwide.

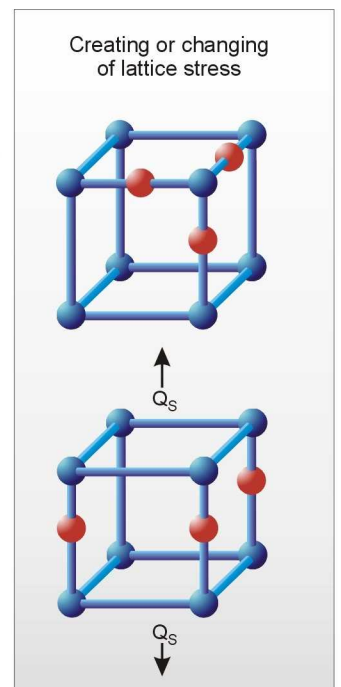
The continual increasing quality standards and corresponding newest state of technology, has given reason to the development of a new hardware and software, that would be introduced under the product name VIBMATIC and would be tied to the use of the past model MX 800 and FOURIERMATIC KD 16.

How does the **VSR** process work?

The microprocessor program of the VIBMATIC control unit uses a Fourier-type method to determine the optimal treatment frequencies of the component or workpiece. In this way, a maximum number of vibration conditions is achieved in the individual zones of the component. The material is optimally kneaded, thus stabilizing its previously instable condition. The parts become inert and can no longer settle and warp as a result of machining operating stresses.



Expansion areas of residual stress of first, second or third order and as micro or macro stress.



Re-arrangement of carbon atoms at interim lattice positions.



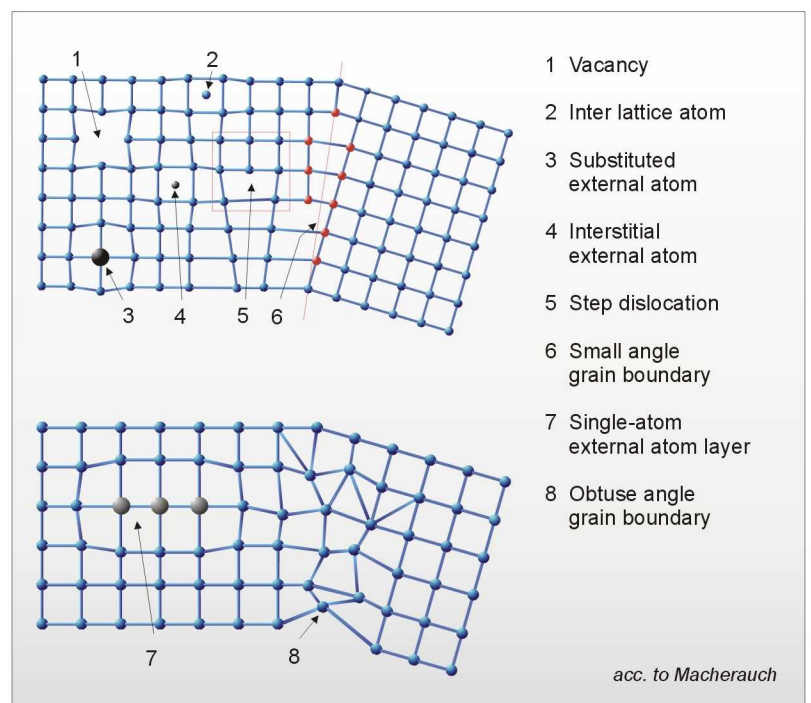
Not only in the macro-range but especially also in the micro-range, the internal stress peaks are reversed, equalized, reduced and stabilized. This is also known as relaxing.

If internal macro-stresses are removed or built up during machining or operation, unstable internal micro-stresses in the material may react by deforming into a single direction, i.e. the material warps and cracks may form.

With a vibration-relaxed workpiece, this effect is almost unknown because the lattice matrix in the material is dimensionally stabilized.

With this kind of stabilization, the median macro-stress level is largely unaltered. This has been the subject of most scientific investigations to date and is useful to show the effect of stress-relief annealing. But the internal micro-stresses resulting from dislocation, cavities, interstitial atoms, mixed crystal inclusions and grain boundary defects are brought into equilibrium, well below the nominal yield level, by transposition processes in the lattice and by local flow.

The workpiece becomes dimensionally stable and extremely resistant to deformation.



Various lattice defects arranged in points, line areas, and three-dimensional forms.

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The main advantages of the **VSR** process are as follows:

- Dimensional stability of workpieces is achieved, which is usually as good as, or in most cases better than, that produced by stress-relief annealing, i.e. the deformation behavior is just as good or even better.
- The vibration process results in significantly less distortion during relaxation than when annealing is used.
- Energy consumption is very low compared to annealing. This saves resources and reduces costs.
- The treatment time of approx. 30 mins. is short. Vibration of a workpiece is normally carried out, in the condition as supplied and prior to final machining.
- The work processes involved in annealing, such as transport, descaling, repriming, and correcting distortions, are unnecessary.
- Smaller over measures for machining can be used. This saves material and reduces machining times.
- Even in the case of large components, tolerances in the range of hundredths of a millimetre can be met.
- Workpieces of 100 kg to over 200 t can be treated by the VSR process, which is suitable for, among others, all welded, rolled, forged and cast parts made from all usual steel and iron materials.
- Distortions and cracks during welding, or repair, can be reduced or avoided.
- The mechanical quality values, e.g. COD, can be improved.
- The limits to this metal physical process, e.g. for use against stress crack, corrosion cracks due to dynamic service load, and hydrogen embrittlement, have not yet been finally determined, although many positive indications for a successful VSR application are already available.
- The strength values remain unchanged. Dynamic cracks can not occur as the treatment time is too short, and the vibration loads and amplitudes are far too low.
- Major savings are possible through rationalization, quality improvement, reduction of scrap and shorter fabrication times, because parts which would formerly not have been annealed, due to cost reasons, can now also undergo stress-relief treatment.
- Extensive research literature on vibration stress relief can be obtained through the BAM in Berlin, among others.
- **The VSR-process is the simple and reliable process for eliminating stress problems of stainless and DUPLEX steel.**



VSR treatment procedure

The workpiece is placed on rubber pads so that it can vibrate. The vibrator and accelerometers are clamped to a point, which should be as stiff as possible, whereby the vibrator should, if possible, not vibrate parallel to one of the main axes. In this way, the wave energy reaches all parts of the workpiece the best. It also avoids the build-up of local vibrations of large amplitudes which can become dangerous in time.

The vibrator speed is automatically increased by the processor control. Through the signal of the accelerometers, the treatment frequencies, applicable to the workpiece (up to 100 Hz), are analysed together with the upper frequencies (up to 2 kHz), and are evaluated by the micro-processor and recorded.

Those treatment frequencies are determined, which cause a maximum number of over amplitudes, thus resonance is produced in a maximum number of areas of the workpiece to allow relaxing. At the same time, the current consumption of the vibrator motor at these frequencies is stored.

The values described above are displayed graphically and alphanumerically, whereby the time is also taken into account. Vibration is then carried out at the determined frequencies until the vibrators current consumption falls to a new lower level and remains constant. The reduction of motor current consumption generally lies within a range of 5% to 50 % below the previous figures. If required, the automatic control can be replaced by manual operation.

The treatment time is up to 30 mins. The workpiece is now stabilized and will deform only within very small, tolerable limits during subsequent machining, usually much less than with stress-relief annealing.

Treatment is carried out on the workpiece in its, initial state, i.e. as supplied, and should, if necessary, be repeated prior to end finishing where very tight tolerances have to be met.

The printer will print out a treatment record showing the treatment data as evidence that vibration stress relief has been carried out.

VSR means **V**ibration for **S**tress **R**eduction



Equipment design

Control unit VIBMATIC: (III.1)

- Industry-PC with Hard disc
- CD-ROM-drive
- 3½" floppy disk drive
- 12" LCD- color monitor
- Keys und mouse pad
- Frequency converter
- Motor control
- Accelerator card

The PC has a modem with ISDN connection, in order to obtain, when necessary, updates of the program, or evaluation supports online by the service company, or directly by the manufacturer.

Accessories:

- 2 Accelerometer (III.2)
- 2 Fixing clamps (III.3)
- 4 Vibration pads (III.4)
- 1 Color monitor (III.5)
- 1 Vibrator with frequency-controlled motor 3 phase (III.6)
- 1 Stroboscope (without III.)

Areas of application

Application before and after machining

Above all, the VSR process prevents the material from becoming deformed, during and, as a result of machining. It is stabilized, enabling exact tolerances to be achieved. Treatment is so rapid and easy that more parts can now become vibrated than were formerly annealed. One feels more confident and is able to cut away greater amounts of metal during machining, without fear of critical deformations occurring.

Application for bending

With high-tensile structural steels, vibrating produces greater ductility. This makes them easier to bend without being bound to the technical values of the material.

Vibration instead of annealing

As a physical process for treating metal, vibration cannot always replace the metallurgical effects of annealing. Nevertheless, there are many reasons

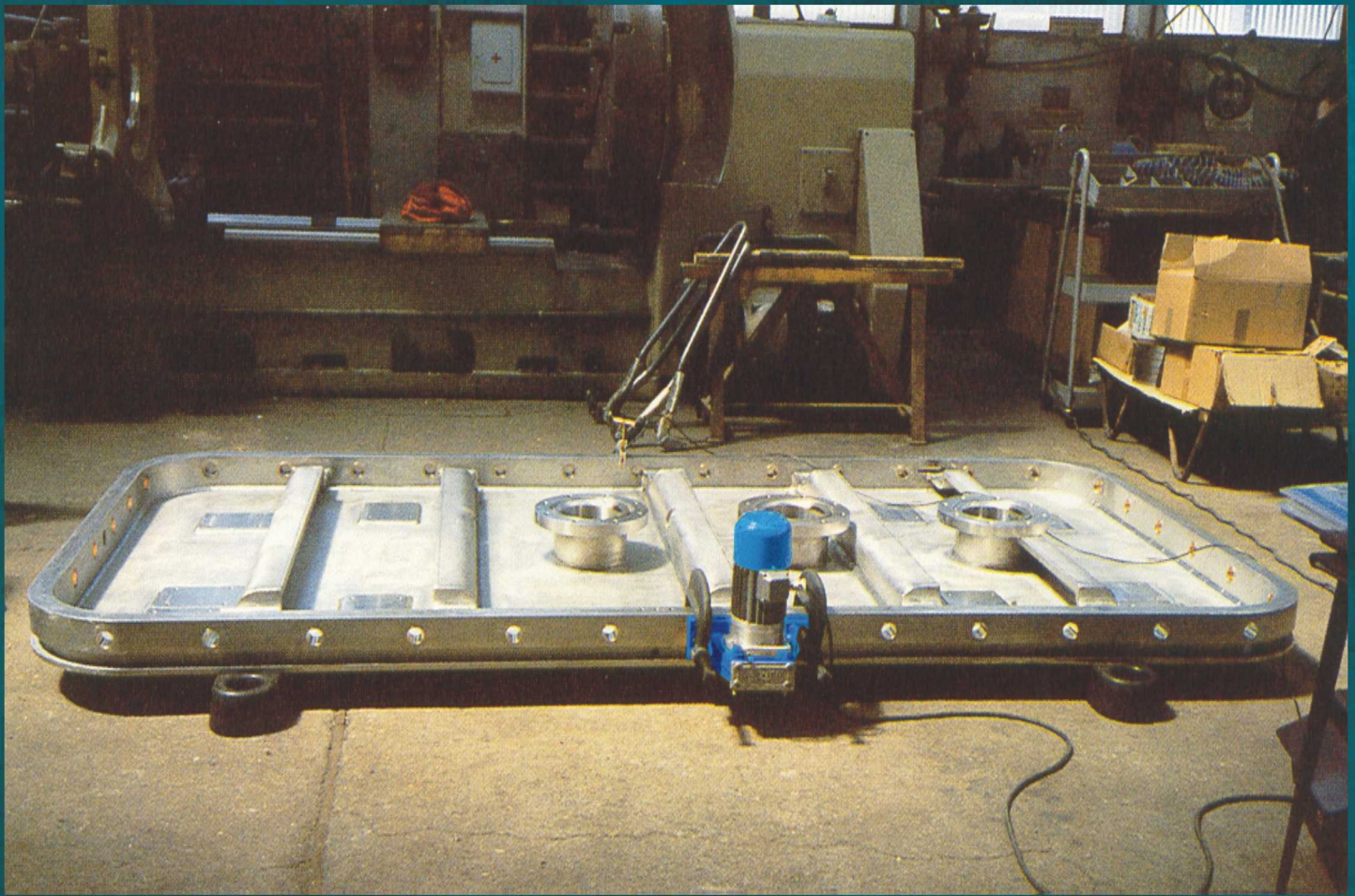
Application for welding purposes

The VSR process is often able to reduce the deformations and hardening of heat affected zones that occur during welding. Critical steels, e.g. those water coated, do not crack any more, as the solidification conditions are changed and the welding stresses are lower.

Application during annealing

Even if heat treatment should be necessary for metallurgical reasons, foregoing vibration can reduce the deformation that occurs during annealing. Vibration during or after annealing improves the results as well.

not to anneal, see for example the AD publication for pressure vessels HP 7/2 "Heat treatment of ferritic steels". Vibration can significantly improve the unannealed welded state.



Materials

Most materials of the machine and process apparatus industry can be relaxed by vibration. There are only very few exceptions for which the process is not suitable. There are also hardly any restrictions regarding the size, the shape, or the way of manufacturing, of the workpieces.

Suitable materials

Grey cast iron, nodular cast iron, and cast steel, non-alloy, low- and high-alloy ferritic steels with normalized, tempered or stress-relief annealed structures, alloys unsuitable for heat treatment, which are hardened by particle or phase precipitation, or by mixed crystal formation in coherent precipitation form. Dispersion or precipitation hardening of materials after solution heat treatment are also included, as well as, all the aforementioned materials when connected by welding.

Partially suitable materials

Martensitic and austenitic steels, as well as, alloys of aluminium, nickel and titanium, if hardened by cold or warm tempering.

Unsuitable materials

Materials which were strengthened by cold rolling and thus suffer from strong matrix distortions. The crucial factor is the degree of deformation, whereby values greater than 5% are usually critical. For this reason, pipe and bar material is often unsuitable. The same also applies to materials that have been aged or hardened by incoherent precipitation.

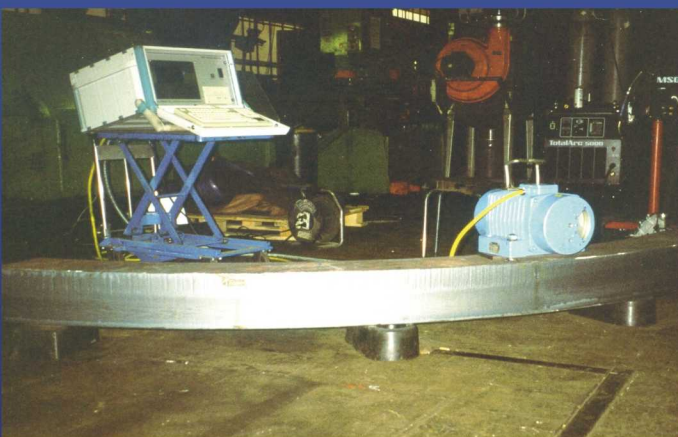
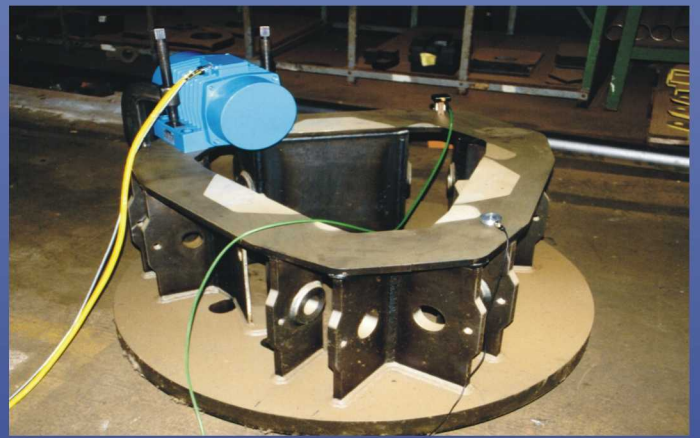
Minimum weights

Because of the close interrelationship between the workpiece and the vibrator, the parts should, if possible, weigh 100 kg and in no case, less than 50 kg. However, it is sometimes possible, to treat several lighter parts at the same time, on one vibrator bench. In this case, however, individual process examination is necessary to determine the suitability of vibration relaxation with regard to distortion effects. Workpieces weighing far more than 50 t (200 t) have been successfully subjected to vibration treatment. Larger pieces can be treated from different opposite fixing locations.

A final word on annealing

Stress-relief annealing as a metallurgical process reduces the high 1st degree and 2nd degree internal stresses. However, many other residual internal stresses remain unaffected. With vibration stress relief, as a metal physical process, relaxation is better, especially in the micro-range. For this reason, most pieces are deformed less than during annealing, and annealed pieces can be improved by additional vibration, if done by the correct procedure.

VSR Examples of applications



Industrietechnik GmbH
www.vsr-industrietechnik.de • info@vsr-industrietechnik.de

Am Alten Schacht 6
47198 Duisburg
Postfach 17 04 62
47184 Duisburg
Tel. +(0) 20 66 - 99 66 30
Fax +(0) 20 66 - 99 66 62