



**WIAP**®

**MEMV**®



Maschinen Entwicklung Metall Verarbeitung

Metall entspannen mit Vibration

Patented process from Switzerland

## Metal relax with vibration

Technology as an alternative for stress

MEMV® is a method of Swiss WIAP AG with several patents. The "Metal relax with vibration" can be applied, or even replace it, although established, but energy-intensive technology in many cases as an extension to the "stress-relief". The purpose of both methods, stresses and distortion at Bauteilen- about as a result of welding operations - balance.

In which cases stress relieving should now be used and when is the MEMV® process more appropriate?

### XXL components

In the component size is available for the MEMV® process almost no bounds. Up to 200 tons and be relaxed by using the vibration technology components. During stress these limits are reached more quickly, since only the transport already is a major challenge to the annealing furnace of such a component. Also, the annealing furnace must be of sufficient size itself. Especially in such cases, the MEMV® is the technology of the future and provides no competitive process is to stress relieving Optionally, a combination of both technologies conceivable. Since spannungsarmgeglühte components often have residual stresses, such components may be subsequently been processed in addition to the MEMV® process ,

### Inaccuracies due to transportation

Not infrequently, the components are processed at a supplier, consuming provided with a measuring protocol and subsequently transported to the mechanical engineer on a highly accurate machine. When commissioning is this then undesirable changes in the dimensions fixed, for example, caused by transport. Such problems can be overcome, often enough even a 40-minute "MEMV® treatment". Even in such cases, this process is not a competition against the stress relieving, but can be seen as an extension of the possibilities for their own precise machine tools.

### Pre-painted components

If a component already be pre-painted after fabrication, to delay problems can not be solved with an annealing furnace in most cases. Here, too MEMV® may be the drug of choice - it burns for a no color and the components do not have to be dismantled.

It often happens that even more improvements need to be made on already assembled machines or systems, such as with welding work. The WIAP AG has already received orders for such cases where the delay problem was successfully treated in a semi-mounted system with vibration. The stress relieving come here out of the question without all the parts have to be dismantled. However, such cases are likely to be seen as temporary solutions and can be avoided with good planning. Nevertheless, the MEMV® process can also help here, to save tens of thousands of euros. Quite generally it can be said that the vibration method is particularly suitable for repair include welding work.



Figure 1: Two headstocks are vertically with the multi-function machine WIAP DM3S with the MEMV® (Metal relax with vibration) process relaxed (all photos: Hans-Peter Widmer)



Picture 2: headstocks: Vertical MEMV® relaxed with a multidirectional process

## Stress relief - description of the procedure

Stress relieving is applied to internal stresses - often also due to welding operations - reducing. Here, the steel is heated to 500 ° C to 600 ° C and the yield strength decreases. All tensions that were previously at room temperature on the yield strength will now be reduced to the lowered yield. However, the annealing temperature may not be achieved in quenched and tempered steels. The holding time at temperature reached is 2 min / mm thickness. is also called slow cooling in the furnace. The structure will not change until at 723 ° C (c1). A stress of stainless steels in the temperature range of approximately 500 ° C to 650

° C is to be avoided sweeping, since the susceptibility to intergranular corrosion increased significantly here or entering through elimination of unwanted hard phases embrittlement of the material. Intergranular corrosion occurs in the metal relax not occur with vibration. This too is one of the advantages of MEMV® process.

The stress relieving already been used for a long time used. Yet little is available online scientifically sound evidence of the exact efficacy and especially actual precision. In part, it is probably because older literature online is not as present as current new technologies. WIAG AG is currently working to expand this topic with more data information.

## MEMV® Process - metal relax with vibration

The WIAP AG Ltd SA, based in Dulliken calls her metal relaxation method using vibration MEMV®. If Swiss specialists expand the decades consistently used method VSR. When "VSR-vibrate" a vibrator is located at a certain position and stimulates one direction. After about 30 minutes, the variation of the amperage and the G value is determined ( $1\text{ G} = 9.81\text{ m/s}^2$ ), which were observed during the process. Also, the walking of the translating self-resonance point of a speed range at the beginning with respect to the after about half an hour is a proof that voltages degrade. However disadvantage here is that the transducer is attached usually only in one place.

In order to assess the behavior within the package even better, considerably more data points are needed. Thus, the component including in zones can be divided. This very important zone information provide much more detailed evidence of what at which point the MEMV® process was effected. The more measurement points are present on a component, the more detailed information received by the user via the vibration relaxation process. Comparable is one such recording processes as in computer tomography (CT) or in a magnetic resonance imaging (MRI), English: MRI Magnetic Resonance Imaging, in which entire body and not just parts of it are considered. The older system VSR with the single-point filled not reliable its purpose in many applications. With the expansion towards the MEMV® process with significantly more measurement points, for example, 24 pieces, can now achieve even better process security beyond and also confirm the success proved.

## Patented: simultaneously stimulate horizontally and vertically

Below is especially the "2-axis stimulator" is mentioned, because this is the most commonly used activator (often called vibrator). The WIAP AG offers a variety of models, such as V5 for components up to 5 tons, V20 (20 tons) or V50 up to 50 tons workpiece weight. Come here now a single-axis measuring probe for use to measure the vibrations of the stimulator should always be mounted in those axial direction in which even with the MEMV® process is relaxed. However, this previous point measurement that can be made with a 3D probe, not nearly as meaningful as a multi-point measurement. Therefore, the new MEMV® technology is to replace rule over the older technology.

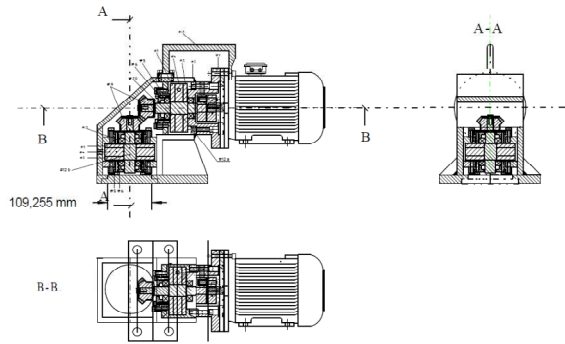


Figure 3: The new VS-vibrator for horizontal and vertical excitation in all three axis directions was filed in 2014 in Switzerland and 2015 in Germany for patent. He is, among other things especially to encourage all axial directions simultaneously during a welding operation. In order to achieve the "vibration welding" can be significantly better results.



Figure 4: The CNC multi-functional machine bed WIAP DM3S at a vertical MEMV® treatment

In series production, a component analysis can be made much more precisely by using the multi-point measurement beyond.

The WIAP AG has invested in recent years in a sustainable process-related measurements in vibration method. In the numerous measurements, the Swiss found, for example, that there are a hand in every excited axial zones which vibrate strongly. On the other hand, there are again areas, some of which behave almost neutral or not vibrate. This led to the following conclusion: The older technology (VSR) resulted in a very respectable sum results.

Nevertheless, some areas were not or only insufficiently achieved with the vibration. That could now critics of the process Metal relax with vibration inspire. Or you could get the idea to stimulate the components with extremely high imbalance and more energy to still reach each zone. However, it must be remembered that, especially in the "weaker" components, the zone deflections must not be too large to avoid approximately cracking. A better solution is a Mehrachsanzregung can often be used here.

**Welded plates: glow or vibrate?**

In intensive investigations, the WIAP AG considered welded plates closer, which were annealed on the one hand and, alternatively, vibrates to each excited with the 1-direction process (VSR), in two directions and also to the 3-direction MEMV<sup>®</sup> method. Measurements illustrated the behavior of the corresponding post-treated plates. The relaxed in an annealing furnace plate reached as a reference value of 0.1 mm. The processed with VSR process plate scored 0.6 mm. The delay in an untreated plate would be from 1.5 mm to 5 mm. Both stress relief as well as the one-direction process thus improved the component stresses significantly - but with minor plus points in the end result in this case in the annealing process.

### consider component differences

Among other things, the shape of the component affects the results of the vibration relaxation. Therefore it makes sense to divide the components into different groups in order to achieve optimal results. Rotosymmetrical parts are to relax, for example, using methods other than cubic. Is a cubic component measured, the G value in the direct axis is comparatively high, in the transverse axis, however, it is close to 0 G. Once a part is round, and the transverse axis values are multiplied solid. This in turn is the basis that with a one-way system like the VSR same results can not be effected as with the multi-directional system MEMV<sup>®</sup>.

### Numerous measurement experiments confirm the good results with the MEMV<sup>®</sup> method

The WIAP AG has conducted hundreds of component surveys in recent years, especially with the insightful multi-point measurements that were previously economically hardly justifiable. For example, different axial direction were measured, with about 0 °, 45 ° and 90 °. Also carried out further in a fourth direction (135 °) and in the horizontal axis direction excitation.



Figure 5: The "45 ° WIAP vertical MEMVrelax<sup>®</sup> are longitudinal and transverse vibration modes excited "



Figure 6: The "90 ° vertical WIAP MEMVrelax<sup>®</sup> excitation is "transverse vibration modes



Figure 7: Horizontal WIAP MEMV<sup>®</sup> relax: Horizontal and transversal waves are excited longitudinally generated. For thin components rotationssymmetrischen this Aufspannungsmethode is needed circumferentiale to produce excitation.

Numerous other measurements are planned. The detailed analysis of the data information about the component shapes ensures permanent for additional improvements in the use of various MEMV<sup>®</sup> method. This also applies to customers who WIAP systems have been in use. Again, confirm the safety process and documented accordingly even better data collection.

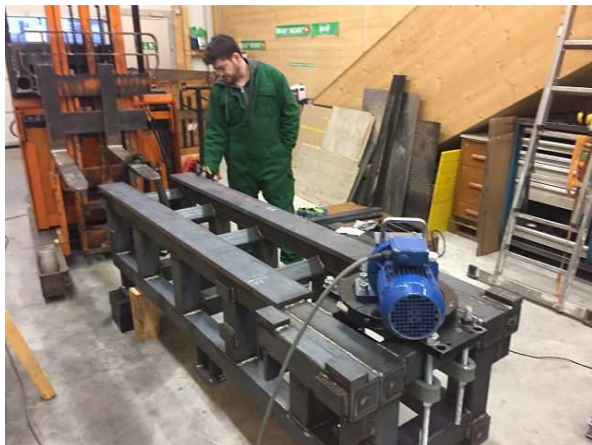


Figure 8: WIAP vertical MEMV<sup>®</sup> Stimulator in 45 ° arrangement: The component measurement on WIAP DM3S machine bed is very important to recognize the "dead zones". Dead zones can be explained so that longitudinal and transverse vibration modes and transverse or shear waves propagating perpendicular in one component. Depending on the axial direction there are zones where these meet and collide. At these points, the excitation is neutralized or locally, the components are not relaxed. The solution here is a change of direction in the process of metal relax instead of Vibratioen with the new MEMV<sup>®</sup> process.

All collected data are extremely important for WIAP, including simplifying the software at a fully automatic WIAP MEMV® system critical programming. In addition, it provides essential information, the direction in which the exciting means is disposed and which subsequently at which point exactly happens with the component. There are also cases or partially specific component designs in which the re-clamping of the exciter is essential because, for example, the dead zone within a component can not be moved far enough through the change of direction of the exciter or if the component has a great stiffness and not all zones can be excited enough from a single point.

### safely avoid cracks

The WIAP AG in terms of vibration long- standing expert. The one-direction method VSR put the Swiss three decades one (1981 to 2014). The results were not yet sufficient often the imbalance weights were increased. The upper limit is now among the Swiss to max. 20 G limited, even a little less. Even so has the WIAP AG on MEMV® system integrates an electronic control that enables the device to a G-value is exceeded immediately in the stop mode.

### Only competent professionals in action

The WIAP AG relies exclusively conscientious, serious, and well-trained professionals in MEMVa® method. Professionals to take into account material and quality differences have the necessary know-how in mechanics and metallurgy. Even with software technical support decides a MEMV®-operator with which the component is G-excitation to relax. Another new feature is a convenient way to store next to the printing of the Minutes of that same on a memory stick - for a paperless process safe operation even in duplex steel, aluminum, cast iron, welded structures and much more.

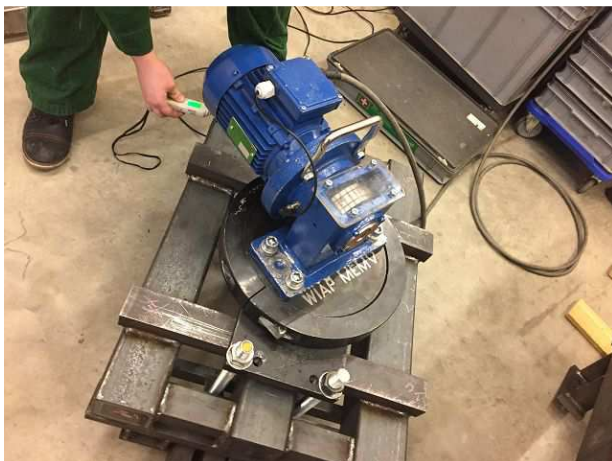


Figure 9: headstock base when WIAP Vertical MEMVrelax®

### Automotive industry relies on vibration technology

The Swiss specialists conducted studies in flame-directional (hot directed) components, which were then annealed in the oven. Once placed in the furnace, the temperature is raised

slowly, then maintained constant (rule of thumb: per 20 mm thickness of member about 1 hour) and then cooled again. However, many component previously flame or hydraulically directed to go back to a curved position - further work would be necessary again, with appropriate risk. the MEMV® method solves this problem along the lines set vibrate + + edit = no delay. The problem was so far the scientific evidence, even though hundreds of customers can already prove that it works exactly in this form. Especially in the automotive industry such time- and cost-intensive processes appear more often. For example, many car racks are required in the assembly where welding operations were carried out. Align or even glow comes at such parts hardly be considered - as a solution many customers use here the vibration technology. Not without reason, the manufacturers of such chassis set today by almost all automobile manufacturers to vibration. The realization that degrade rather unequal with the flame straightening introduced into a component voltages promoted rethink. Today, the formula is: flame-related components plus MEMV®-relaxed = no delay. This proof has been furnished and has brought the importance of MEMV® process to a new level.

### Wholesale or heavy rollers with MEMV® treat instead stress relieving

In tests on large and heavy rollers showed that only minor suggestions are necessary to ease the tension. Even with smaller suggestions often only in the region of 0.2 to 0.8 G, the voltages could be eliminated - measured and compared between the annealed and treated MEMV® rollers and acknowledged the end user.



Figure 9a: roller with 100% by volume, because there are no voids



Figure 9b: rollers -Aufspannvorrichtung - robust connected to the component



That already can degrade most voltages with few load cycles, has even been documented in older literature. But here all zones can not be excited - because the dead point, the almost every component has. At the dead center, no tension can be reduced because the Punktauslenkung = 0.

## Sand Test method for determining the offset

The natural form is an internal dynamic characteristic of a free-swinging structure that has a specific deformation behavior. This property of structural components was Ernst Chladni (1756 - 1827) first observed in the 1787th He attached a horizontally mounted metal plate at a point, sprinkled them with a little sand and took it with a violin bow to the blades. The vibrating plate formed of standing waves, the node of which the sand is collected. The sand placed depending on the excitation frequency in different geometric patterns - their own forms - on. This phenomenon is also seen when we put in a component, which is expanded by vibration an object on the part and this begins to move. This sand test method can be seen, for example, at which point towards the material moves (collection point) and what happens when the stimulator is turned.



Bild9c: Sand Test 1 on a plate



Image 9d: vertical MEMV® 45 °



Picture 9e: Vertical MEMV® 90 ° - Mehrfachaufspannvorrichtung



Picture 9f: MEMV® Sand Test 2: Check the shift in Achsrichtungswechsel on a Gear (accompanied, among other and regulated by a professor)

## Small digression into physics

As a rule, each vibrating body has several such natural frequencies or vibrational modes. Characteristic of such modes are the way they are spread and the direction of vibration. In solids, a distinction longitudinal and transverse vibration modes. Longitudinal waves vibrate in the direction of propagation, shear waves or transverse or shear waves perpendicular thereto. For tubes or rings, there are, depending on the Anregeranordnung also the Circumferentialwellen excitation.

This physical basis helps to realize that in addition to the Stimulator arrangement and the various directions also the interpretation is to be determined. This is especially true at different component shapes. Here effect various Stimulator axis directions different longitudinal and transverse vibration modes respectively longitudinal and transverse (lateral / shear waves). When the Anregerichtung is 90 degrees, this has rotated, for example other effects on the component and an arrangement by 45 °. Here, the longitudinal waves turn into another axial direction, while the transverse or shear waves remain constant with the same Anregerstärke. Therefore, the WIAP AG calls the longer axis on a component today Z axis. The short transverse axis as the X axis (the cubic member) and refers to the perpendicular to the axis as the Y axis. Thus, the user can understand easily where the component has its fixed directions, what, when, where happens. The aim is to monitor both cubic and rotationsymetrische components, full or tubular frame component designs, uniform.

## The WIAP G-shift measurement method

improve the Swiss vibration specialists constantly their processes and the necessary equipment. For example, when 0 °, 45 °, 90 ° and 135 ° or is worked vertically, and the stimulator must then be re-clamped horizontally is examined, the importance of the many G-Verschiebungswerte have. During the every 8 minutes per passage axial direction takes place. It is clear, for example, already: If all zones are touched or the nodes (dead zones) are shifted accordingly, significantly improved resultative can be reached. To prove this, not only qualitatively but also quantitatively, how and where exactly the improvements take place, the stakes are a Neutron diffractometer planned. It is to be punished if voltages are only moved or really degraded. The WIAP AG wants to integrate a universally accepted method of measurement with the G-shift in their concept. Ultimately, it is intended not only for the

MEMV® be applicable procedures, but also in stress-components allow for follow-up, about to check how much residual stresses still remain in one component. When neutron diffractometer 20 measurement points are fixed on a component which can be selected freely programmable from 0 to 50 mm into the material interior. allow precise thus 3.8 mm along, 3.8 mm across and 3.8 mm high a zone accurately measured. Tense components have larger differences in the atomic distances, low-stress, however, have only minor differences in the atomic intervals. Here are also compressive and tensile stresses measurable. The comparison measurement is performed between three identical components: annealed, treated and annealed MEMV. Due to the fact that many older reports were made, where showed insufficient results for small parts, the part size is set to the maximum of the measuring equipment. In a second step is then to be investigated why for large parts of the success of the vibration stress relieving is better than small parts. Here are some innovations that are ready for testing. Even for small parts it should therefore come to convincing results.

### **MEMV®-Prüfprotokollsystem: a must for process safety**

The MEMV® protocol system with marking solution can seamlessly still be detected in 20 years. Such a secure, long-term detectable system requires a reliable logging. The WIAP AG has defined an appropriate marking method: In this case, the operator brings beat numbers labeling with numbers in the component a - a sufficient depth and at a location which is easily accessible to a shaft, for example the front side. This marker must by hand and are not made with a vending machine (quasi as a manuscript or the fingerprint measurement confirmed). Then, an image with a 2-component putty so that the putty impression can be stored as original in no log is created from the chosen numbers. This procedure is easy to perform and can not be copied to other components - interchanging making it detectable. This solution is reliably together with the MEMV® system and thus ensures the appropriate quality assurance. Moreover, the plaster mold can be detected electronically with a scanner - a shelf hardware is unnecessary then. The data storage system is normalized and the number system itself is fixed.

### **Improved vibration methods and measurement methods**

When Metal relax with vibration can be expected further development thrusts future. The same procedure for 50 years of 1-Richtungsvibrierens (VSR) to be improved. Already, WIAP AG has numerous device models that work with the MEMV® process. The measuring methods for the degraded tensions if during annealing or vibration, improve the Swiss permanent. Currently, intensive further research be operated here. In future, the methods are to improve your ability to scientifically prove the results of the stress relieving metal with vibration.



Image 10: A directional WIAP-MEMV® machine with automatic clamping - rotation axis direction



Figure 11: multi-directional WIAP vertical MEMV® machine with V 20 Stimulator

Many older reports favor among others the well-test method to identify voltages. The Swiss specialists are today due to the decades of experience, however, ensure that the stresses in a component can often be settled very deep below the surface. It is these deep tensions - and not closer to the surface - can be a major cause of some very large component distortions. This is also a reason why not often represent X-ray measurements, the best solution; they often do not reach far enough into the depths. Which measurement method is therefore the most appropriate?

A few years ago a college made the WIAP AG to the Barkhausen Noise Measurement Method attentive. In radiographic residual stress measurements, the Swiss watch as described a deep problem. There is also the cut-compliance and a stress vision method. can be used as another method "Pulse-OverLap diffractometer" are used: POLDI is a thermal neutron diffractometer, which was specially developed for applications in materials science.

## New WIAP MEMV® CNC machine

The WIAP AG currently designed a CNC MEMV® expansion device with which all axial directions can be excited in a few minutes. Whether horizontal or vertical: The MEMV® system offers all in one device. Numerous findings from the recent past flow into the product with one, as if only a few G's suggestions are necessary, but all zones are reached.



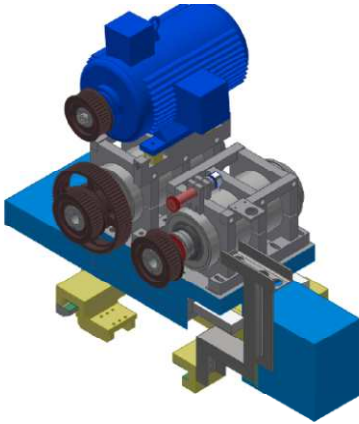
Figure 12: New CNC-controlled metal relax unit WIAP MEMV® CNC (in preparation)

In the issue lies beyond still plenty of potential, for example as can be achieved in the future in relation to the energy-intensive stress relieving in the oven the same benefit with significantly less energy. The WIAP AG is required to provide the best long-lasting quality to survive in demanding engineering on. The reach the Swiss, among other things, by using the system's own relaxed components in their devices. The electronics and software must be so sophisticated that the user selects its own program depending on the component form, in which the parameters are then set automatically. The new WIAP MEMV® system should be an operationally reliable, easily usable for the operator system, the importance of Technology Metal relax with vibration (MEMV®) into a new position for the production of components.

### The future for mechanical engineering with the MEMV® process

Thanks to the new MEMV® process today can be used numerous ways that facilitate the use of this cost-saving technology crucial. The WIAP AG is currently building machines, as shown in the 3D CAD drawings. Without the comfortable MEMV® process of Swiss specialists applying this profitable, compared to the stress relieving significantly less energy-intensive technology would be much more complicated than it is today - many arguments for the extended MEMV® process "Metal relax with vibration" that production managers and should convince manufacturing company.

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Picture 13 CNC-controlled machine tool WIAP DM3S with mobile double headstock: All components were with their own WIAP MEMV® process treated

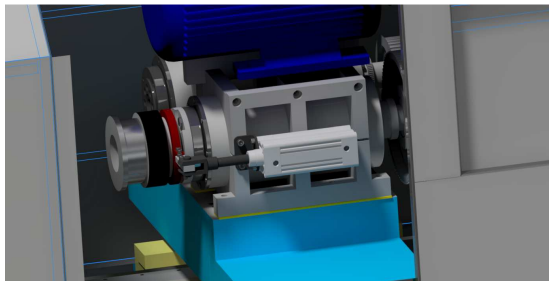


Figure 14: Multi-turret with thread-rolling head on the multifunction machine WIAP DM3S: All components of the construction come to 100% of the WIAP AG

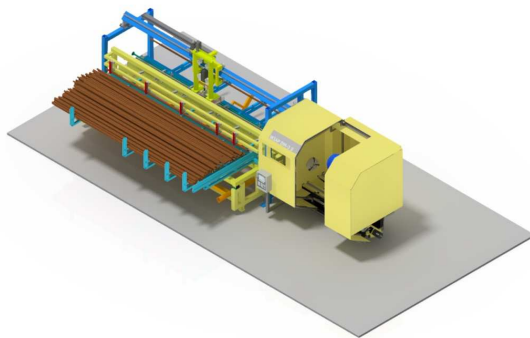


Figure 15: Fully automatic CNC multi-function machine tool WIAP DM3S for unmanned machining steel reinforcing bars (design and manufacture: WIAP AG)

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