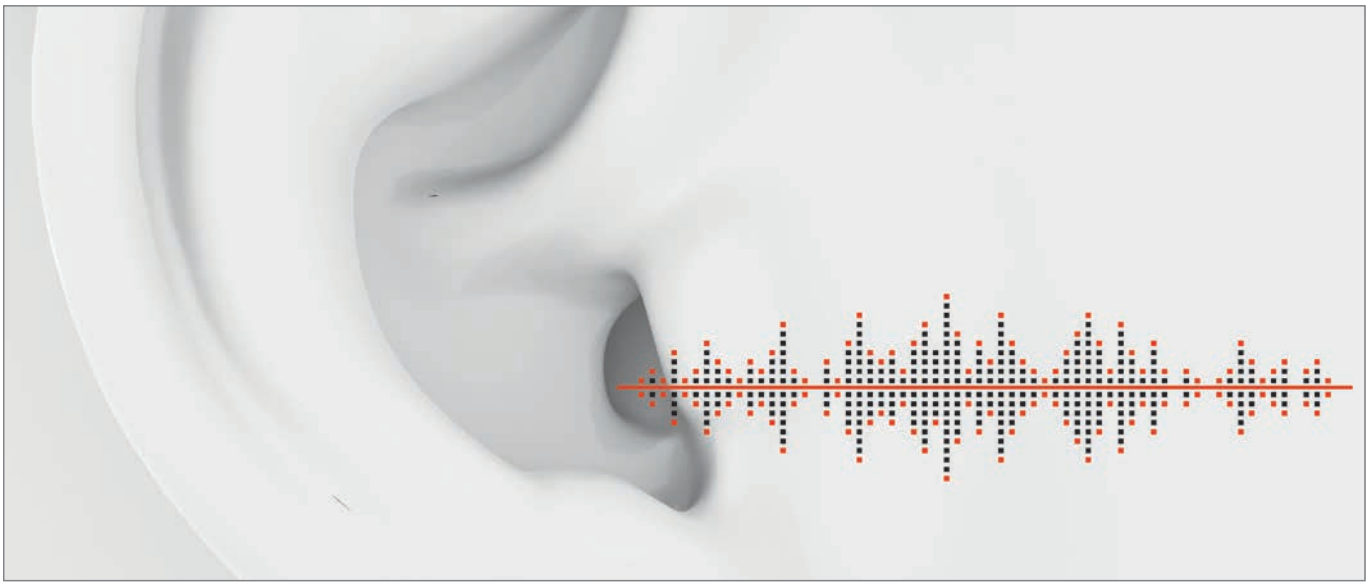
TELSONIC
ULTRASONICS

A Sound Solution For Manufacturers

Ultrasonic Technology Explained In Brief

PLASTIC WELDING | METAL WELDING | CUTTING | CLEANING | SIEVING



Bronschhofen (CH), 10/2022

The world of manufacturing has been relying on ultrasonic technology for many years. Today, countless products are welded, joined, cut, sealed, and cleaned using this powerful and flexible technology. Just like many other processes, once established, it is generally taken for granted. Users apply it and know it works but never really look behind the scenes to find out how and why it works. This article by Telsonic's Reinhard Züst investigates the science behind the technology to provide a valuable insight into this powerful manufacturing process.

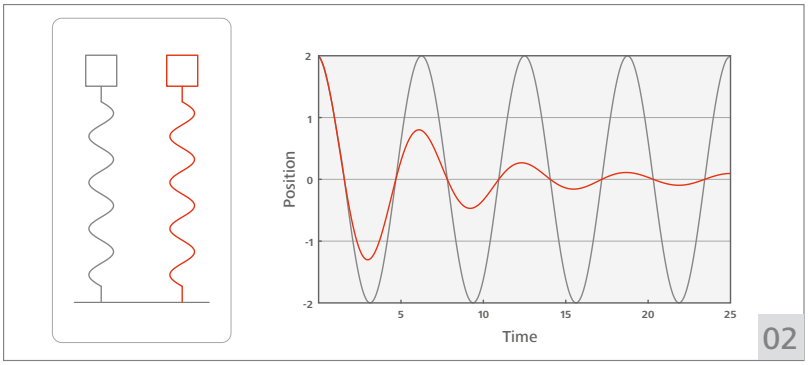
To begin to understand how ultrasonic technology works, we must first establish the basic principle of sound which is, that any change in pressure in the air, water or any other medium is sound. Every change in pressure propagates through an elastic medium. The number of changes in pressure per second is called the sound frequency and this is measured in Hertz (Hz). The frequency of the sound produces a characteristic tone. If the propagation speed and frequency of the sound are known, its wavelength can be calculated.

Sound is only audible when it reaches our ears and excites the eardrum with a maximum of 20,000 vibrations per second. Vibrations that are too slow, that is less than 30 per second are also inaudible.
Whenever the vibrations of a sound source occur inaudibly quickly, we speak of ultrasound. The infrasound range is <20 Hz, the audible range lies between 20 Hz and 20,000 Hz (= 20 kHz) and the ultrasonic range is from 20 kHz – 1,000 MHz (= 1 GHz) with the hypersonic range > 1 GHz. For industrial ultrasonic applications the range is between 20 and 150 kHz. By comparison, medical diagnosis, therapy, and non-destructive material testing applications use the frequency range between 1 and 15 MHz.

01 Medical diagnostics with ultrasonics

Ultrasonic applications are wide and varied with the technology being used for depth sounders – known as sonar, non-destructive material testing, level monitoring of liquids and bulk material. There are also applications for ultrasonics in the form of diagnostics in medicine and also breaking down kidney stones. Even nature takes advantage of ultrasound as it is used by Bats and Dolphins,

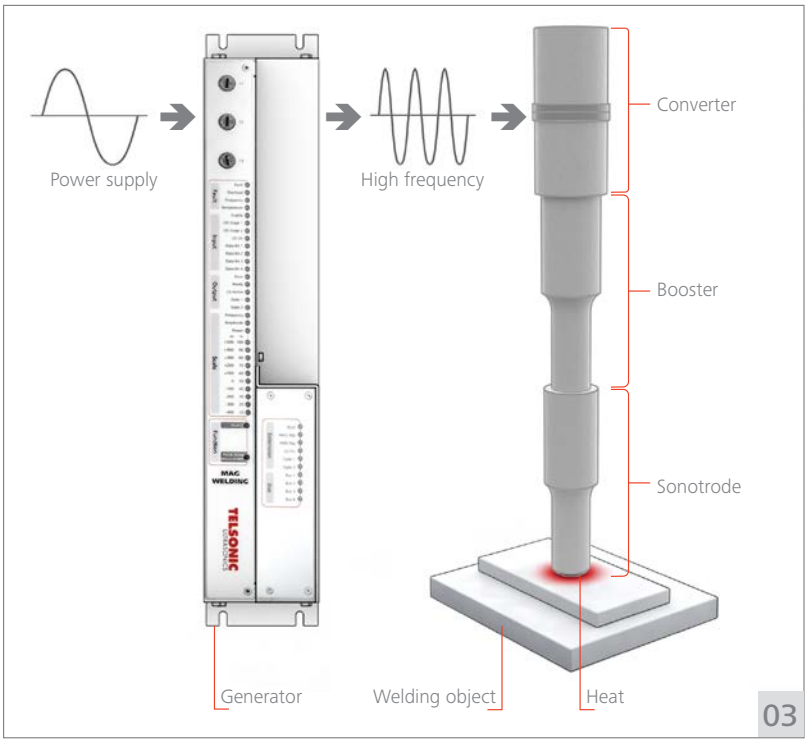
sending out ultrasound waves and using the echoes, or reflected waves, to identify the locations of objects they cannot see. This is known as echolocation. From an industrial application point of view, ultrasound is mechanical energy that can be converted into other forms of energy, for example, heat, and as we will see later, this is the basis for ultrasonic welding.



02 ■=Resonance system, ■=Attenuated resonance system

Industrial Ultrasonics Use Resonance

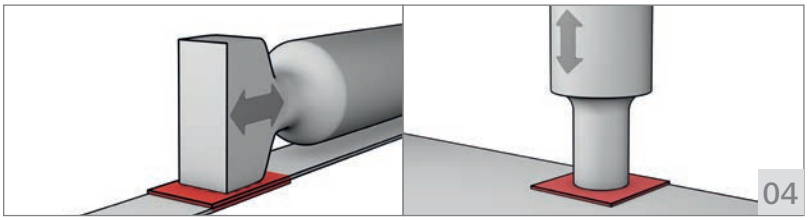
A resonance system has minimal damping. Only a small amount of energy is required to maintain the vibration. This effect is used for industrial ultrasonics. There are however both intended and unintended effects from resonance systems. These are probably best explained by using the following examples.
A tuning fork vibrates at its exact resonant frequency. After a single touch, it will resonate for some time, with the shape of the tuning fork defining the frequency, or the tone. An excellent example of the effects from an unintentional resonance system was the collapse of the Tacoma Narrows Bridge at Tacoma, Canada, on the 7th of November 1940. In this instance, the wind provided the energy for the resonance system to vibrate with catastrophic results.



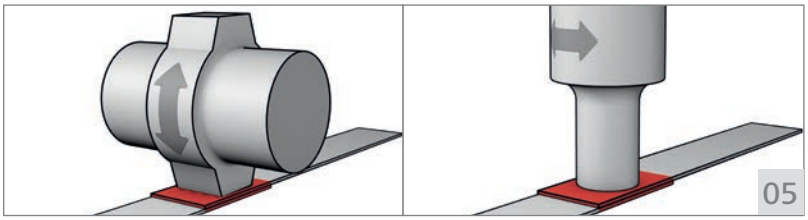
03 Components for mechanical energy transfer of a resonance system

Components and Principles of an Ultrasonic System

The components for mechanical energy transfer are a resonance system. These components include beside the generator, which is used to produce the frequency required, the converter which translates the electrical energy into mechanical energy and the booster and sonotrode which transfer mechanical energy to the component being processed.
In simple terms we can perhaps compare the elements of an ultrasonic system in a similar way to the various components which make up a vehicle drive train. The engine in the vehicle performs the same function as the generator together with the converter and the gearbox can be compared to the booster. The motion of the drive wheels in the vehicle can be compared to the energy released from the sonotrode, which in turn provides the heat needed for welding.



04 Ultrasonic energy delivered in a Linear manner.
Left: For metal welding and Right: For plastics welding



05 Telsonic's SONIQTWIST® – Right and PowerWheel® – Left technologies offer high performance solutions for both plastic and metal welding applications

Ultrasonic welding can be considered to be a fusion welding process, where friction and vibration energy is converted into heat, which in turn leads to a molecular connection in fractions of a second. Amplitude, force, and exposure time, the welding time and energy, are the main process parameters of ultrasonic welding, and vibration in the horizontal direction can be compared to friction welding. Thermal energy is generated by internal friction as well as by macroscopic boundary surface friction.
The components which make up the ultrasonic system can be used to deliver the ultrasonic energy in different ways, for example, if the

06 Ultrasonic welding offers a wide range of solutions for **plastic welding**

07 Ultrasonic welding offers a wide range of solutions for **metal welding**

application is welding metal or plastic. For metal welding the configuration of the system would be horizontal, and the energy delivered in a linear fashion. In the case of plastic welding the ultrasonics would be configured in the vertical orientation, in both cases, with the energy delivered in a linear fashion.

The flexibility of the process is highlighted further by the capability to also deliver the ultrasonic energy in a torsional manner. Telsonic has developed SONIQTWIST®, which can be used effectively on either metal or plastic welding applications, and offers a gentle welding process e.g. for power electronics components. This unique process can also be used for copper, aluminium and other non-ferrous metals. PowerWheel® which is targeted at metal welding applications, is being used to produce a wide range of EV related items with large cross sections such as cables, connectors and battery components.

Benefits of an Environmentally Friendly Process
Ultrasonic technology offers a number of significant benefits when compared to alternative processes. The flexibility of what is widely accepted as a “gentle” process, combined with its proven reliability, and low energy usage are key factors in the continued success of ultrasonics in multiple market sectors.
Users benefit from short cycle times and therefore high productivity levels. There is no requirement for the machine to “warm up” and there is also no pre-heating of the parts required. As a digital system, users are able to intuitively select the optimum settings required for the specific material and application.
Ultrasonic technology from Telsonic also brings with it important environmental benefits including the fact that no glues or solvents are used. Ultrasonics also offers high levels of efficiency, low energy consumption and minimal heat input. It is also possible to weld a range of compatible bioplastics and recyclates.

08 Examples of both single cycle and continuous process applications with **Cut'n'Seal**

One Process With Multiple Applications

The versitility of the ultrasonic process means that it can be applied to a wide range of applications and joining tasks. These include welding, spot welding, riveting, sealing packaging products and also embedding items such as threaded metal inserts within plastic moldings.

09 Reinhard Züst, TELSONIC AG

The benefits which the ultrasonic process delivers for plastic welding are also relevant for metal welding applications. Ultrasonic welding offers a high quality solution for joining copper and aluminum with resultant good excellent electrical conductivity and optimum strength. Also there are no structural changes to the parent material or damage to any adjacent material. The key characteristics of the process: being a cost-effective solution with short cycle times, generally less than 1 second, with low energy consumption and no consumables, remain the same.

In addition to the traditional welding and joining processes for plastic and metals, Telsonic has also developed the Cut'n'Seal process, which uses ultrasonics to both cut and weld, and is particulary useful on applications where fabrics are involved. Cut'n'Seal can be used as either a single stage or two stage process. Well suited for thick non-woven's, laminates and fabric items can be both cut and the edges sealed, or cut and welded to another part, in a single processing step if required. This can also be either a single cycle or continuous process when high speeds and volume production is required, for example when laminating, micro bonding, cutting labels lengthways and seam welding.

As can be seen from the explanations and examples described within this article, ultrasonic technology offers the ideal solution to many of the welding, joining and cutting applications which are found across a number of market sectors. The popularity of the technology as a joining solution will only continue to increase as more and more businesses realise the potential which the process holds.

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