The Krautkrämer Story

The way it all began.

The legendary garage

The history of Krautkrämer begins – as so often in those days - in a garage. It's the year 1946: The university of Cologne, where Dr. Josef Krautkrämer is lecturer and Herbert Krautkrämer a student, is in ruins. The two brothers want to try and earn some money until the university reopens – naturally with something they know how to do best: physics. So they hire a garage, set up a laboratory in it, and nail a sign beside the door*: Dr. Josef and Herbert Krautkrämer, Company for Electrophysics*. They hope to get a few orders for the repair or development of all types of physical measuring instruments.

The challenge

One day they are faced with problems of a different type from industry: the Krupp-WIDIA company is looking for a nondestructive test method that would help reduce the reject rate of their products. This concerns wire drawing dies made of metal carbide which in many cases show blowholes and pores just underneath the material surface. As these defects are not revealed till the grinding process, the work done here is quite uneconomic involving a lot of wasted time. How is it possible to detect such material flaws before any further processing of the components? X-rays are not suitable anyhow, they're no use for detecting even the largest accumulation of pores.

Clearly, this is a challenge for passionate physicists like the two Krautkrämer brothers. Their answer: the development of an ultrasonic instrument that operates according to the through-transmission method - a principle which, though already described in scientific publications, had not yet been applied successfully in field conditions. However it works, but is not the thing needed because the tests take by far too long. It's only a sort of "warm-up round" in ultrasonics, the real breakthrough is yet to come.

1949: the first "real" Krautkrämer instrument

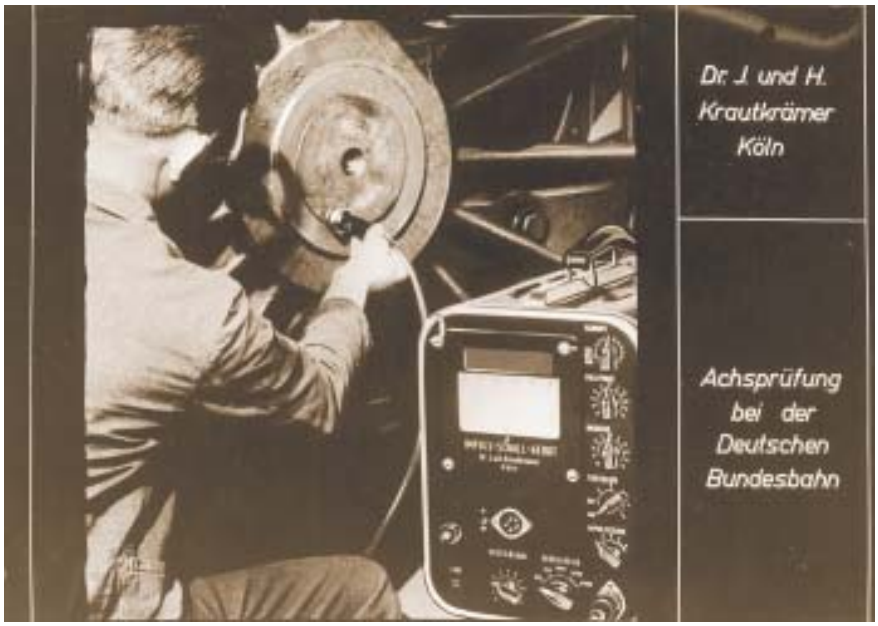
We're in 1949. The Krautkrämer brothers have discovered the fascinating world of echoes as they have further developed their idea and built an ultrasonic flaw detector in which the ultrasonic signals transmitted into the component are displayed on an oscilloscope. It's true that this instrument does not solve the actual problem because, due to unsufficient resolution, it cannot deliver proof of the detected porosity just below the surface. It's also true that the disappointed customer therefore shelves this new development. It's likewise true that this took a good bit of wind out of Josef and Herbert Krautkrämer's sails since they had used the advance money paid but not carried out the order. But they did develop an instrument able to do something else, viz. to nondestructively detect material flaws in components made of steel. Nobody at that time had the slightest idea of the possibilities opened up by this "black box".

Not even the Krautkrämer brothers themselves, although they are convinced of their own development. In August 1949, a meeting of the *Verein Deutscher Eisenhüttenleute* - Association of German Ironworkers – takes place in Düsseldorf, on which occasion they aim to present their meanwhile advanced ultrasonic flaw detector – the first German instrument of this type, and already a typical "Krautkrämer product" with all the bits and pieces, that means with all the features pointing the way ahead for the later development: highly sensitive, high resolution, display of flaws measuring only one millimeter at a depth of less than ten millimeters (radio-frequency display with a 50-millimeter range), pulse repetition frequency up to 1000 Hertz, and portable with its weight of around 20 kilograms.

This makes 1949 the year when the ultrasonic flaw detectors from Krautkrämer were born.

The beginning of a wonderful (business) friendship

A few hundred people are present at the meeting in Düsseldorf when Josef Krautkrämer begins to read his paper titled *Nondestructive Ultrasonic Testing*. Herbert Krautkrämer operates the projector. When the lights are switched on again after the performance, only three members of the whole audience are left. One of them is the head of quality assurance at the *Federal German Railways.*



The ultrasonic instruments are being continuously improved along with the experiences gathered in the field; orders also start to come in slowly but continuously. From January 1951 onward, all engines belonging to German Rail are tested using Krautkrämer equipment; a number of more or less important cracks are detected in the axles in this connection. Express train services can now be continued without risks thanks to ultrasonic testing.

left: Axle testing at
the Federal German Railways

The people at the German Rail are interested. They have a few problems with their surviving cars and engines after 1945. The readiness for service is not guaranteed, axle breakage and rail failures are to be expected. X-ray devices, whose introduction has been promoted by the German Rail itself, are not available. In addition, this new method presented by Josef and Herbert Krautkrämer involves other promising possibilities for easy field application. The German Rail is very soon to be one of the first and, all through the Krautkrämer history, one of the company's most important customers.

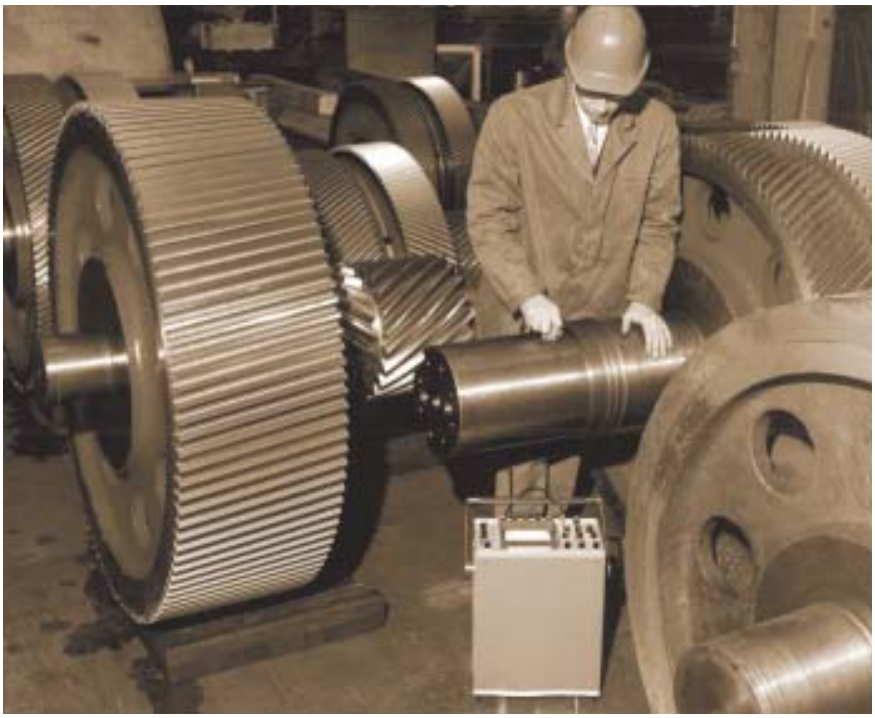
Starting off

For the time being, however, the Krautkrämer brothers are unceasingly traveling around everywhere in order to demonstrate the usefulness of their development on site. And it works: it is possible to use ultrasonics to demonstrate whether there are material flaws inside a component or not. Every time a component is identified as defective using ultrasonics, the defect becomes a fact when the workpiece is subsequently cut open. It is then that another step towards convincing people has been taken. Sometimes there are discussions as to whether an expensive component should really be destroyed in order to confirm the defect, sometimes it takes hours until the component breaks apart; but the tests are always successful.

A truly portable USIP

From the garage
on tour around the world

The feeling of starting off changes into euphoria. Since the university of Cologne has reopened, Dr. Josef Krautkrämer continues his teaching activities, and Herbert Krautkrämer completes his studies of physics. They commute between the university and the garage which is still the company's headquarters. In the meantime, this place has become a well-known meeting point for students of physics who are infected by the enthusiasm and become both cheap and effective helpers. At the same time, the company's activities expand. In 1952, the point is reached when the first two employees are hired: Dr. Ludwig Niklas and Dr. Werner Grabendörfer, both of them likewise physicists and form Krautkrämer's first department "Research and Development". Not that we could speak here of any specialized jobs: everybody is still doing everything. The first foreign representatives'



offices of the young company are likewise already founded in Belgium and France in the early 50's. Representatives in almost all European countries and in numerous countries outside Europe are added to this during the years that follow. The triumphal march of Krautkrämer test equipment around the world cannot be stopped. "You think you're the driving force, and it's you who are driven by the continuously growing demand from all corners of the world" – that's how Dr. Josef and Dr. Herbert Krautkrämer put it 20 years later.

Another trade mark: the transfer of know-how

With all the worldwide activities, sales figures shooting up, growing number of employees and building activities starting from the mid fifties: from the very beginning, Krautkrämer is not only interested in products and in the implementation of the technically feasible. The inspector or test operator and his experience as well as the knowledge acquired in the field are always incorporated into the work. Looking at it the other way round, it's also part of the company's philosophy to impart company know-how to the inspector. The fact is that the first major successes of ultrasonic technology established that in his work the user profits from his knowledge of the theory of test methods and of the way to handle the equipment. Consequently, the first of the monthly training courses titled *Introduction to Ultrasonic Test Methods* is held in the new building on the Luxemburger Strasse in Cologne's city quarter Klettenberg as early as in 1955. Many thousand will follow. The participants come from all economic sectors. Starting from 1956, the customer magazine *the echo* is published, a forum that has always been, and still is, aimed at presenting substantiated information from the ultrasonic world. Moreover, a forum that has accompanied us – also as a thank-you to our customers - through 50 years of Krautkrämer history.

Up to this very day.

Reminiscenses of the early years with Krautkrämer

C. D. Wells, Wells Krautkramer, Great Britain

I first became involved with ultrasonic testing in 1952, using Krautkrämer equipment (an USIP 9) about 1954/55. My association with the Krautkrämer company started in 1957 and so I was very much involved in those early pioneering days. It was pioneering in the sense that it was a completely new technology, relatively unknown in industry and often referred to as a "black art". We were all very busy at that time speaking at seminars, conferences and running training courses as part of the process - "to spread the word".

In those early years a demonstration of the equipment at a potential customer, had to start with an explanation of ultrasound, piezoelectricity and the two axes of an oscilloscope, before showing its capacity on some faulty specimens. Those were the early days of television and to see a small CRT on a factory floor invariably drew a small crowd and some wisecrack such as "What won the 3'0 clock race today?"!!!

Covering the whole spread of industry with site work and representation for Krautkrämer, raised many testing and often fundamental questions and I was a frequent visitor to Köln. I found it a great strength to be able to go to this "fount of ultrasonic knowledge" with my problems. Having dealt with the commercial business at the offices in the Luxemburger Straße we invariably visited "Works II" further down the road, the restaurant Unkelbach, and there together with one of the Drs Krautkrämer, or Niklas or Grabendörfer would try to solve the latest technical problem, leaving all our technical secrets scribbled on the paper table serviette!!

In December 1959 I went with Josef Krautkrämer to the institute of Physics in London, where he gave the first representation of his paper on the DGS (AVG) diagrams for the variation of amplitude with distance from disc shaped reflectors. The amplitude was measured for the first time in Decibels and this was also the introduction of the calibrated attenuator to ultrasonic testing. This original work took the "black art" out of echo amplitude and gave ultrasonic testing a clear amplitude reference unit which was adopted immediately by all the workers in this field. I believe that this was the most important milestone we have seen in the history of ultrasonic testing.

Those were the days, as the oldies would say, they certainly have given me many happy memories, lifelong friends, and I feel privileged to have been a part of that "historical" period of ultrasonic testing, which was synonymous with the name Krautkrämer.

The Krautkrämer staff in 1969 with C. D. Wells (first row, the sixth from the right).
At the far right, Dr. Josef and Dr. Herbert Krautkrämer.

Yoji Kobayashi, Krautkramer Japan

My first contact with Krautkrämer happened in 1963. At that time I was working with a German trading firm in Japan and responsible for imported NDT-products. X-Ray and Eddy Current instruments were well known even at that time, but Ultrasonics was a lesser known factor. Of course, I did not know anything about this method - and was sent to Germany to get trained at this company. I remember Dr. Herbert Krautkrämer being displeased with my non-professional questions....

All parties had to learn from each other. Krautkrämer had to learn that the voltage in Japan was 100 Volt - not 115 Volt as in America, or 220 Volt as in Germany - and I had to learn, what ultrasonic testing of materials was all about.

Back in Japan I was sent to carry out demonstrations with the heavy, mains-operated best seller USIP 10. Once I had five of these instruments in the boot of my car, when somebody hit the rear and seriously damaged my car. The outcome of this story was that I had to demonstrate and give information to the police at their headquarters in Tokyo. Needless to say, up until now we have not received any instrument orders from them...

In 1971 I founded my own company, Krautkrämer Japan Ltd., thanks to the kind understanding and support of many people at Krautkrämer. This company now exists for also almost 30 years - so as you can see this is a partnership which has been going steady for quite some time!

Now I am preparing to join the "Krautkrämer old boys club". I trust that the younger generation will further develop the next half century of Krautkrämer's successful history.

Manfred Müller, Krautkramer Forster Española, Spain

Stand at a fair in Madrid in 1967: Manfred Müller (center) talking with the Minister of Industry, Mr. Lopez Bravo.

The first time I had contact with Krautkrämer was in 1963 – I was in charge of destructive and nondestructive testing at *Siaisa* in Madrid at that time. Having demonstrated Krautkrämer instruments at several customers for some years, I received the offer to set up a Spanish branch office for Krautkrämer in 1966. That's the way *Krautkramer Española* was established in the middle of the year 1966.

The first years were very much characterized by travelling; we were constantly away on business dealing with ultrasonics. One week "on the road" at the customers, one week in Madrid to do the work there – that was the rhythm of our life. Free weekends? A rarity.

Nevertheless, we were successful in our operations. The business developed continuously, and in 1971, we took over representations of other German companies – for example, of the institute *Dr. Förster* in Reutlingen and the *Tiede GmbH* in Aalen. In the course of this, the name of our company was also changed to *Krautkramer Forster Española*. The staff also grew along. At the beginning, the team consisted of three persons - a service electronician, a secretary and myself; in 1997, we had come so far that our staff numbered 20 persons.

We managed to achieve this boom thanks to our consistent customer-oriented work: individual problem solutions and a good after-sales service for our customers were always in the centre of our attention. We have achieved in our country that the name *Krautkrämer* or *Krautkramer Forster Española* came to be identified with the term *ultrasonic testing* (just as stock-cubes and *Maggi* were at that time...). What more could one wish for the image of a company?

Rudolf Brutsaert, the Brutsaert company, Belgium

The companies *Brutsaert* and *Krautkrämer* are united by a really long history. It must have been in 1951 when my father heard of Krautkrämer for the first time – to be more precise, the occasion was a contact with a German manufacturer of medical instruments: this manufacturer had just received an order from Dr. Josef Krautkrämer to make a series of printed circuit boards for an "industrial ultrasonic instrument". I remember that my father talked about it at home and that he thought about possibly accepting the representation of this instrument – whatever it might exactly be - in Belgium. A little later, all uncertainties as to the type and significance of this ultrasonic instrument were dispelled; and as early as in 1952, the official cooperation between Brutsaert and Krautkrämer started.

This decision turned out to be just the right one soon enough. The breakthrough with the new method was already achieved with one of the first customers – the Kuhlmann chemical works. All of a sudden, it was possible to measure wall thicknesses on sulphuric acid cisterns nondestructively and quickly! As this news very soon reached the customer's headquarters in Paris, the future of Brutsaert was sealed: all other activities were stopped, ultrasonic testing was immediately in the centre of attention. And so it came that a lot of pioneer work was done in Belgium and France in the years that followed.

This shows that Brutsaert was "one of the party" to make the ultrasonic method known and to disseminate it in Europe almost right from the beginning - and thus likewise looks back on almost 50 years of company history.

left: Rudolf Brutsaert in the fall of 1960 on the Severin bridge in Cologne.

below: Rudolf Brutsaert, this time without hair, approx. 1970, at Krautkr mer in Cologne-Klettenberg

All safe and (ultra)sound, play it safe with ultrasound

The past and present of ultrasonic test applications.

The history of materials and quality testing has always been a quite "inconspicuous" one. It's in the nature of these things. However, if we consider that in many respects material testing is the very thing that makes life safe, it should have deserved a bit more attention. Sad enough, it's mostly not talked about unless it has not been carried out - or not been carried out properly - and damages or even accidents could not be prevented. The result that documents no flaws is seldom worth mentioning. We would therefore like to seize this opportunity and for once do something for it in order to devote to ultrasonic testing – largely unnoticed in public – the space due to it. A few application examples are meant to serve this purpose, chosen from the great variety of field applications. In this regard, the history of Krautkrämer is inseparably connected with the ever increasing possibilities of solving test problems over the course of the past 50 years.

top: Mechanized weld testing using USIP
below: Heavy plate testing using free water jets

Nothing done by halves with semifinished products

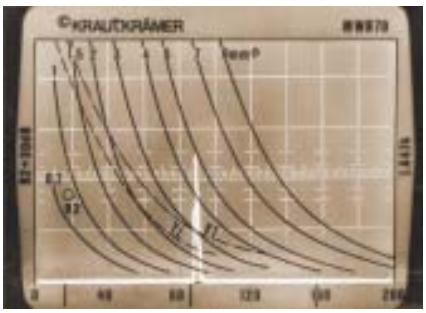
Metal sheets or plates, tubes, rods or bars, billets – a great variety of fabricated materials are ultrasonically tested before being further processed or finished; this often enables optimizing the manufacturing process itself. The first "case" of the Krautkrämer brothers – blowholes or pores lying close below the material surface in wire drawing dies made of metal carbide – already involved the task of reducing the reject rates within the manufacturing process, that means of detecting material flaws as early as possible during the working process. It turned out very soon that the testing of semifinished products would be a domain of the automatic testing because it deals with large piece numbers having identical geometries and with the integration into the production process. So it came that an automation project for plate testing in a rolling mill was already worked on in the 50's. The idea developed at Krautkrämer of coupling via free water jets in through-transmission technique in order to avoid probe wear contributed to the construction of the first heavy plate testing machine. As early as in 1960, a tube testing machine using rotating probes was developed, the first of its type.

Automatic testing machines have always been and will always be designed in close cooperation with the end user. A recent example includes the technical progress on the one hand, but on the other hand, it also shows that the principle hasn't changed: this system performs a 100 % volume test on a wire having a maximum temperature of 1000 °C, and it does it at rolling speeds ranging from 10 to 45 m/s. Both internal flaws and surface flaws are detected and evaluated ultrasonically – in this case using so-called rod waves which are excited electrodynamically in the test material, that means without any couplant.

top:
Weld testing

left:
Ultrasonic testing of an axle shaft

right:
DGS scale as of 1967; developed on the basis of the General DGS Diagram from 1958



Smooth transition: weld testing

In the early 50's, the inspection of welds was already a matter of great interest to the industry. Welds always were and still are something that cause problems, for example in the individual components of chemical and power plants, and also in tank construction, shipbuilding and bridge construction. Inspection of welds was already prescribed in those days due to the obvious safety relevance. The newly appeared ultrasonic method stepped beside the previously used radiographic method and complemented it as it could be carried out faster and without expenditure for ray protection.

For the Krautkrämer brothers as pioneers in the field of ultrasonic testing, weld testing was of course something they took up at once: in 1952, a USIP 5 was already used for testing the large-diameter, longitudinally welded pressure pipes of the Schluchsee power plant in the Black Forest. At this stage, the position of each flaw had to be determined by measuring and calculating; location aids were still unknown. A true evaluation of flaws with reference to their position, type and size – essential factors in terms of any possible impairment of the weld – wasn't possible till Dr. Josef Krautkrämer developed the DGS diagram in 1958. In modern instruments, such as the USLT 2000 or the USM 25, DGS diagrams and trigonometric functions (display of sound path, projection distance and flaw depth) for flaw evaluation are integrated into the instrument by means of software.

The way is clear for the German Rail

The first truly usable ultrasonic flaw detector in Germany, which the Krautkrämer brothers had developed in 1949, was suitable for detecting material flaws in components made of steel. One of the first beneficiaries of the new method was the Federal German Railways who had big problems after 1945 with the axle breakage on express engines due to war damage. Part of the wheelset axles showed more or less large cracks that could not be recognized from the outside. It was possible for the first time to use the ultrasonic method to nondestructively detect the partly extensive fatigue fractures in the wheelset axles. The extent of the cracks could be estimated with astonishing accuracy on the basis of the flaw echo sequence. A systematic test of all locomotive engine wheelsets was carried out, on which occasion a lot of engines had to be put out of service. This was the only way to ensure that the train service could be safely continued.

The guaranteed safe operation of means of communication and transportation is still one of the most important tasks of ultrasonic testing today. Even if manufacturing technology has advanced further and further – there's always a risk left due to material defects, unrecognized errors and flaws produced during the manufac-

turing process, unforeseeable stresses, or a combination of several causes which cannot be fully excluded by the usual safety precautions. Shafts and axles of trains and trams or streetcars must continue to be systematically checked for any fatigue cracks at regular intervals.

Not a bad move: NDT on all routes

Ultrasonic testing plays a part in safety and reliability in many different ways within the automotive industry - and again, it's almost unnoticeable in the background. Who could really claim that he knows that valves, pistons, cylinders, crankshafts and many other items are not used unless they have passed a material test? Dreaded breaking of axles and cardan shafts, spring and valve fractures of the past are long gone and only very seldom happen today.

A particularly high safety relevance makes ultrasonic testing indispensable in the aircraft industry as well. Riveted joints and bondings, for example at critical transition points between fuselage and wing, or at the wing edges, landing gears, turbine blades, vital parts of engines – these are all objects liable to be subjected to the most thorough ultrasonic inspection.

Though laid on thick: just the remaining wall thicknesses

The first ultrasonic gauge, exclusively meant for measuring wall thicknesses, was developed by Krautkrämer in 1967. The wall thickness measurement became especially important – for example on pipelines operated by refineries – in terms of safeguarding environmental protection. A reduction of the wall thicknesses, for example due to corrosion, can lead to disastrous damages and accidents here. The ultrasonic method has the special advantage of allowing the wall thickness measurement to be carried out on objects which are only accessible from one side. Wall thicknesses which are too low can be detected in good time using systematic ultrasonic checks. In addition, downtimes and consequently also cost and time expenditure can be reduced.

Thickness measurements are carried out on various test objects subject to wear: pressure vessels, gas cylinders,

Wall thickness measurement: two are better than one.

storage tanks, receptacles for chemical processes, material handling systems and pumps, facilities in shipbuilding and structural steelwork. When the D-Meter thickness gauge, no bigger than a camera, was introduced by Krautkrämer in 1971, it signified a spectacular improvement. It was spectacular because it was important in connection with plant supervision tasks, for example within the chemical industry, that small and lightweight equipment be available for the "comprehensive climbing exercises". The latest Krautkrämer thickness gauges only weigh around 250 grams, and they offer even more advantages. For example, they enable precision wall thickness measurements even through coatings, without having to remove the coating first.

Tales of layers

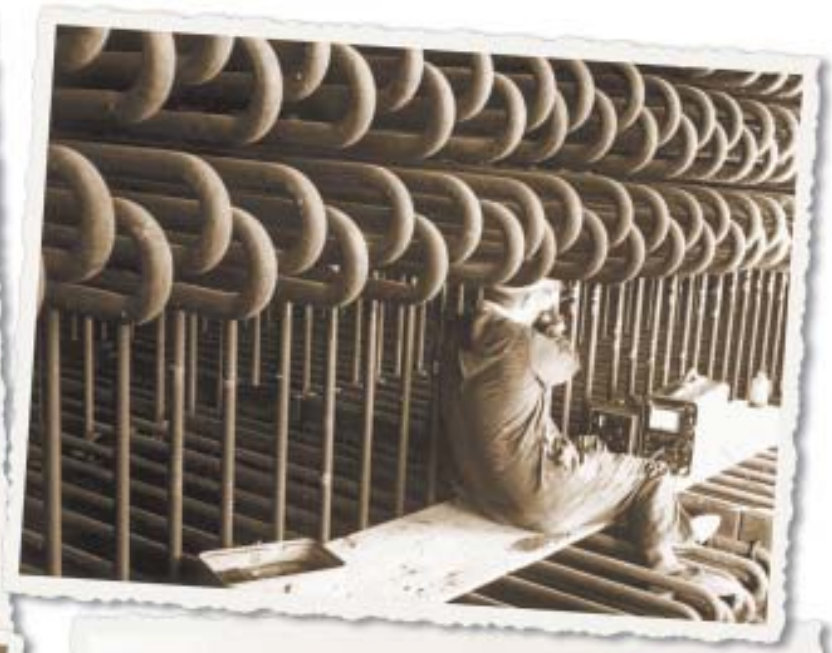
Coatings are not only important in wall thickness measurements. In many branches of industry, the assessment of the coatings themselves is an integral part of quality assurance. What's at stake here is also the exact control and monitoring of coating material quantities, which in the end aims at material saving and cost reduction. The measurement of coatings is required for example at automobile-body works for the paint coating layers on metal sheet base material, or within the wood working industry for sealing varnish or protecting lacquer layers on wooden base material. These applications are nowadays also part of ultrasonic test repertoire, and the innovative technology from Krautkrämer is decisive here. In this regard, it was possible to implement an ultrasonic measurement resolution – in the micrometer range - which was previously unattained.

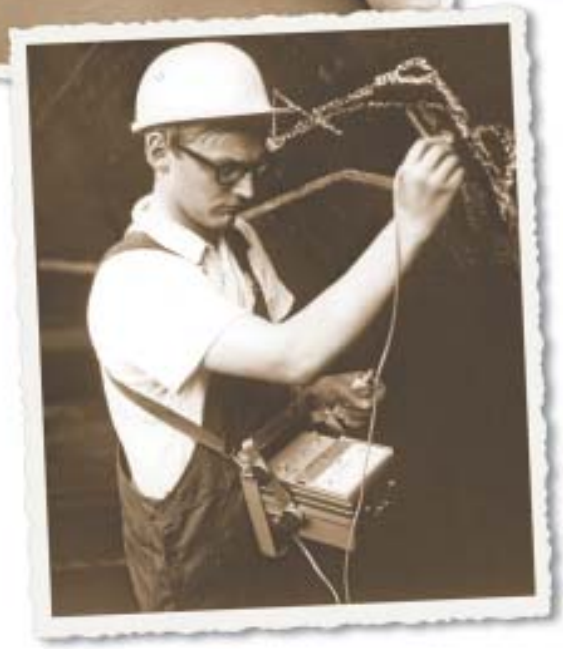
Play it safe with ultrasound

In the course of the 50 years ever since 1949, during which time Krautkrämer has been active in ultrasonics, many things have changed. An ever increasing number of test problems could be solved, more and more new requirements from the field could be met. There were quantum leaps in technology, such as digital technology or the miniaturization in electronics, which has led to the present-day systems which are ultrasonic instrument and PC in one and fit into a laptop. Something has nevertheless also stayed as it has always been: material flaws cannot be excluded, the risks due to them still exist, for example fatigue fractures due to cracks are nowadays just as topical as they were in 1949 when the Krautkrämer brothers started to deal with this problem. The answer to the question concerning a possible solution for all these problems referring to materials testing and quality assurance is today the same as it was yesterday: play it safe with ultrasound.

The application examples mentioned were taken from specialized literature, e. g: Klaus Egelkraut; Werner Grabendörfer: Ultraschall-Prüfung in Deutschland. Erinnerungen an die Anfänge (Ultrasonic testing in Germany. Reminiscences of how it all began). Minden 1993

TESTING YESTERDAY






KONTROLLDATAMATIC
USM 2