HANS-JOACHIM PAHNKE

AND THE DEVELOPMENT OF THE OPEN DIE FORGING PRESS

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About the author

This chronicle was written by Walter Westermeyer, a close employee and then subsequently partner of Hans-Joachim Pahnke. Their fruitful cooperation went back many years – from their first meeting in 1970 at SACK GmbH in Düsseldorf-Rath, to 1997 at PAHNKE Engineering GmbH in Düsseldorf, and at WEPUKO-Hydraulik in Metzingen and WEPUKO PAHNKE Engineering in Springfield, USA. Walter Westermeyer retired in 2008 and lives in Neuss.

The editing was undertaken by Clemens Bilharz from Stuttgart.

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Introduction from Michael Pahnke

Michael Pahnke, Managing Director of WEPUKO PAHNKE GmbH

*The **80-year corporate anniversary of WEPUKO in 2012** coincides with the 55-year anniversary of two significant developments by my father, Hans-Joachim Pahnke. My father became involved with the company in the fifties, specifically with oil-hydraulics. The development of a powerful oil-hydraulic radial piston pump started in approximately 1957, and was initially made under license by WEPUKO with the model name "RP". The pump was further developed by WEPUKO and is still in use today under the model name "RX". With its unparalleled output adjusting speed and with a capacity of up to 600 kW, there is no pump in the market that compares to it.*

The other pioneering development was an open die press with a two-column under floor construction. This design, in accordance with a patent from Dreyer, was revolutionary at the time. It was the first open die forging press with two columns and the first with the main drive cylinder below ground. Despite this construction being unconventional, it was quickly adopted by various competitors domestically and abroad.

This construction principle was improved considerably by my father during the sixties and then became the standard for small and medium-sized hydraulic presses in the mid-seventies.

He also created very successful designs for large hydraulic closed die forging presses.

Further inventions from Hans-Joachim Pahnke were, in 1970, a hydraulically-driven four hammer forging machine – this innovation was also adopted about 20 years later by other machine builders – and in 1975 the oil-hydraulic "sine drive" for forging presses, which was subsequently renamed "PMSD". This innovation allowed the press movement to be controlled directly by servo-controlled pumps without being interconnected by valves. This significantly reduces the shock loads on the system, providing higher availability and very low energy consumption. And still today this design principle also has no peers.

In the course of his career, my father wrote more than three dozen publications in technical journals, received approximately 20 patents and contributed to many additional patents or registered designs of his colleagues. He also worked intensively with the technology of open die forging and constructed the first fully-programmable forging press, where the entire forging process is carried out in accordance to a theoretical program. He became one of the leading and best-known experts on hydraulic presses in the world.

His professional success and scientific developments are even more astonishing, considering that he only had a basic secondary school level certificate, due to the fact the 15-year-old orphan was not able to pay school fees that were required for a grammar school in those days. After the war, through great personal sacrifice, he completed his engineering study, where he finished this schooling in only two years instead of the usual three.

In 1973, Hans-Joachim Pahnke founded his own company for hydraulic forging presses and at the age of 70 he took over the high-pressure pump manufacturer WEPUKO. He led this company out of a 10-year period of stagnation until I was provided the leadership opportunity in 1999. Unfortunately my father was not able to experience the continued success of WEPUKO including the PAHNKE presses. After suffering several strokes in 2002, he only had a very limited perception of the world up to his death in 2010.

At this point I want to say a special "thank you" to my wife Tanja, who with her whole heart took care of my father many years. She had the idea for this book.

My father was not just a great engineer, he was also a successful and widely-respected businessman, who was just as popular with his employees, who he passionately guided in their pursuit of excellence, as he was with his business partners. For this reason, he had many friends, who brought pleasure to his long and at times demanding life.

The early professional years

Hans-Joachim Pahnke, at the age of 29

Hans-Joachim Pahnke was 28 years old when he started employment at Maschinenfabrik SACK GmbH in Düsseldorf-Rath in 1954 with the job that would come to define his career.

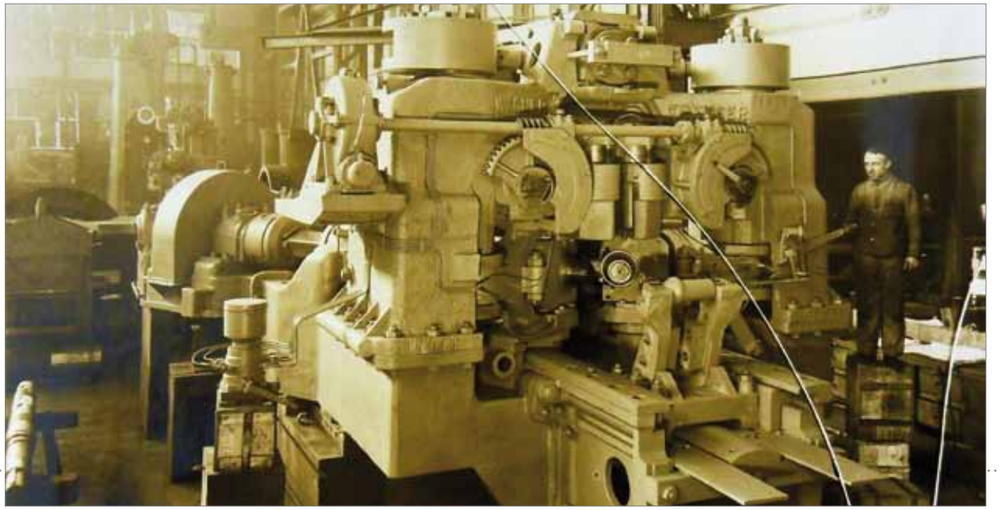
SACK was known as a supplier of rolling machines and other metal forming machines, such as hydraulically-driven open die presses, extruding machines, bending presses, closed die forging presses, stretch benches, hydraulic shears and manipulators.

His task was to build a new hydraulics department and to promote special hydraulic machines. His responsibilities included all forming machines with the exception of the rolling machines. Despite the challenges in Germany during that time frame, he managed – with expertise and commitment – to develop a modern division for water hydraulics and increasingly for oil-hydraulics too. Even with the wide spectrum of machines offered by SACK GmbH at the time, it became evident that his preference was for open die presses with manipulators and also extrusion presses.

In this development phase, Hans-Joachim Pahnke's preferences probably relied on market research, but later, his passion for this technology and knowledge from his previous employments became the driving factors:

Prior to SACK, Hans-Joachim Pahnke was employed at Sauer & Sohn – manufacturers of pumps and hydraulic control systems in Kiel. This is where he learned the advantages of radial piston pumps and even developed such a pump with adjustable displacement. There is a prototype pump from that time frame in the Technical Museum in Munich. After leaving Sauer & Sohn, Hans-Joachim Pahnke developed an improved pump construction for which he received a patent. He subsequently licensed the manufacturing of his patented radial piston pump with displacement controller to WEPUKO-Hydraulik GmbH, who at that time, mainly made triple plunger pumps, compressors and valves for water-hydraulic drive systems. This business relationship with WEPUKO provided him with the opportunity for his work at SACK, where water-hydraulic drives were mostly used for the presses at the time.

His previous experience at Kreuser Wagner in Dortmund, in the field of hydraulic presses and ring rolling machines also likely contributed to Hans-Joachim Pahnke's subsequent preference for the construction of open die presses.

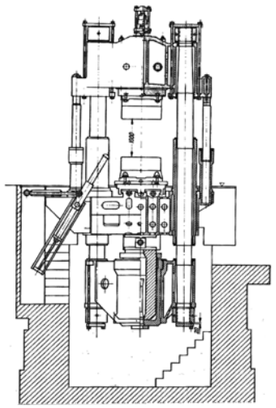


Kreuser ring rolling machine from the fifties

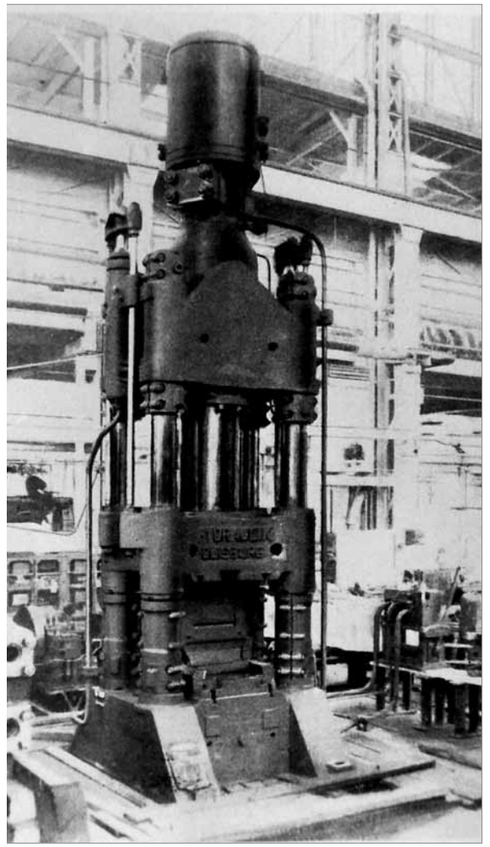
The first two-column open die forging presses at SACK

The first open die press constructed at SACK GmbH in 1956 under the management of Hans-Joachim Pahnke was a 10 MN two-column under floor construction with Z-shaped cross heads and a water-hydraulic drive.

Both columns had a classic round shape with column end nuts and the upper and lower lateral heads were tensioned with tie rods. This concept corresponded to a patent of Dreyer, who worked for Hans-Joachim Pahnke as an essential engineer in the department.



10 MN open die forging press,
Schoeller Bleckmann, Ternitz, Austria



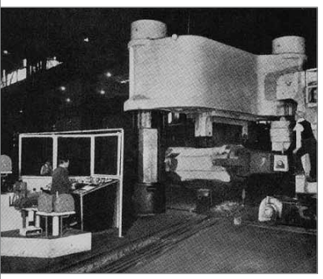
A four-column above-floor press that corresponds to the standard at the time: “Hydraulik Duisburg”

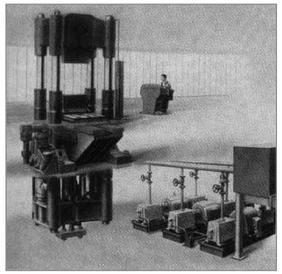
This type of construction was revolutionary, because it was considerably different from the standard open die press at that time:

Until that time, open die press frames were constructed with a four, round column, above-floor design. Column nuts above and below the fixed cylinder cross head and the bed plate provided the structural integrity.

Hans-Joachim Pahnke recognized the design advantage over the conventional press design, with greater accessibility, better hydraulic control technology, which at the time hadn’t been overly developed, much lower center of gravity and the load on the pull down frame was much more stable at high stroke rates. At a load of more than 40 to 50 impacts per minute, there was a danger of the conventional press frame design to sway. The operator then had to stop the press and wait for the vibrating frame to stop. For these reasons, Hans-Joachim Pahnke chose an under floor construction.

The first two-column press with under floor drive was quickly accepted by the industry because of its benefits of improved operation at higher reciprocating speeds of up to 70 impacts per minute, and the improved accessibility to the working area was also impressive.

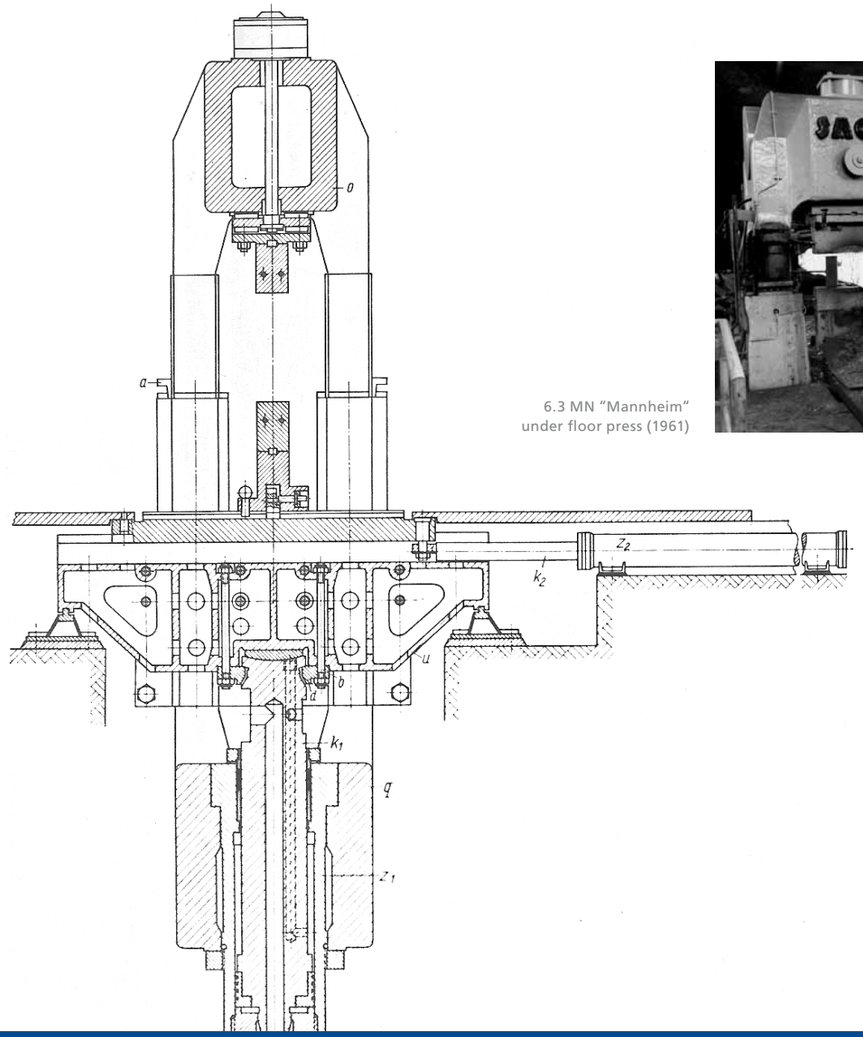




Under floor presses around 1960 by
Walter Sommers (left) and Eumuco (right)

It therefore did not take long for this type of construction to also be used by Davy in England and Loewy in the USA. Those were also with round columns. However, the round column design turned out to be not the best in terms of guiding quality and wear, and the frame connection was not as reliable as planned.

Hans-Joachim Pahnke therefore improved the frame construction. At SACK GmbH, a return to the four-column construction type was made, but this time with a square cross-section of the columns, so that adjustable flat guides could be implemented on mounted wear strips. The frame was formed from two chain-link shaped cast steel elements – similar to a rolling mill frame. Both frame elements were held together by tensioning rings, which were shrunk fit onto cast-on pegs at the top and bottom. This construction resulted in a four-column frame with the stability of a single piece frame. The under floor construction was retained here, as with the first two-column presses.

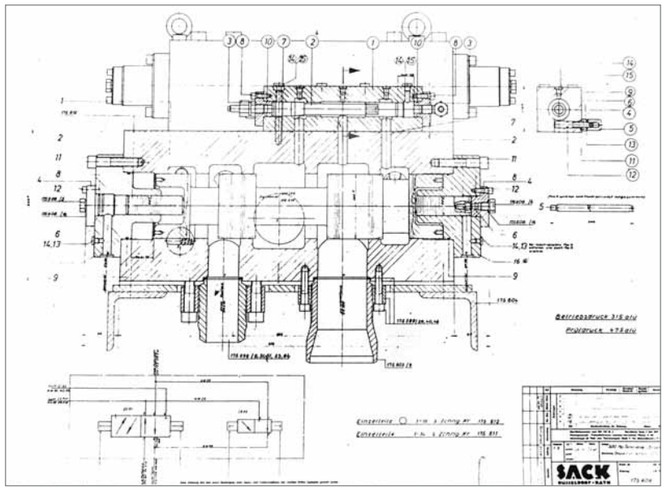


6.3 MN “Mannheim”
under floor press (1961)

The introduction of the hydraulic oil drive

For the drive, Hans-Joachim Pahnke changed to oil-hydraulics using the "RP" type radial piston pump constructed by him and WEPUKO and control valves he designed and built. The control valves followed the principle of a sliding spool valve with two or three positions. Valves of this type were constructed over the course of the years up to a nominal diameter of DN 250 mm for an 80 MN press. Electro-hydraulic directional control valves with adjustable control throttles were first used as a pre-control, in order to make the switching time of the spool adjustable. The middle position of a three-way spool valve was achieved with three different control pistons, which acted on the main spool.

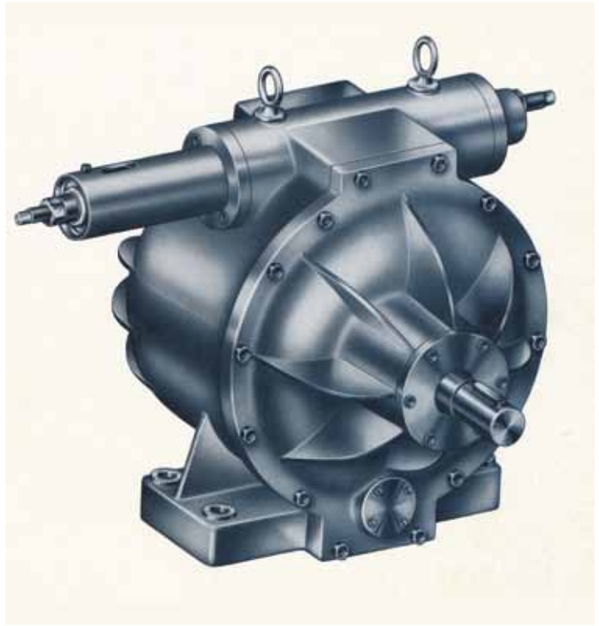
With the arrival of electro-hydraulic servo valves (EMG type) and displacement sensors connected to the pistons, simpler settings for the positions and the acceleration and deceleration time of the spool was made possible, which further improved the function of press control. Furthermore, a main advantage was that hydraulic oil systems were more cost-effective than water systems. In addition, the oil drive did not require as much space.



Typical three-way
SACK-type spool valve

The first open die press of this type was supplied to the "Mannheim" forge in 1961; it has a pressing force of 6.3 MN and an oil drive with an "RP" radial piston pump made by WEPUKO-Hydraulik. This press was sold to the "Vorländer" company, in Siegen in the seventies, where it is still in use.

Competitors generally reacted negatively to the hydraulic oil drive system from SACK for open die presses. A major subject of criticism was the alleged risk of fire from the oil. Considering the fact that water presses at that time lost a considerable amount of water in the pumping and valve stations, as well as at the working cylinders, this was an argument that needed to be taken seriously. The imagination that open die presses with oil drive would lose a comparable amount of oil was initially difficult to counter. However, because all the working cylinders of the press were under the floor and hence below ground level, the risk of fire could be minimized by the nature of the construction alone.



Radial piston pump RP, around 1962

In 1965, a 20 MN version of this construction was supplied to Latrobe Steel and a 27 MN open die press was supplied to Union Electric one year later. The Latrobe press had two rail manipulators of 7 US-tons each and the Union Electric press had one rail manipulator with a load capacity of 20 US-tons. The equipment for Latrobe Steel was the first open die press ever to be equipped with two manipulators for integrated work. This was an industry first for the open die forging industry, and introduced by Hans-Joachim Pahnke.

20 MN press for Latrobe Steel (1966 to 1995). Has been in use in Aceralava (Tubacex) in Spain since 1997 – modernised and converted from valve control to PMSD system with 10 RX 250 pumps

This four-square-column dual frame design offered a very stable frame that is resistant to bending. And the customer feedback to the replaceable wear strips with the adjustable flat guides was excellent.

The two-column open die press for Wyman-Gordon

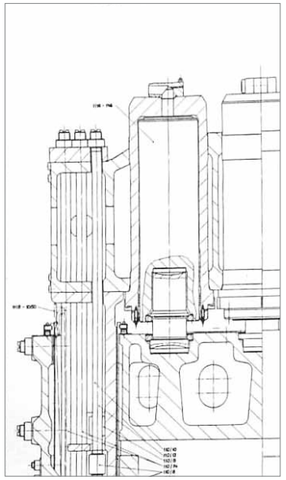
Despite the robust design of the four-column construction, there were disadvantages. These were the relatively high production costs and the limited accessibility in comparison to the two-column construction type. For this reason, Hans-Joachim Pahnke returned to the two-column design, but this time connected to a robust, chain-link shaped, cast steel, frame.

Instead of square columns, the stiffness calculations led to a rectangular column cross-section with at least the same, but generally higher resistance to bending and flexing than that of the four, round column, frame presses constructed by competitors such as Hydraulik Duisburg or Schloemann (Düsseldorf).

Wyman-Gordon in Grafton, USA, received the first press of this new construction type in 1969. It was an 18 MN open die press (corresponding to 2000 US-tons) with a cast steel frame made of one piece, here too with hydraulic oil drive and a rail manipulator with a load capacity of 7 US-tons.

SACK open die press with two-column construction

One-piece cast steel frame
(with test piece under eccentric load and tension lines)



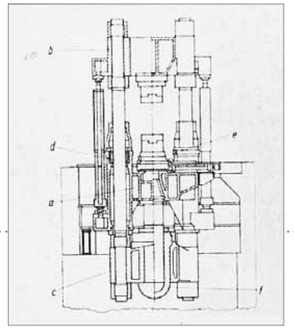
Working cylinder with power transfer via a dual-supported pendulum

In all the frame concepts discussed above, Hans-Joachim Pahnke had the conviction that the working piston should not be rigidly integrated with the frame guiding, as was common with the competitors. Therefore the press frame was made with sufficient guiding length and a pendulum type connection was used between the main piston and the movable frame. All SACK and subsequent PAHNKE presses thus reached a considerably higher lifespan for the cylinder packing and the piston guide bushings. Typically, the service life of the seals was up to ten years with this design and corresponding figures from competitors were much lower.

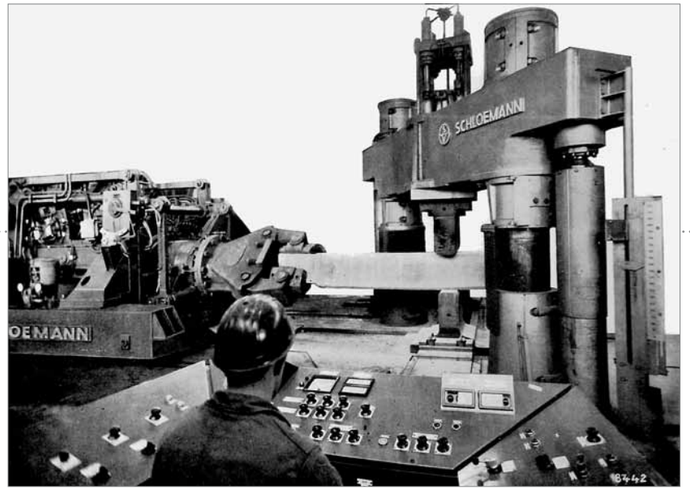
It was not long, before this new press design was copied by other firms, including foreign press manufactures. The English company DAVY was the first to successfully implement the SACK two-column design.

18 MN underfloor press from DAVY

SMS (Schloemann, Düsseldorf) and DEMAG- Hydraulik (Duisburg) subsequently developed two-column frame designs; with questionable success, because the working piston mostly remained integrated in the frame guiding system and round columns continued to be used.



14 MN underfloor press from Schloemann

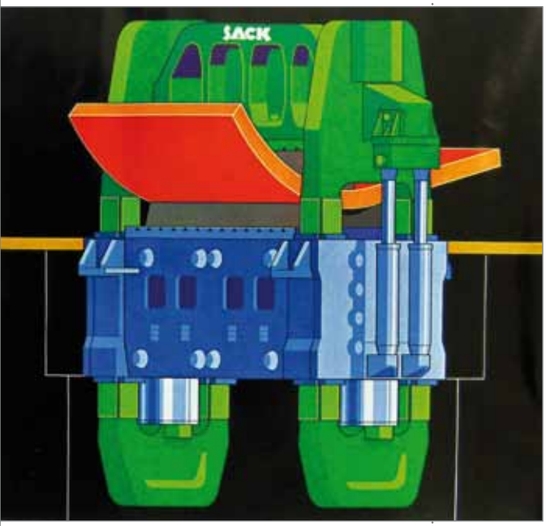


Schloemann forging plant with integrated control

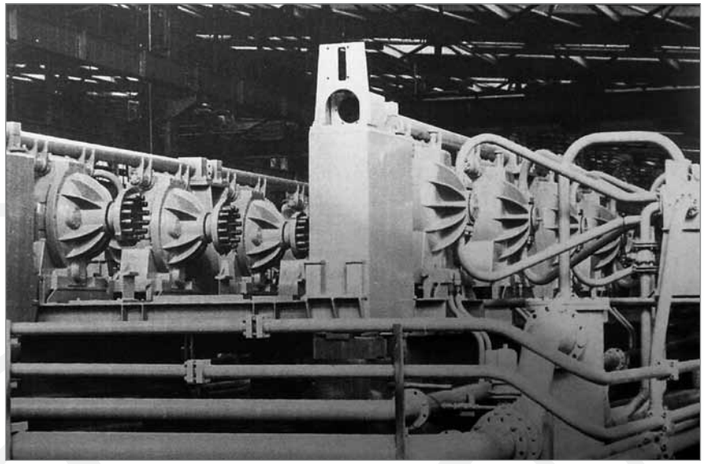
At the time, it was not easy for SACK GmbH to position itself against the mostly cheaper frame designs from the competition. However, under Hans-Joachim Pahnke, it was nevertheless possible to achieve sales success due to his talent for presenting his design in a convincing manner and successfully completing contracts exceeding customer expectations.

The two-column bending press for Combustion Engineering

During this period, a 14000 US-tons beam type bending press for heavy hot sheet metal was supplied to Combustion Engineering (Chattanooga, USA). The construction of this press was similar to that of the Wyman-Gordon frame design, where two similar two-column cast steel frames were located at each end of a movable suspended load beam. Again utilizing the under floor design. The two press frames were guided in an extremely large base plate, again with adjustable flat guides on replaceable wear strips.



The 120 MN bending press from SACK:
The design on the left and in use on the right



120 MN bending press drive:
through two central control cylinders
freely-adjustable radial piston pumps

The drive of this bending press was comprised of two groups of six "RP" radial piston pumps, each assigned to one of the two working cylinders. Each group of six pumps was mechanically connected at the controller with a servo adjustment cylinder. The servo cylinder, equipped with a travel sensor, worked in a closed loop control circuit. This central adjustment was state of the art at that time and provided the guarantee that all six pumps would have synchronized displacement adjustment. The two controllable drive groups made it possible to move the load beam of the press in parallel or with an offset. This allowed the bending beam to perform any desired pre-selected bending process. This bending press has been working in France since 1999 after the initial user ended the production process for this press.

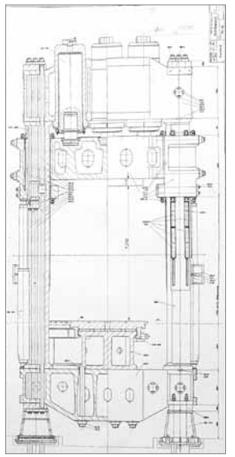
The open die press for Japan Casting & Forging

100 MN press for Japan Casting & Forging (1972):
clamped columns screwed to the cross head

In 1971, a 80/100 MN push down press was put into operation at Japan Casting & Forging (JCF) in Tobata, Japan with a 250 metric tonne rail manipulator and a press drive consisting of twelve RP 500 pumps.

The construction of this press featured a multi-part cast steel frame with a two-column construction and three main cylinders. All smaller presses mentioned previously only used one main cylinder, with the exception of the 27 MN Union Electric press, which was a three-cylinder pull down press. With the JFC press, an upset pressure of 450 bar was also achieved at a working pressure of 315 bar. The 450 bar was created by four of twelve RP 500, which featured smaller pistons.

A few years later, the 110 MN open die press, the largest open die press in two-column design for a long time, was put into operation at Creusot-Loire.



PAHNKE Engineering for
Creusot-Loire (1976):
110 MN press with several tie rods
per column (= pre-tensioned frame)

The four hammer forging machine for VSMPO

At the end of the sixties Hans-Joachim Pahnke was convinced that he could construct a four hammer forging machine. Such four hammer forging machine would have benefits for the working process, and would be able to be built more cost-effectively than the pure mechanical version from GFM in Kapfenberg, Austria.

SACK partnered with Edelstahl Witten (Edel-Witten) for the production of a four hammer forging machine prototype (R 250). with a pressing force of 2.5 MN per hammer and equipped with two manipulators to forge round, square and flat bar material. Hans-Joachim Pahnke named this construction type "radial forging machine" with hydraulic drive. The development process for this prototype at Edel-Witten took a few years. Once the necessary safety for the concept of this machine had been worked out, a purchaser for an 8 MN forging machine (R 800) was found, Ti-West, a company in Texas. However, the American company went bankrupt and cancelled the order shortly before delivery of the machine, which had already been made. Nevertheless SACK found the Russian company VSMPO as a new purchaser for the machine, where it is still successfully in use today.

SACK R 800 radial forging machine at VSMPO, Russia

Programmable 18 MN forging press at Sandvik, Sweden

Until the Hydraulic Machines business division was sold at the end of 1973, SACK GmbH still supplied the following presses of the "Wyman-Gordon" construction type:

- 18 MN for Sandviken Steel with 2 manipulators of 6.3 t each (the first programmable, fully-automatic working open die press)
- 20 MN for Uematsu, Japan, together with licensee Mitsubishi Nagasaki (MNM)
- 36 MN for Pacific Metals with a 20 US-tons manipulator, again together with MNM
- 20 MN for Techno Cogne, Aosta, Italy (was taken on by the purchaser, DEMAG-Hydraulik, Duisburg, as an existing SACK order). However this press received, instead of two SACK manipulators, manipulators from Glama (each with 12 tons of load capacity)

The start of PAHNKE Engineering GmbH

PAHNKE Engineering founders
(Eric Koik on the left, Fritz Thumm on the right)

When SACK GmbH sold the press manufacturing division to DEMAG-Hydraulik in Duisburg in 1973, Hans-Joachim Pahnke decided to work for himself. With partners Fritz Thumm (Metzingen), owner of WEPUKO-Hydraulik, and Eric Koik (USA), he founded PAHNKE Engineering GmbH in Düsseldorf in October of the same year. At the same time, the previous licensees MESTA (USA) and MNM (Mitsubishi Nagasaki Machinery, Japan) cancelled their agreement with SACK and immediately entered into new licensing agreements with PAHNKE Engineering.

Hans-Joachim Pahnke initially intended for his new company to limit its business to project planning and consulting. The company's office was located in his private house. Christa Stränger was the first employee of the company, and Walter Westermeyer was the next employee, joining the small team in January 1974.

PAHNKE Engineering initially generated revenue from project planning for forging plants. The orders included a forging machine for Special Metals in Dunkirk (USA) in 1974, a 50 MN open die forge for Björneborg in Sweden, and finally, a 10 MN pre-forging device with rotating heating furnace arranged upstream of an existing billet mill, for Villares in Brazil.

The open die forging press for MEFOS

At the end of 1974, Hans-Joachim Pahnke received an order from MEFOS in Luleå (Sweden), for a 5 MN open die press with manipulator, which was a forge to be used in a research facility of the company. Sandviken Steel was also involved in this project as a planner; PAHNKE already had a good working relationship with them due to the supply of a SACK 18 MN forging installation the year before. PAHNKE Engineering was thus requested to carry out not just the project planning, but also the complete construction of the facility for MEFOS.

Here, Hans-Joachim Pahnke brought an old idea back into play, namely controlling the direction of movement and speed of a forging press with a pump that regulates the flow, without the use of control valves. The change in the output and in the direction of the flow of the drive pump should be used for this function. The advantages of this design were, in his opinion:

- the infinitely variable working speed for the press movement,
- the shock-free decompression via the pump by reversing the flow direction,
- a maximum press force limit by regulating the flow if maximum working pressure is reached; as a result of this, the safety valves are not activated and energy losses are avoided,
- the energy recuperation during the decompression process, because the pump is driven as a motor by the working pressure in this phase,
- lower consumption of energy overall,
- lower manufacturing costs.

In other words, this construction did not have any valves that affected the change in the direction of the press movement. This function should, in addition to regulating the working speed and working pressure, also be performed by the WEPUKO RP pump. This was achieved by the pump pressing the oil flow first into the press cylinder and then, after reversing, sucking the oil out of the working cylinder. The return force was provided by an accumulator system that exerted a constant force on the return cylinder. The working cylinder and a return cylinder were both located in the centre axle of the frame.

5 MN pull down open die forging press for MEFOS (first PAHNKE press and first Pahnke Modified Sinusoidal Direct Drive)

PAHNKE Engineering gave this drive the name "Modified Sine Drive". The reason for this was the fact that a crank drive at a given stroke amplitude provides a pure sine movement with a fixed amplitude, whereas this hydraulic drive could provide a sine movement with variable amplitude. However the order from MEFOS came with the condition that the press drive be switched to a valve system if the prototype "Sine Drive" would not work.

It was necessary to increase the workforce at PAHNKE Engineering to be able to implement this 5 MN open die press in full. So in 1975, Hans Schubert, Erhard Paller and Willi Busse joined the team, with Hans Kubiak and Erhard Thimm joining somewhat later.

A year later, in 1976, "MEFOS" in Luleå went into operation – and the new "Modified Sine Drive" principle was a complete success. Numerous measurements and evaluations during forging gave excellent results such as

- extremely short commissioning time (because there are less valves)
- an impact-free movement, even at stoke rates of 100 per minute
- the best forging dimension precision in the range of ± 0.5 mm
- low consumption of energy due to recuperation of the compression energy in the oil.

The open die presses for Villares and Creusot-Loire

Interest in a 10 MN press was expressed by the Brazilian company Aços Villares in São Paulo, but this was ultimately not ordered. Instead, PAHNKE Engineering was to optimise the water control of the existing 20 MN open die press. As an additional service, modifications to improve the frame of this four-round-column push down press, with three press cylinders, were requested. The water drive for this press received a separate decompression valve with oil-hydraulic servo control, in order to allow the press to work more softly. These valves were constructed by PAHNKE Engineering in house. A modern electronic control unit was also supplied for this press.

90/110 MN push down open die press for Creusot Forge (1976)

In 1975, the company Creusot-Loire, France (now Creusot Forge, part of the AREVA Group) placed an order for the construction of a 90/110 MN push down open die press with water-hydraulic valve control to connect to the existing pressure accumulator station. This press order also included modern electronic controls.

The new press was added to a 60 MN press and took on the task of forging large rings up to seven metres in diameter. A forge crane and balancing bars were used for manipulation. This equipment was manufactured in the Creusot Group and was put into operation in 1977. The press is still in use today, it had its first general overhaul in 2010 only, 33 years after it was put into operation.

The open die press for MIDHANI

After a successful start of his still-young company, Hans-Joachim Pahnke dared to take on his first project in Asia in the same year. He concluded a contract with the Indian government in 1977 for the construction of a 15 MN open die press, beating the offers from numerous competitors. The equipment also had two manipulators with a load capacity of 6 and 8 US-tons, a bogie car, a lifting rotary table, and a 3-ton freely movable batch loading machine. As a drive for the press, a "large" Sine Drive with six WEPUKO RP 250 pumps was used for the first time (only two RP 250 pumps were used for the MEFOS press).

It was however necessary to increase the workforce again to be able to implement the "MIDHANI" construction press optimally. Initially contracted as an engineer, Fritz Ecken could be obtained as a full-time employee. The manufacture of the complete mechanical equipment was taken on as a package – as with the MEFOS equipment earlier – by Wilhelmsburger Maschinenfabrik in Geesthacht. Erhard Thimm and Josef Affelder were entrusted with the assembly of the equipment at the customer on site, the latter being an employee on loan from Dillinger Stahlbau, who was also subsequently employed by PAHNKE Engineering.

The MIDHANI 15 MN open die press was successfully put into operation in 1980, however it was only after a period of several months that errors in the design of the Sine Drive could be rectified under the management of Michael Pahnke, the son of Hans-Joachim Pahnke. Michael Pahnke, an engineer with a master's degree, joined the American subsidiary of PAHNKE Engineering, Pressure Systems Inc. in 1977 and had engineered and put into operation a 6.3 MN press with a strong "Sine Drive" with 4 RX 250 pumps at the same time.

The success of the MIDHANI open die press impressed Alloy Steel Plant (ASP) in Durgapur, also in India. There, a 20 MN water driven open die press that had been made in Japan was in use. The high amount of maintenance on this machine, in conjunction with a high requirement for replacement material for the water drive and control, suffered from the time-intensive process of obtaining material. As a result, the equipment in Durgapur was down over 70 percent of the time.

15 MN MIDHANI plant (1980)

The design proposed to ASP by Hans-Joachim Pahnke was a replacement of the existing water technology in favour of the "Modified Sinusoidal Drive" principle, which had now become established. Quickly persuaded by the benefits, ASP placed an order; and Erhard Paller was entrusted to implement this. In the same period, an order was received from the French company Combeplaine, to supply a Sine Drive for two forging presses. This project was also managed by Erhard Paller (together with Hans Schubert).

Considering the dynamics and the requirements of the international market, Hans-Joachim Pahnke and his two partners were already in agreement since quite some time that PAHNKE Engineering should be actively present especially in the USA with a company. This decision had led to the founding of the company Pressure Systems Inc. (PSI) in Springfield, Ohio in 1974.

Dipl.-Ing. Michael Pahnke, Managing Director of WEPUKO PAHNKE GmbH

After successfully finishing his studies in mechanical engineering, Michael Pahnke, the son of Hans-Joachim Pahnke, started his professional career in May 1977 at Pressure Systems Inc., the American subsidiary of PAHNKE Engineering GmbH. He was mainly responsible for WEPUKO pumps there. After successfully engineering and implementing the first Sine Drive (PMSD) for an open die press in a commercial production system his next major project he was in charge of, was in India, where, over the course of several weeks, he implemented the necessary corrective measures for the Sine Drive of the MIDHANI open die press. At the end of 1981, he returned from the USA to Germany, to perform various special tasks as a management assistant at PAHNKE Engineering.

In 1984, Michael Pahnke was appointed Chief Engineer and in 1990 he became the Managing Director of PAHNKE Engineering GmbH – the latter in addition to Hans-Joachim Pahnke, who retained his position as Managing Director, but took on the management of the technical office in the daily business. The strategic and operating business activities of the company were from now on managed by Michael Pahnke.

After PAHNKE Engineering took over WEPUKO-Hydraulik GmbH in 1996, Michael Pahnke led one year later the merger of the PAHNKE press business with Siempelkamp Pressen Systeme. At the same time, the consolidation of WEPUKO under the management of Hans-Joachim and Michael Pahnke was consistently pursued.

At the start of 1999, Michael Pahnke returned to WEPUKO-Hydraulik. A year later, he took over the sole management of the company from his father and has managed the continuously expanding company successfully up to now.

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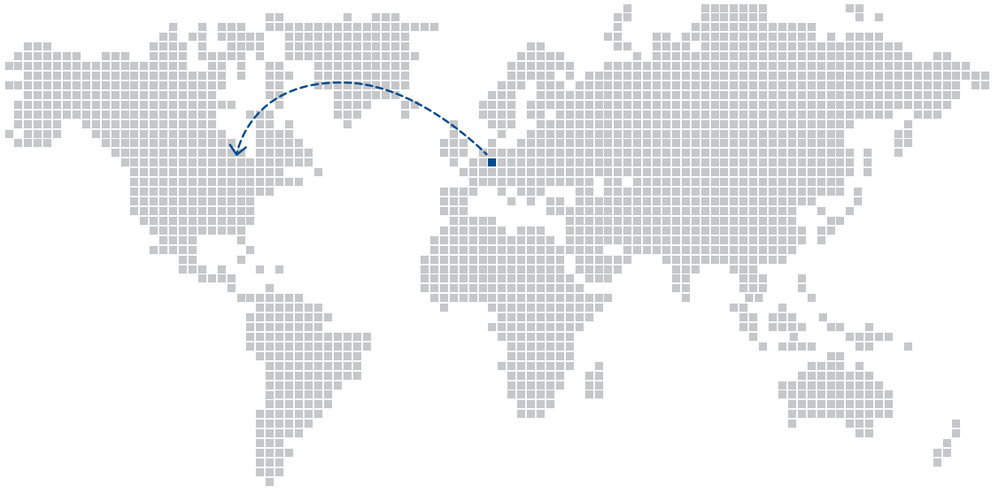
PAHNKE Engineering, a successful manufacturer of presses, and its subsidiary in the USA

Pressure Systems Inc. (PSI) was Hans-Joachim Pahnke's first company in the USA. Its president, Guido (Guy) Maddalena was lured away from the competitor Towler Hydraulics (Leeds, England). Guy Maddalena had a management position at the American subsidiary of Towler's called Kelsey Hayes in Springfield (Ohio). For this reason, Maddalena recruited his new employees primarily from his previous team of colleagues at Kelsey Hayes and Towler

One of Michael Pahnke's projects at PSI (1979): PMSD drive, two manipulators and new control for a 7 MN press at Press Forge Co.



The establishment of his company in the USA provided an enormous advantage for Hans-Joachim Pahnke. For American customers, the whole process from accepting the order through to manufacture and assembly, could all take place on American soil. This was the case for the first time with an order placed by Wyman-Gordon.

For this project, MESTA (as a PAHNKE Engineering licensee) was to supply a manipulator of the same construction type as the existing SACK manipulator for a 2000 US-tons press, combined with a conversion of the press hydraulics and equipped with a new electronic control unit including programme controls (programmable forging).

For this work, PSI took care of the supply of manipulator hydraulics to MESTA, which manufactured the machine completely, tested it and supplied it to Wyman-Gordon. The electronic control unit was supplied by the US company Nord Instruments (Roanoke, VA). Based on the experiences of automatic forging with two integrated manipulators at Sandviken in Sweden, an attempt was to be made at Wyman-Gordon, to control the forging process there, which was somewhat more difficult due to the greater amount of more complicated shapes. The execution of the "programmed forging", using pass schedules that were pre-calculated and created using a copying process, was only partially successful.

PSI cooperated well with PAHNKE Engineering in Germany, but had the best success with its own projects – mostly drives for modernising existing press equipment.

The increasing amount of orders required certain restructuring at PAHNKE Engineering in Germany, for example, Walter Westermeyer was assigned the tasks of project planning and sales, as well as purchasing of the core equipment. Hans Schubert assumed the position of head engineer and ultimately managed the work of around 10 employees.

Not satisfied with the quality of modern industrial electronic controls from third-party suppliers, Hans-Joachim Pahnke decide to create his own electronics department in 1977. Heinz Steinröder was enrolled as a manager; he had previously worked in the AEG development department in Konstanz. The presses for MIDHANI and ASP were previously equipped with purchased electronic control units (Nord Instruments), but Hans-Joachim Pahnke became autonomous thanks to the microprocessor control units developed by Heinz Steinröder and his team. It was only from 1993, when PLCs became the new standard for industrial controls, making the in-house microprocessors superfluous, that Hans-Joachim Pahnke again purchased control units from third parties, but the required software continued to be developed in-house.

Typical PAHNKE control panel for an open die press with two integrated manipulators

The closed die forging press for Weber Metals

At the end of the seventies, Hans-Joachim Pahnke took, together with MESTA, the order for a 300 MN closed die forging press for Weber Metals in Los Angeles, a subsidiary of the Metalwerke Fuchs in Meinerzhagen.

This press, equipped with a working table of 2.5 x 5 metres, was to cover an eccentric load of 300 MN in a circle of 1000 mm and in doing so, not have a declining gradient of the upper moving tool plate in relation to the lower fixed working table of more than 0.5 mm per metre, or – calculated on the basis of the length - no more than 2.5 mm for a 5 m distance. The reason for this requirement was the fact that both Weber Metals and Fuchs forged large components for the aviation industry. They required parts that were as close to the final dimensions as possible, which was to be achieved by the new press for the first time.

To meet these requirements, a hydraulic balancing system was developed at PSI by Michael Pahnke, which could provide as much counter torque as 300 MN of pressing force generated at an eccentricity of 500 mm. The frame of the press was developed as a pull down construction, so that it could fit into an existing hall. Four right-angled columns were connected to the upper and lower cross head using numerous anchors. This movable frame was guided in a massive footplate, containing the only working cylinder (piston diameter 2500 mm). A pressure intensifier was integrated into the working cylinder, which raised the pressing force from 175 MN to 300 MN. The maximum operating pressure of the intensifier on the working side was 620 bar or 9000 psi.

Balancing was assigned to eight cylinders with 17 MN of force each, which were sensibly located two each at each column. Two each of the 17 MN balancing cylinders were connected hydraulically, with which the required counter torque could be created depending on the location of the point of force in the die. The parameters required for this were deduced from the inclination of the movable frame as well as from the respective column tension and the correction was achieved by using a calculation program (algorithm) and optimised through empirical testing.

The drive for the main piston was comprised of twelve main pumps, of which six pumps provided a servo-controllable flow rate and the other six were fixed pumps. The main drive could not be used for balancing, because they needed to be used for the working process, and crossing into the balancing function was not permitted. A separate high-pressure drive with accumulator was therefore installed. The self-developed servo-valves were fed from this system (600 bar), which provided the pressure control for the pair of balancing cylinders.

Closed die forging presses for Weber Metals:
300 MN / 350 MN (left) and 110 MN (middle and right)

With the direct pump drive of the twelve main pumps, the closed die forging press achieved the desired pressing speed for the forging of aluminum alloys. Because titanium material was also forged at Weber, a press speed of approximately 80 mm/s also had to be achieved here, however limited for a stroke of 100 mm. To meet this requirement, the hydraulic drive station was equipped with an oil accumulator station with sufficient oil volume. The energy stored there and provided by the main pumps was routed through servo valves into the main cylinder and discharged again.

MESTA built the press in accordance with the construction drawings of Hans-Joachim Pahnke; the hydraulic drives were manufactured by PSI in accordance with their own drafts and those of PAHNKE. Put into operation in 1982, the 300 MN closed die forging press for Weber Metals turned out to be a great success for everybody involved. As a result of this positive experience, Hans-Joachim Pahnke received more orders, one for a 110 MN push down closed die forging press (1989) and others for new electronic control units on all seven forging presses (2002 to 2007).

The isothermal forging press

The comprehensive experiences in high-quality press construction and related drive technology that was gained allowed Hans-Joachim Pahnke to take an order for an isothermal forging press in 1986. An isothermal press forges superalloys to near end shape with heated dies – with the speeds required for the superplastic forming process.
This means that the press speed must first be freely adjustable from 25 mm/s down to 2 mm/min and then controllable in this low range. The dies were inductively heated inside the press to a temperature of 900° C.

Because this press was also to carry out open die forging at 6 MN, a working piston with four times as much speed with the same drive had to be available. To this end, a new working cylinder design was developed, so that the force of 20 MN or 6 MN is always transmitted in the same axis. The result was the first use of a cylinder with dual pistons (2 in 1). Many years later, namely 2008, this design was also used for the construction of open die presses with large forces: 60 MN (for Tong Di) and 43 MN (for Villares Metals).

This concept of a main cylinder of 2 in 1 working pistons has clear cost benefits, because it allows the press frames to be constructed more cost-effectively. As a result of the power always being transmitted in the centre of the movable cross head (or moving beam) there are no bending loads in the cross-beam, as there are with a three-cylinder design. A 60 MN press of this design that was subsequently made also showed that this concept should only be used for a pressing force of up to 50 to 60 MN, because the necessary cylinder design can only be manufactured by a few firms in the world.
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20 MN isothermal press with power levels of
15 and 6 MN with in-built ISO tools (1986)

For all presses with the desired power levels, the 2-in-1 design is an unbeatable advantage, because the pistons that are not yet in use are in an idle position and thus do not need to be supplied with filling oil. These circumstances contribute to presses that are built to this design operating quietly, even at very high stroke rates.

In the second half of the eighties, the outlook for investing in the open die press sector in Germany was good. There were a total of eight projects in Germany, of which six were taken on by PAHNKE Engineering:

- 10 MN open die press with manipulator for Metallwerke Aue (DDR)
- 12 MN open die press with manipulator for Stahlwerke Plate
- 6 MN piercing press with robot for Benteler Werke
- 55 MN open die press for Buderus Werke
- 16 tons rail-bound manipulator for Stahlwerke Gröditz
- 20 MN open die press with manipulator for Schmidt & Clemenz

30 MN forging press, Simmaco, Bao Tou (same construction as QSP)

Business conditions were good in China in the nineties, which resulted in a number of new orders. The projects involved commissioning new equipment in new facilities, as well as refurbishment and modernization projects in existing facilities. These projects occurred between 1989 and 1995:

- Used 10 MN forging press with manipulator (from Metallwerke Aue from the former east Germany)
- 12 MN 4-high roller mill facility with roller conveyor, cutters, coil box and high-level storage (from Metallwerke Aue from the former east Germany)
- 20 MN forging press: conversion from water system to PMSD system
- 30 MN PAHNKE press with two manipulators (new facility for QSP, Qiqihar)
- 30 MN PAHNKE press with one manipulator (new facility for SIMMACO, Bao Tou)

The takeover of WEPUKO-Hydraulik and the merger with Siempelkamp

As a result of the significant changes to the nature of the market at the end of the nineties and the collapse of the Eastern bloc market, there was an oversupply of open die presses. Many of these facilities were primarily purchased for strategic reasons and were often not even installed, let alone put into operation. A consequence of this was that a relatively large second-hand market arose, which largely covered the demand for open die presses, so that a regression of the core business of open die presses could be seen for the next few years. For PAHNKE Engineering GmbH, it was a question of survival as a relatively small company with expectedly noticeably more difficult competition with large, financially-strong competitors.

It was evident that other companies were also having similar thoughts at this time. So in 1995 a merger offer was made by Siempelkamp Pressen Systeme (SPS) from Krefeld to PAHNKE Engineering. Before this, there had been a joint project to supply a forging line for railway wheels to India (DSP), where Pahnke was a consortium partner for the supply of hydraulic drive systems and electronic control units.

WEPUKO-Hydraulik GmbH

The negotiations with SPS coincided with the offer to take over WEPUKO-Hydraulik GmbH in Metzingen a short time later. As a result of the years of friendship with Fritz Thumm, who has now passed away, his daughter Barbara, the owner of WEPUKO at the time accepted this offer from Hans-Joachim and Michael Pahnke in 1996. Furthermore, the takeover of WEPUKO would prevent the WEPUKO pumps needed for the press drives being bought up by another competitor.

In 1997, the PAHNKE press construction was ultimately taken over by Siempelkamp Pressen Systeme (SPS). Whilst it became evident in a relatively short period of time that there was not adequate integration of PAHNKE Engineering into SPS, Hans-Joachim and Michael Pahnke worked consistently and successfully at the consolidation of their new company, WEPUKO-Hydraulik.

Siempelkamp Pressen Systeme was interested in strengthening their market position in the USA. At the same time as the takeover of PAHNKE Engineering by SPS in Germany, SPS acquired a 50 % stake in the American Pahnke company in the USA in 1997. The company Siempelkamp Pahnke Engineering (SPE) was created in the process. However it became evident that machine manufacturing implemented by SPE on American soil did not generate any notable sales volumes. The revenue situation was better in the service area, but the buildings and facilities that were expanded for the manufacture of hydraulic drives were not viable. As a consequence of this, Michael Pahnke and the other shareholders bought back the SPS stake in 2002 and continued to manage the company independently as WEPUKO PAHNKE Engineering LP (WPE) from then on.

After a few years of the merger, it was also evident within the German division that Siempelkamp used neither the Pahnke expertise nor the rights to the name for itself, so Michael Pahnke had the rights to the company name PAHNKE completely transferred back to him after five years.

WEPUKO-Hydraulik under the management of Michael Pahnke

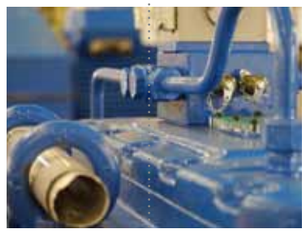
After seeing through the merger of PAHNKE Engineering and Siempelkamp Pressen Systeme, Michael Pahnke returned to WEPUKO-Hydraulik in 1999, where he took on the sole management of the company from his father one year later. Unfortunately Hans-Joachim Pahnke suffered serious strokes in 2002 and 2003, the effects of which meant he was in need of permanent care afterwards. In February 2010, he died at the age of 84.

While WEPUKO in the following years was focusing mainly on hydraulics and pumps, as well as reconditioning and modernisation of existing press equipment, an increase in demand for new open die presses became evident from about 2002/03. Both WEPUKO PAHNKE Engineering in the USA and the production of PAHNKE presses at WEPUKO-Hydraulik in Germany, which had started again, benefitted from this positive development.

WPE open die presses for Villares Metals

At WPE, three large presses were built in a relatively short time, a 30 MN open die press for Weber Metals, a 55 MN push down open die press for Union Electric in Pittsburgh and a 50 MN open die press for Villares Metals in São Paulo. Parallel to that WEPUKO-Hydraulik in Germany built the same 30 MN press as the one in the USA for Fuchs in Meinerzhagen, the parent company of Weber Metals.

The relationship between WPE and Villares was primarily developed during the years from 2001 to 2008. Before the order for the new 50 MN open die press, the Brazilian company invested in the modernisation of its forge shop, initially with a 30 MN open die press facility, which needed new foundations and manipulators and a new hydraulic drive station with electronic control. The same process was repeated in 2004 for a 20 MN open die press.



Weber open die press (same construction as the press for Fuchs) with PMSD drive (2009)

Villares Metals TFP 43 (new facility)
- 2-in-1 main cylinder design
- Pressing force levels: 20 and 43 MN
- Upset force: 50 MN (420 bar)
- Drive: 12 x RX 360 PMSD

Villares Metals 30 MN (modernisation)
- 3 cylinders
- Pressing force levels: 18 (2 cylinders) and 27 MN (3 cylinders)
- Upset force: 30 MN
- Drive: 8 x RF 650 – valve control

WEPUKO-Hydraulik open die presses for China

In the years after Hans-Joachim Pahnke, WEPUKO-Hydraulik GmbH also managed to expand in the field of open die presses. The development was primarily due to major orders from China. The Chinese government responded to the sometimes extreme levels of pollution in the industrial and high population areas by making significant investments in the modernisation of existing industrial equipment. WEPUKO-Hydraulik has received several orders from Chinese customers since 2006:

- A 60/70 MN push down open die press for Tong Di close to Shanghai with an innovative 2-in-1 cylinder design, where a small piston is located concentrically in the main piston.
- For CITIC Heavy Machine Corporation (HMC) in Luoyang a year later, a 165/185 MN push down open die press with a proven 2-column frame design and equipped with the Pahnke Modified Sinusoidal Direct Drive, which was a milestone in the company's history - the strongest open die press up to now.
- In the same year, a drive station for a 360 MN extrusion press equipped with 42 large RX 500 oil-hydraulic pumps and a 150 MN pre-shaping press for Norheinco in Baotou in Inner Mongolia, which is probably also a record-breaker with its 30 MW of installed power.
- The last major order from China up to now was a 100 MN pull down open die press for Bao Ti, a company that specialises in supplying titanium alloys for the aviation and space industries, which are currently assembled on site after delivery.

Extrusion line with 360 and 150 MN presses, operated with a 42-pump PMSD drive (RX 500) for Norheinco, 2009

185 MN forging press with a 7500 kNm manipulator (DDS) for CITIC, 2011

Other small orders from different customers in Asia are for modernisation or reconditioning of existing forges and the installation of electronic control units and drives.
It is evident precisely from the successful development of recent years that the core competence in the business area of open die forging presses of PAHNKE Engineering has again been fully absorbed by WEPUKO-Hydraulik. Consequently the name of the company in Germany was changed from WEPUKO-Hydraulik GmbH to WEPUKO PAHNKE GmbH at the end of 2011. WEPUKO PAHNKE currently has a presence in over 74 countries in the world on all five continents and is active wherever innovative solutions and high-quality products in the field of piston pumps, hydraulic drives or open die forging presses are in demand.

Both in North and South America, as well as China and India, the WEPUKO PAHNKE corporate group has been able to build on the good reputation of Hans-Joachim Pahnke and continue the press business In addition to WEPUKO PAHNKE Engineering in the USA, a second sister company, WEPUKO PAHNKE Systems, is being founded by Michael Pahnke in Shenyang, China.

This is how we are continuing the heritage of Hans-Joachim Pahnke successfully and with pride.

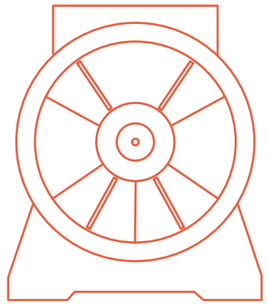
20-pump PMSD drive to the 185 MN press (RX 500)

A speciality of
WEPUKO PAHNKE GmbH – the PMSD drive

PMSD stands for Pahnke Modified Sinusoidal Direct drive. This is a specialty in the field of press drives, developed by PAHNKE Engineering in accordance with plans from Hans-Joachim Pahnke. This drive does not need any valves for the control of the press movement, but works with WEPUKO's quickly-controllable RX-series high-pressure pumps to be able to determine the force, the speed, and the direction of movement of the press. This drive system is characterised by a particularly smooth operation (free of shocks) and thus extreme reliability, not least because the pumps in this equipment last for at least 30,000, sometimes much more than 50,000 hours of operation without needing repair.

Another elementary advantage is the fact that this drive system needs considerably less energy than any comparable drive. The energy saving can be between 20 % and 30 %, depending on the design, in comparison to other oil-hydraulic drives and up to more than 60 % in comparison to water-hydraulic drives.

All of the new presses mentioned above with hydraulic drives have a drive in accordance with the PMSD principle.



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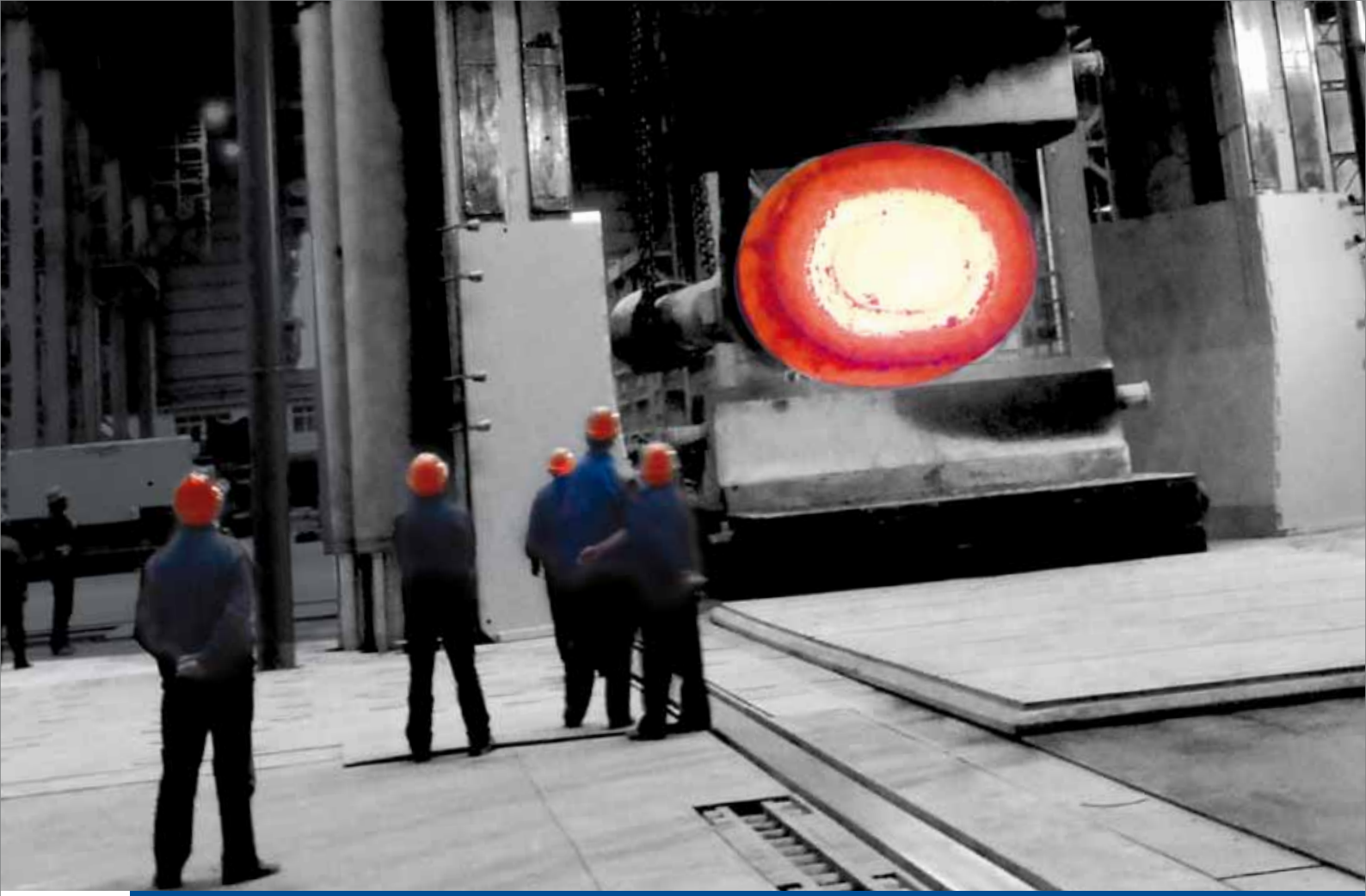

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