Rhode & Schwarz ESEF military VHF FM receiver

Ulrich Fierz HB9AIK

The ESEF receiver was designed and made by Rohde & Schwarz (R&S) in the early to mid-1950ies. The available circuit diagram carries the modification date 9.4.1956, so the radio must be dated before that. It is a compact unit (**Figure 1**), covering 22.5–45 MHz in 4 bands and is designed to receive NBFM signals from tactical radios with the then usual parameters for channel spacing (100 kHz, as marked on the dial) and deviation (±15 kHz). There is no squelch, no AM or CW facility or any other control that would make successful operation less 'soldier-proof'. The receiver is housed in a welded-steel box and a heavy rubber sheet behind the front panel protects it from humidity. The box has a lower compartment to stow the two power cables (110/125/220 VAC and 12 VDC) and a hinged cover with a rubber seal; two clamps are used to close it. The ESEF weighs ~18 kg and has a foldout-handle on top of the box to lift it. More details may be gleaned from **Figure 2**,which is a scan from the original leaflet which was somewhat damaged and had to be edited.

Figure 1. The Rhode & Schwarz ESEF military VHF FM receiver (after restoration)

More questions than answers

What also becomes clear from **Figure 2** is that the receivers were removed from service and disposed of in Germany mid-1959 **[4]**. This gives this expensive piece of equipment an unusually short lifetime of only a few years. What caused this fact remained a riddle to the author, despite considerable effort in research. That was not the only remaining mystery: who actually ordered it and for what purpose was it used and by whom, remained in the 'dense fog', as well.

At first, it was thought that it was part of the initial equipment for the *Bundeswehr* (1.1.1956), but they usually required German labelling. Also, no reference to this receiver was found in the available texts of the early *Fernmeldetruppe*. Was it perhaps ordered by an allied force such as the BAOR? It appears to have been issued

and used as indicated by a white hand-painted marking “104 SP” on the right side panel, but to whom?

FEMEG Fernmeldetechnik, München 2, Augustenstraße 16

Sonderangebot E III/59

Rohde & Schwarz VHF-Empfänger für Batterie- und Netzbetriebe.

TECHNISCHE DATEN:

Frequenzbereiche:
I. 22,5 – 28 MHz
II. 27,5 – 34 MHz
III. 33,5 – 39 MHz
IV. 38,5 – 45 MHz

Eingangsimpedanz: ca. 60 Ohm

Betriebsart: . . . . . F3 Schmalband-Frequenzmodulation mit 15 KHz Frequenzhub
Empfindlichkeit: . . . . . weniger als 5 Mikrovolt für 26 dB Rauschabstand
Spiegelfrequenzsicherheit: . . . . . Größer als 60 dB
Zwischenfrequenz: . . . . . 5,5 MHz; 50 KHz Bandbreite
NF-Teil: . . . . . 300 – 3000 Hz
Ausgänge: . . . . . 2 x 4000 Ohm; Lautsprecher-Ausgang 15 Ohm
Ausgangsleistung: . . . . . 2 Watt
Stromversorgung: Netz 50–60 Hz, 110, 125 u. 220 Volt, Batterie 12 Volt = über Zerhackerteil
Stromverbrauch: . . . . . ca. 50 Watt
Abmessungen: . . . . 350 x 265 x 250 mm Gewicht: . . . . . ca. 18 kg

Verkaufspreis DM 260.- ab Lager München.

Figure 2. Extract from 1959 sales flyer (edited)

Another open question is the operational deployment of the receiver. The technical design was aimed at a single purpose: to listen to VHF NBFM emissions easily, the set being mechanically robust, readily moved and without much operational training. Not so much a surveillance tool for intelligence than a receiver to monitor radio signals on known frequencies anywhere in the field.

Just guessing

Looking at similar concepts in the Swiss army, the author was reminded of what was termed an ‘alarm receiver’. This was deployed to anti-aircraft units and used to receive current air-situation reports and other alerts broadcast by regional powerful ‘alarm transmitters’ operated by the air force. While in our hilly and mountainous country shortwaves were used, it appears feasible that in the most threatened flat parts of Northern Germany, VHF might have been the better choice. Could this receiver have served in a comparable way?

Obviously this is just an idea and the author’s knowledge of operational concepts within the allied forces in Germany are very limited. There is quite some room for more research, there might even be members in VMARS who know better and could add valuable information.

A further mystery is the reason for the early retirement of this receiver. It cannot be its stability, quality or reliability of the unit, so the reason has to be found elsewhere. Was it the frequency range? Was it the lack of selective calling (the Swiss alarm receiver of the time provided 5 different alarm groups in this way)? Did it simply not meet the requirements of the users? Was it superseded by something else? Unfortunately more questions than answers.

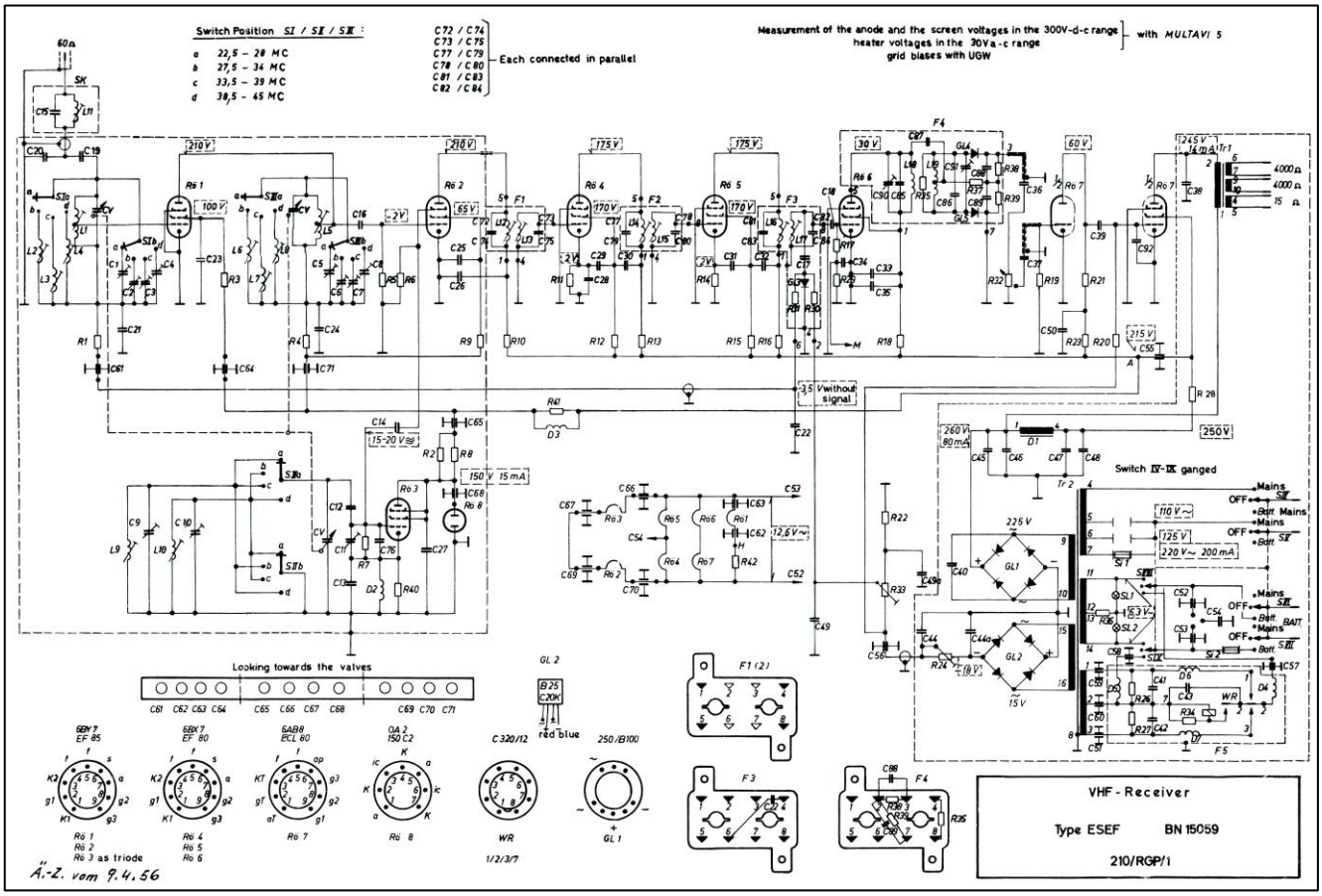

Figure 3. Circuit diagram of the ESEF VHF Receiver

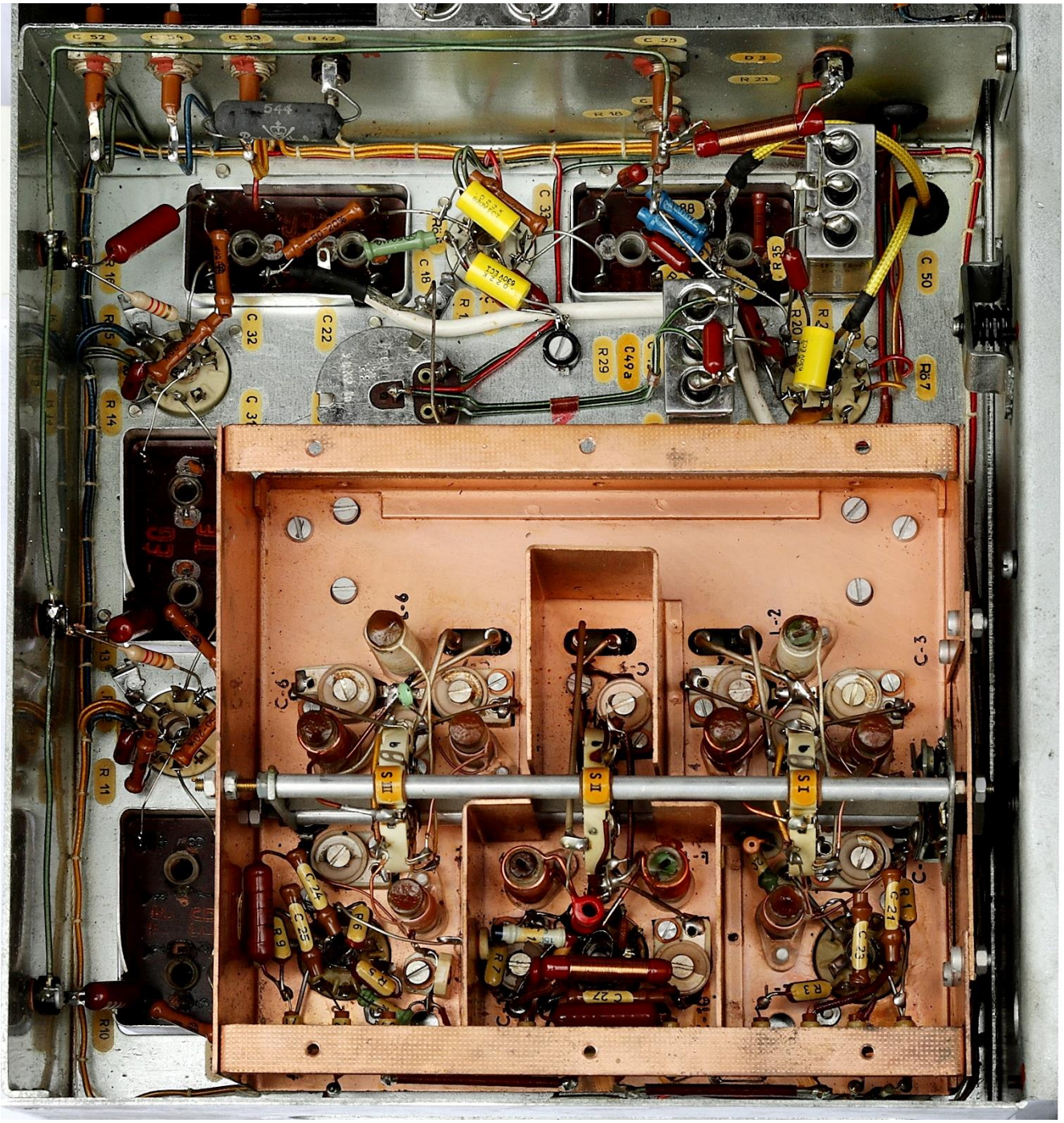

Figure 4. Under-chassis layout of the ESEF VHF Receiver (after restoration)

Circuit Description

The receiver is a conventional single conversion design (**Figure 3**) with an IF of 5.5 MHz (the standard CCIR TV IF). This is followed by a NBFM detector and a two stage audio amplifier.

In designing the receiver, the engineers at R&S used the then new generation of European Noval valves designed for TV sets (in this case produced by VALVO) and germanium diodes to obtain excellent performance for a receiver of the time.

The coaxial antenna input goes, *via* an IF trap, to the RF section in a screened box (**Figure 4)** where three vari-µ EF85 pentodes are used for the AGC-controlled RF amplifier, the mixer and a separate oscillator. The oscillator (in triode connection) is wired in only two bands, with its frequency is situated above or below the receive frequency as required. Tuning across the bands is *via* a butterfly variable capacitor, thus avoiding any contact problems on the rotor. A 150C2 stabilizes the anode voltage of the oscillator.

The following IF amplifier uses three EF80 high-slope pentodes: two amplifier stages followed by a limiter. After the second IF stage, a germanium diode is used to produce a delayed AGC signal that is applied to the RF amplifier. This AGC action reduces the input voltage range of the IF amplifier and limiter and helps to reduce

the detuning of the IF filters (by the Miller effect, so well described in *Signal* recently **[6]**). The limiter drives the Foster-Seeley discriminator which uses two germanium diodes.

The two audio stages are implemented using an ECL80 to produce up to 2 W output to two high-impedance headphones and an external speaker.

The power supply uses selenium rectifiers, a choke, hermetically sealed filter capacitors and a single power transformer for both mains and vibrator operation.

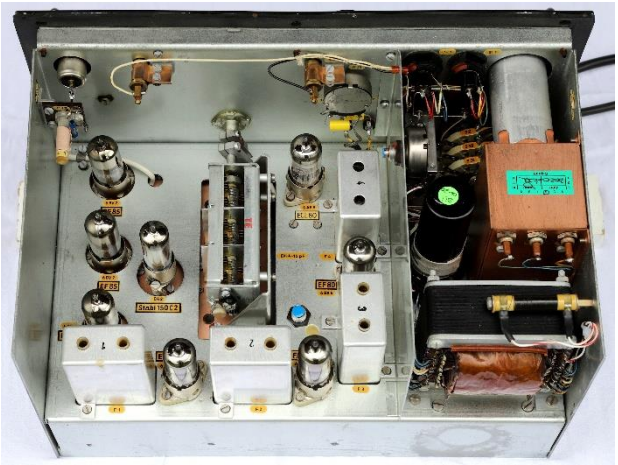

Figure 5. Above-chassis layout of the ESEF VHF Receiver (after restoration)

Mechanical Design

The receiver is built on a galvanized welded steel chassis with a separate compartment for the power supply (**Figures 5 and 6**). The RF circuitry is enclosed in its own box made from solid copper (**Figure 6**). Another such box houses the vibrator filter circuitry (**Figure 5**). There is an inner front panel where controls and connectors are mounted followed by the rubber seal and the outer visible front panel. All this results in a very stable construction that stood the time well.

Figure 6. Under-chassis view of the ESEF VHF Receiver with copper box cover in place and showing the PSU (after restoration)

The wiring is conventional but everything superbly executed – as usual with R&S products (**Figure 4**). No expense was spared in the use of high-quality components throughout. The tuning capacitor is gold plated. Plenty of feed-through capacitors are used to keep the power supply noise out of the circuit and any IF products out of the RF section. All components or their locations are marked with decals indicating the circuit diagram reference. The entire circuitry of the author's old receiver still looked as it might have been just after leaving the factory.

ESEF Ser.Nr.Z241/364

This receiver was indeed obtained in Munich based on the pamphlet in **Figure 2** – however, in late 1963, only for a much reduced price. Still expensive, but considered worth it.

The local amateur community in the early to mid-1960ies was moving from the 29.6 MHz AM net to 2 m AM and eventually a 70 cm FM relay was put up on the highest point near the city. The author's idea was to use the ESEF as a tuneable IF for converters to enable listening to the local amateur traffic on 2 m and eventually 70 cm, providing FM and AM (after modification). However, the output frequencies of commercial converters were not covered by the RA-1B then the only receiver in the young SWL's shack **[5].**

Geloso 2 m converters were available locally at the time. A 4/151 converter was purchased and, with a suitable internal power supply, put into operation. The crystal frequency was changed to avoid the IF sitting on a band edge of the ESEF and the new range 30.3-32.3 MHz carefully marked with a red felt-tip pen on the dial. Whether this was really necessary remains somewhat unclear.

The AM function was added in a minimally invasive way: the two IF amplifier valves were changed to EF89 vari-µ pentodes and a germanium diode was used as detector and contained in the same filter can as the AGC diode. With AGC wired to the EF89s, both functions worked satisfactorily but, looking back, certainly at a much reduced performance than the original when in FM mode. The mode selection was done using one of the headphone connectors, wiring the AM and FM audio sources separately to banana jacks and a coaxial cable routed through the third jack hole to select the desired function. As the work was done carefully, it proved as easy as hoped to reverse this modification when restoring the ESEF.

Anecdotes

Sometimes amateur equipment is put to other uses, in the author's case of my ESEF this happened twice.

In 1967 the author was charged to conduct tactical radio training for radio-link signallers using the SE-206 **[1]** VHF radio. To improve the debriefings, it was decided to record the network activity. However, no suitable equipment could be found in time so the author decided to use his own ESEF receiver and E36 ReVox tape recorder for the purpose. The receiver was connected to the 'regulation' vertical outdoor antenna FA83 and one of the headphone outputs fed the line input of the recorder. It operated flawlessly during all sessions and provided excellent recordings. This is mentioned here as this application appears close to the original purpose of the receiver.

Much later, in the 1990ies, there was a need for wireless microphones for a musical performed by girl guides. While high-quality microphones could be borrowed, there was no receiver to feed the PA amplifier. Or that is what the girls thought – until in came the ESEF and the problem was solved. This just shows the quality and longevity of these R&S products – no, this is not an advertisement.

Restoration

Taking the receiver out of its long hibernation, nothing much appeared to have changed. The only visible damage to the steel box – water at one time dripped on top from a leak in the roof and caused some corrosion – was only an external problem. The inside of the receiver was as clean as ever.

Careful investigation showed problems with the epoxy-sealed capacitors **[2]**. C40 across the high voltage AC side appeared ready to blow and the coupling capacitor C39 was shifting the ECL80 bias. So all epoxy caps were replaced by new film capacitors. Ceramic capacitors, rather than mica, were used througout in the RF and IF sections and no problems were detected. Germany always had a high quality porcelain industry and *e.g*. the famous company *Rosenthal* **[7]** made such capacitors. The carbon-film resistors measured all slightly on the low side, but definitely not worth replacing. The selenium rectifiers – these really produce ugly contamination when they fail – were replaced by silicon diodes. The main bridge rectifier (GL1) was built into the old black AEG case including a series resistor to compensate for the lower internal resistance of the silicon bridge. All the previous modifications were, of course, removed and the original condition restored. Finally a new set of NOS valves was installed.

No surprises were encountered when testing the receiver. All voltages were on the high side because the set was designed for 220 V and now 230 V is the norm in Europe. It was decided to insert a series resistor into the mains primary to correct this situation. One small difficulty was encountered when setting up: the output pentode uses fixed bias which is set by R24, but the anode current is not easily measured. An available 21Ω ±1% wire-wound resistor was inserted in series with the anode supply to allow a simple check.

Realigning the radio was no problem, given the superior performance of today's test equipment. The author was certainly less successful with his instruments in the 1960ies. A few key specifications were tested using a HP 8640 generator and found to meet the original data sheet. No operational tests were done as there were no signals around, but this old radio has found a nice place in the author's 'museum' – another successful 'lockdown' project.

Geloso 4/151 converter

It might be of some interest to VMARS members to describe the Geloso converter which might not have been common in the UK. In 1962, Geloso had quite an extensive offering of sets and components for radio amateurs. The receiver G 4/214 and the transmitter G 222-TR are probably the best known products **[3].** However, many other gadgets were offered, such as VFOs, receiver front ends and converters besides all the components also aimed at the radio industry, generally.

The 4/151 is the 2 m 'first generation' converter by Geloso designed using frame grid triodes to obtain good VHF performance. Later models, available for all four VHF bands, were designed using 6CW4 nuvistors. The 4/151 input stage is an EC86 in grounded grid configuration, followed by a cascode ECC88 amplifier. This VHF amplifier uses stagger-tuned resonators to cover the band from 144–146 MHz and the tuning instructions call for a sweeper. The signal is then fed to a ECF80 additive mixer, bandpass filter – also to be aligned with a sweeper – and cathode follower. The local crystal oscillator uses another ECF80 as an oscillator and tripler to generate the heterodyning signal.

The converter is on a galvanized chassis built into a steel box and great care is taken to screen and filter the various connections and heaters. The oscillator/tripler is inside its own box. There was no power supply originally, but the author built his own inside the case, similar to the 4/152 model that includes it.

Performance is good but, as no DX was attempted, the author has insufficient experience to compare to other converters. For the intended purpose it was certainly an excellent solution.

The unit was not powered up at this time although it would be interesting to measure the performance once properly retuned (which is certainly not the case now…). As Geloso specifically mentions the required high-quality of the EC86, there might be a little room for improved results using available E86C and E88CC valves? But that's for another day.

References and notes

1. http://www.armyradio.ch/radio-e/se-206-e.htm
   A short description of the tactical radio.
2. The epoxy develops cracks and moisture enters the capacitor. Among others Rifa noise suppression units from the 1980ies (connected directly across the mains) are known to blow up – this has happened to the author on one occasion: it is quite a spectacular 'audio-visual' event. NOS epoxy potted caps should be inspected for such cracks before use.
3. http://www.geloso.net/pagineIT/bollettini.asp?MyVar=bollettini From this archive by Paolo Di Chiaro the Geloso bulletins may be copied (free, no registration). Issues 85 and 91 cover all items referred to above. While the site is in Italian, the bulletin descriptions are in Italian and English side by side. They also cover diagrams, troubleshooting, alignment, *etc*. There are more ham radio issues, look for *Dedicato ai Radioamatori* below the green header.
4. DM260 in 1959 is some EUR600 today: http://www.lawyerdb.de/Inflationsrechner.aspx
5. The author obtained his HB9 licence in 1966 and the VK2 in 1969 – just in case you wondered.
6. PE Chadwick G3RZP. Input capacitance of valve amplifiers. Signal 2020, **55** (May), 52–55.
7. Rosenthal Isolatoren GmbH (RIG), then a joint venture with AEG, now Hoechst CeramTec.