Some things at face value can’t work and shouldn’t work, yet they do. SM5GDQ reviews some German WW II equipment that fits that criteria.

The Fusprech.f Transceiver
A Forerunner To Today’s Compact Transceiver

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The next time you are picking a weak signal out of the mud or working a string of DX with the latest transceiver available, stop and try to think about the amateur of 50 years ago or the type of gear in use during that time. Maybe you can think of it, or perhaps you remember pictures of big, crude-looking boxes or racks with all sorts of knobs and meters across their black, wrinkled steel panels. It was an era of big equipment, not miniaturization.

There were many designers of the time, however, who were working and trying out ideas that have found their way into the very rigs we use today. Prior to WW II, German engineers were working on the concept of a ubiquitous vacuum tube that would perform many functions and still be physically small. Obviously, their thoughts at the time were military, but the equipment they produced is still remarkable, even by today’s standards.

Most amateurs throughout the world have probably seen (and used) war surplus equipment made by the U.S. or Britain. It is very rare for the average amateur to have seen let alone used German WW II gear, for very little survived. One interesting development by the Germans, for example, was the RV12P 2000 tube. It was a multi-purpose tube with outstanding features developed around 1935 for the military. The Allies were to develop close equivalents later on in the Acorn tubes and the RF pentode, 6AK5. The way the Germans used their RV 12P 2000, however, was rather unique. It was used for all types of applications in receivers and in the low-power sections of transmitters. Receivers used to be equipped with that tube straight through from the RF part to the final AF amplifier. You can judge the size of the tube from the photograph.

Design Features Of The Fusprech.f

Fusprech.f, or Funksprechgeraet.f, simply means Radiotelephone Set, Model f. As the picture shows, it was a compact, small transceiver. Fifty years ago it must have been one of the smallest and best-developed transceivers in the world. It used seven tubes. The transceiver was normally fitted under the dash of armored vehicles and used for short-haul communications between similar vehicles.

The Fusprech.f contained 6 of the RV 12P 2000 tubes and an RL 12P 10 power tube. The RL 12P 10 was also developed for the military and is very similar to the better-known 6V6. The transceiver operated on the 15 meter band and certainly would have been popular among post-war amateurs had many rigs survived the war.

As can be seen in the block diagram, fig. 1, the Fusprech.f operated as a typical superheterodyne receiver without an RF stage during the receive mode. It could be tuned continuously between 20.0 and 21.5 MHz by means of a stable, free-running oscillator of the famous ECO type with a tuned anode circuit. Tuning was linked directly to the little knob below the dial window.

Operation

When the push-to-talk button on the carbon microphone was activated, a large, centrally-located relay with 10 sets of contacts completely switched the operation of the tubes. The oscillator still ran as...
The mixer tube socket, an IF transformer, and a component board.

an oscillator, but its frequency jumped up by 1.5 MHz, which was equal to the IF frequency of the receiver. Now the oscillator could feed its signal into the transmitter PA stage instead of into the mixer of the receiver. This is shown in fig. 2, whereby the frequency jump is made by one set of relay contacts which disconnect a capacitor in parallel with a coil of high inductance from the tuned circuit of the oscillator. That loss of a high inductance creates a minor decrease in the inductance of the original little coil used in the oscillator circuit. The purpose of this is to spread the band a bit in the transmit mode in order to make use of the same dial engraving for transmit and receive. That was one of the many clever approaches for the creation of technical features, often simple, that could be found in German equipment.

Your first thought may be that it would be impossible to get back to the right frequency again after such a crude switching arrangement with an oscillator running at that high a frequency. However, you could get back accurately enough so as not to cause any inconvenience in normal speech communication. While normally this wouldn’t be the case, it did work in large measure due to the designers’ efforts to make everything mechanically stable. As can be seen in the photographs, the mechanical design is excellent. All the chassis parts were cast from a hard metallic alloy instead of being cut from plates of aluminum or steel. Each tube had its own compartment shielded from each other.

The final receiver audio amplifier tube was switched over to run as a transmitter PA tube by means of the relay. Finally, the receiver AF preamplifier was also used
for modulating the control grid of the PA. The remaining four RV 12P 2000 tubes were not used in the transmit mode.

The big knob that can be seen just to the right of the tuning dial is the receiver incremental tuning (RIT) control. The receive frequency could be adjusted about 10 kHz up or down, just as in modern transceivers. This control simply used part of the capacitance switched out of the oscillator circuit during the transmit mode in conjunction with a variable RIT capacitor in series with a fixed capacitor. It worked very well.

The main dial, which moved behind a window, could be locked mechanically by means of another knob. If the dial was in the locked position, the tuning knob just free-wheeled without engaging the tuning capacitor. The 20.0 to 21.5 MHz bandwidth was divided into channels on the dial. The channels were spaced about 25 kHz apart and marked No. 341-400. The reason behind that number series is unknown, but in all likelihood there were a series of “Fusprechs” working on different frequency bands.

The antenna could be tuned in both the receive and transmit modes by means of two small knobs and a meter that was used to read RF power output to the antenna. The output power was about 2 to 3 watts. The original antenna was a 6 foot mobile whip, but this remaining unit as shown in the pictures ran exceptionally well using a standard amateur radio 15 meter dipole.

There was also a tone-call push-button provided. The button switched to modulator to act as a 500 Hz tone oscillator when depressed. Finally, there was a receiver volume control with a main on/off switch. Connectors were provided for antenna, speaker, microphone, and power supply. Power requirements were 12 volts (from the vehicle battery) and 300 volts from an associated motor generator.

The AF power output was about 3 watts due to the use of the power pentode RL 12P 10 also in the receive mode. That was unusual in military receivers. Almost all German receivers for aircraft, tanks, and so on were equipped with RV 12P 2000s in the final stage and could feed headphones only. But Fusprech.f could feed a large loudspeaker in the vehicle, and that might have been beneficial in a noisy environment. However, we know that the next generation of military radios, those used by NATO and before the introduction of transistors, also delivered the AF power into headphones only.

The detector of the receiver was an RV 12P 2000 with its grids connected to either the anode or the cathode in order to get it working as a diode. That is a good example of how the designers tried to hang onto that tube in all of their applications. This detector provided AGC voltage to the two IF stages in the usual way.

**General Aspects Of German WW II Equipment**

There have been previous articles in CQ detailing various specific pieces of equipment, so I will cover some significant aspects only. The primary aspect of interest is the high frequency stability through an excellent mechanical design. Many old timers will remember how hard it was to achieve a stable frequency from a homemade, free-running oscillator.

Apparently, crystals were never found in equipment designed for use on an active battlefield. Crystals were used, however, in larger, more exotic pieces of equipment designed for the Navy or fixed installations up to and including calibration crystals. Beyond this use and service facilities, the Germans seemed to rely on and put their efforts into developing simple, straightforward electrical layouts which were well screened and mechani-
The famous multi-purpose pentode RV 12P 2000—which was pushed into its socket with its bottom side up—and the power amplifier tube RL 12P 10. Note the sizes of these old tubes as compared to the pen.

cally stable. They were reasonably assured that their tuning dials were correct, and that they didn't have to continually check readings against a calibrator. Those of us with experience with post-war, continuously tunable military radio sets, before the age of synthesizers, know what that means.

It is equally amazing that the German VHF radios such as airborne sets FuG 16 and FuG 17 from Lorenz did not need any calibration crystals either. The first of this series was introduced in early 1941 as a replacement for earlier airborne radios operating in the lower part of the HF band, 3–5 MHz. The VHF radios operated from 38–42 MHz and 42–48 MHz, respectively, and the basic design guidelines were the same as those used for the Fusprech.f.

The basic difference in design philosophy for the airborne equipment was that there were two units, a receiver and a transmitter, which meant there was no switching in RF circuits. In spite of this, it is amazing that no calibration facility was required after hours of being in and on the air, because the RF part of the transmitter utilized only two tubes, one in an ECO oscillator and one in the PA, both of which were powerful transmitter pentodes, RL 12P 35. The specifications for this tube are very similar to the more familiar 807. Frequency stability was achieved by running the oscillator tube at very low power.

The basic design, however, was unusual and odd. Variations in antenna loading also did not affect the frequency stability. Output was held to 8 watts, far below the capability of the tube, but that was due in part to controlled grid modulation.

The best evidence for transmitter stability in both the FuG 16 and FuG 17 was in their use in some types of aircraft. In some aircraft the VHF radio was installed in the rear part of the fuselage, out of direct accessibility to the crew. Instead, a form of remote control was achieved by means of geared electrical motors which were able to turn the dial knobs between two defined end-points. The motors were simply affixed to the front panels of the transmitters and receivers, whereby two radio channels could be selected by a switch in the cockpit. The crew couldn't make any adjustments even if they wanted to, but that may not have been necessary. The Germans relied strictly on AM and did not see fit to utilize FM.

One interesting report issued by the Allies on German equipment was prepared by the British Royal Airforce in February 1945. It concerns the FuG 16 ZY and says the following in its preface:

"4. Performance of the FuG 16 ZY/... In actual use the standard is for adjacent frequency channels to be separated by 50 kcs and, in view of the fact that neither the transmitter nor the receiver is crystal controlled, this, in itself, testifies to both receiver selectivity and absence of frequency drift of the transmitter. Similarly, the accuracy with which the equipment retains its calibration is excellent, the general performance being superior to that of special British listening receivers, and at present the only satisfactory interception receiver for FuG 16 ZY traffic is the FuG 16 receiver itself."

The report was stamped secret and signed (Sd) G.V. Calvert S/Ldr for W/Cdr.

Perhaps now when you look at your compact transceiver you can see some of the evolutionary thought that went into its design. Some things that appear to be remarkably new and innovative have been around for years in different forms. Modern technology has made it much easier just to purchase equipment rather than try and build it, and far simpler and safer than waiting around for war surplus.

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