

To the average amateur, surplus is synonymous with outdated American military electronic equipment with little thought to the military part or what the equipment was actually used for. The following article concerns surplus of a different origin, how it works, was used, and is used today.

German World War II Communications Receivers

Technical Perfection From A Nearby Past

Part I

BY DICK W. ROLLEMA*, PAØSE

Radio communication equipment, as used by the allied forces during World War II, is well known among collectors and lovers of wireless equipment from the past.

Communication equipment that was used by the German forces during the war is much less known; that applies not only in the United States, but for Europe as well. This may look remarkable as that same Europe formed one of the main theatres of war. Why was it that so much of the allied equipment was left behind after the German forces capitulated that war surplus shops flourished for many years after, whilst at the same time German equipment has been relatively rare right from the start of the post war period?

Not because these units were manufactured or used in limited quantities. One of the main suppliers of radio equipment, the Telefunken firm, employed some 40,000 workers, spread over 350 different locations, by the end of WW II. How many sets of different

categories were made is unknown to the author. But it has been put on record that of one radio used in tanks, the so called "Bogegerät", some 180,000 units were manufactured.

The reason that so little of the vast German production remained may well be that the allied forces that occupied Germany after it collapsed ordered that all radio equipment that was found was to be demolished. By the end of 1945, and the beginning of 1946 this order was changed in that equipment remaining at that time was not to be destroyed but dismantled. The components that resulted from that action formed the basis for German production of consumer radio equipment, a production that came to a faltering start at that time.

Not only thousands of radio's ended under the crash hammer, also all drawings and other documents that supported design, development and production of the equipment went the same way so that hardly a trace of it was left. What we know about the background for the wartime production of German radio equipment has been reported orally by some of the

leading men who were involved. Please don't get the idea that the author condemns the decision to destroy all wartime German equipment. It was a completely understandable and justified decision. But it does explain why most of us radio amateurs, both in the USA and outside, are in general rather unfamiliar with the communication equipment that was used "on the other side." And that is certainly to be regretted as this equipment was of exceptional technical perfection and beauty.

Of course some German WW II radio equipment escaped destruction and part of what remained found its way into the hands of collectors, some of whom specialize in German radio apparatus. By sheer coincidence your scribe came into contact with one of those specializing collectors, Arthur Bauer, PAØAOB, who lives near Amsterdam. Arthur owns a most beautiful collection of German WW II radio equipment. When I met him for the first time in 1977, his collection comprised more than ninety items. By today it must have passed a hundred easily. It is certainly no simple feat to bring together so much of this rare equipment.

* v.d. Marckstraat 5, 2352 RA LEIDERDORP, Netherlands

Arthur scans the whole of Europe for it and he has his contacts in most of the countries of our part of the world.

PA0AOB not only *collects* the German equipment, he also *uses* it for his contacts with fellow amateurs.

Photograph 1 shows Arthur, PA0AOB, making a QSO via a powerful German transmitter of WW II vintage. The receiver at the left of the transmitter will be described later in this series. Single sideband does not exist for Arthur, of course. Only c.w. and a.m. and a system of teletyping over radio, invented in the twenties by Dr. Rudolf Hell. The machines that use this system are called "Hellschreiber" ("Schreiber" means "writer" in German). The system is different from RTTY as we know it in that the characters are transmitted in a form of simplified facsimile (FAX). The received characters are printed on a paper tape as they are received as "pictures". The charm of it is that the receiving machine does not decode the characters as in normal teletype. The decoding is done by the operator who interprets the "pictures" on the tape as characters. Interference and or fading on the radio path can never result in a wrong character being printed. The picture of the characters may become blurred or smeared by the interference. But due to the supreme capabilities of the human eye and brain a lot of interference can be accepted before the received characters become unreadable. The price for this immunity against interference is increased bandwidth. The signal is about six times as wide as a radio teletype signal of the same transmission speed in characters per second. This is partly compensated by the fact that the Hell system of teleprinting does not need FSK as modulation mode. Simple on/off keying of a c.w. transmitter gives fine results. So in the end the Hell signal occupies about the same bandwidth as a teletype signal of the same speed.

The Hell system is commercially obsolete. But it has been revived by a group of European amateurs, who possess the machines for it. Photograph 2 again shows Arthur typing on a "Hellschreiber" as they were extensively used by the German forces during WW II. Your scribe is so lucky as to have a "Hellschreiber" on loan from PA0AOB and so he meets Arthur and several other amateurs in Europe every Sunday afternoon on forty meters, using this nostalgic way of communicating. One of the members of the "Hell group" is Hans Evers, DJ0SA/PA0CX and he described the Hell system of teleprinting in *Ham Radio Magazine*, December 1979 ("Hellschreibers rediscovered").

But back to the subject of this series: German WW II communication receivers. In the next section we will describe



Photo 1- Arthur Bauer, PA0AOB, amidst some items of his extensive collection of German WW II radio communication equipment. He actually uses several of these sets for making QSO's on the h.f. bands.



Photo 2- Here PA0AOB is typing on a "Hellschreiber," an ingenious system of teletyping over radio. The system was extensively used by the German forces during WW II. It is now commercially obsolete. But a group of enthusiastic European amateurs have revived the system and are using it in regular skeds on the h.f. and v.h.f. bands.

some general characteristics of German radio equipment. One feature we will discuss in more detail: a quartz crystal intermediate frequency filter with continuously variable bandwidth. This type of filter was used in several receivers of the superheterodyne type. Following it we will discuss two receivers of the tuned radio frequency variety and two superheterodynes.

You are probably surprised that the

Germans used t.r.f. sets. But they certainly knew how to make them in superior form. A great advantage of the straight set is that spurious responses are non-existent, even in the presence of extremely strong signals as in shipboard use, where several transmitters may be active at the same time receivers are operated. Another advantage from a military point of view is that the t.r.f. set does not use oscillators and so

the chance of location by the enemy using a direction finder on spurious radiation of the set is negligible.

This article could only be prepared thanks to the assistance of PA0AOB. Not only did he make the receivers available for photography, he also gave the author the opportunity of using some of the sets in his own shack for a considerable period of time.

The fact that PA0AOB could provide the original technical manuals, or exact replicas of them, was also of great help in the preparation of this article.

General Characteristics of German Radio Equipment

The oldest company that manufactured military radio equipment in Germany is undoubtedly Telefunken. During the first World War (1914-1918) this firm supplied radio communication equipment for the German army. Production of military equipment was forbidden in Germany under the Versailles treaty that ended WW I. But when Hitler came to the fore in the early thirties the situation changed drastically. When general conscription was announced in 1935, production of weapons and other war material came into full swing. New communication equipment was to be developed and produced. Again Telefunken was the leading firm. Also Lorenz, a German branch of the American ITT concern, started extensive activities in the field of military radio. In 1937 the German government invited tenders for a new radio for military aircraft. It came as a shock to Telefunken that Lorenz emerged as the winner with their FuG 10 set. This consisted of beautifully made separate receivers and transmitters for different frequency bands that were combined in a rack. Photograph 3 shows part of a FuG 10 installation, at the left a long wave receiver, in the center a short wave receiver and at the right a short wave transmitter. The antenna was matched by a remote controlled tuner, that is visible in photograph 1 on the shelf; it is the box with the rounded corners at the left. The superiority of Lorenz was especially evident in the mechanical engineering of their equipment. In the following years the dividing line between Telefunken and Lorenz products became less clear as equipment was manufactured under mutual licensing contracts. Also other big firms, like Siemens and companies in countries occupied by Germany took part in the production.

We will now take a look at the German radio equipment and see whether we can find some characteristics that make it so unique and different from similar gear used by the allied forces.

In the first place we observe the tendency to use a minimum number

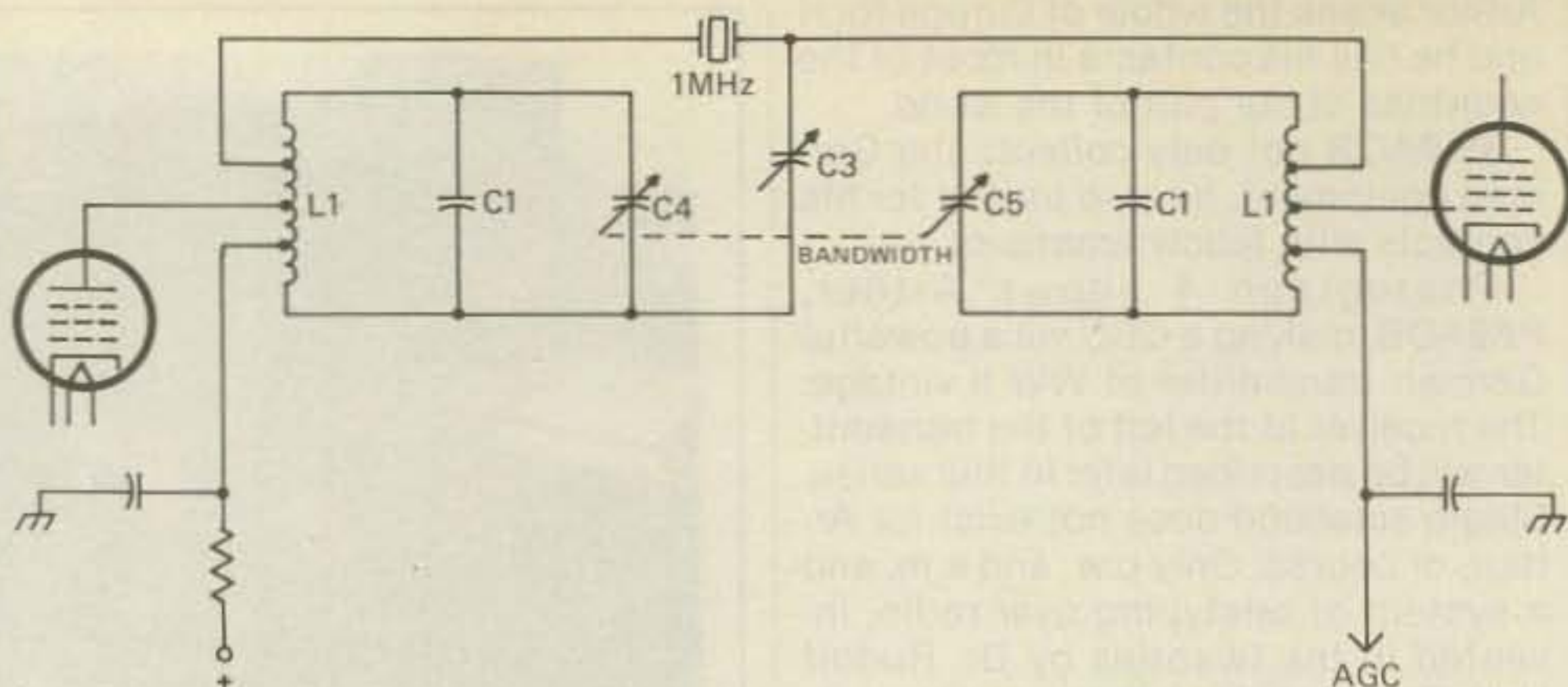


Fig. 1- Quartz crystal bandpass filter with variable bandwidth as can be found in several German World War II superheterodyne receivers.

of different types of radio tubes. Most of the receivers used the same type of tube in all stages! This posed some tricky problems for the designers. We will meet an example of this later on. From a logistic and maintenance point of view it is of course a clear advantage to limit the variety of tubes to the absolute minimum. The tubes were especially developed for this military equipment. They were miniature types, certainly gauged by the standards of those days, and very robust. The tubes fitted special sockets that completely enveloped them and in which they had to be inserted top first. Nevertheless, the hope that a few types of tubes for all receivers and transmitters would suffice was not fulfilled; by the end of the war some 100 different types could be found on the lists of military tubes.

Another feature of German radio receivers and transmitters is that the designers certainly were generous as to the total number of parts used, especially if by doing so potential sources of trouble could be avoided. One finds, e.g., decoupling devices and screening liberally applied in all stages of a receiver or transmitter. Another feature is that even the simplest piece of equipment has the possibility of having its proper operation checked by the user. A built-in voltmeter with selector switch to measure voltages at different parts of the circuit is the minimum always found. Sometimes quite elaborate built-in operational checks can be encountered. Again we will meet an example of this later on in the series.

The most striking characteristic of German equipment is no doubt the mechanical part of it. The traditional chassis, so familiar to radio equipment of the past, was never used as such by the Germans. Instead they filled the space in a cabinet in three dimensions. The circuitry of a radio set was divided in a number of units, "modules" we would call them in our day, that could be easily removed and replaced. Usually such a module took the shape of a completely screened box of cast alloy

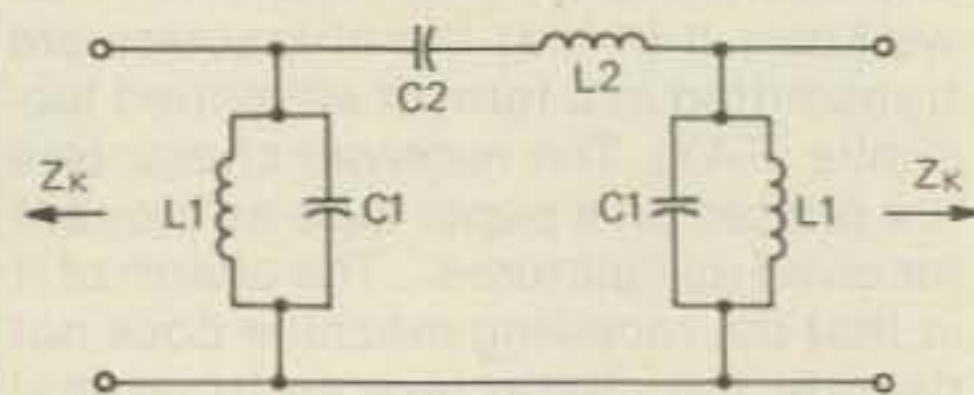


Fig. 2- Prototype bandpass filter section of the so-called constant-K type.

that made it extremely stable, both from a mechanical and an electrical point of view. Inside the box was divided in completely screened compartments that housed the different stages belonging to that unit. The units were combined to a complete set by mounting them into a frame, again made of cast alloy. The electrical connections between the units consisted of multipole connectors on the modules, mating with similar devices on the frame. The whole became an extremely strong combination with almost ideal electrical characteristics and easily accessible on all sides for servicing. The whole assembly slides from the front into a sturdy cabinet that in itself already forms a solid and stable basis.

This battleship-like construction also works out in a negative way; most of the German pieces of radio gear are extremely heavy, no doubt partly due to the fact that aluminum was not used for the boxes and frames. The exact composition of the alloy is unknown to this author, but very likely zinc formed a major component of it.

The moving parts such as gears, tuning capacitors and switches are masterpieces of mechanical engineering. Moving a coil turret from one position to another, e.g., is done by a big solid crank and it feels like opening a safe or the door of an expensive oldtime automobile. Regardless how complicated the mechanical devices, they can always be dismantled in a few seconds by loosening one or two screws. That the mechanical linkage can be complicated is evident when one realizes

that, e.g., variable capacitors or band switches that are ganged are sometimes found in different modules that can be easily taken out of the frame, in spite of the mechanical gears. Nevertheless the mechanisms operate with extreme precision. Examples that demonstrate these principles will be shown when we come to the discussion of the four receivers that will be covered in this article.

The German sense for perfection, that is reflected in even the smallest details like terminals, is also demonstrated in the instruction manuals that come with the sets. These not only provide very complete information for the operational use of the set, but also the maintenance man finds everything he needs to know for performing his job properly.

That the designers certainly had service ability of their products in mind is already clear from a simple visual inspection of a radio set. One finds, e.g., screws that are surrounded by a red ring. These have to be loosened to remove a complete unit (module). If one wants to take a unit farther apart the screws marked with a blue ring have to be removed. It is these details that make it a real joy to dissect a German WW II radio.

As announced in the previous section we will now discuss one feature in more detail: an intermediate frequency crystal filter with continuously variable bandwidth.

Such filters are found in several German communication receivers and they were made for different i.f.'s. The "Köln" receiver for instance, that we will meet later, has an intermediate frequency of 1 MHz. The bandwidth of the crystal filter working on this i.f. can be varied between 0.2 and 10 kHz!

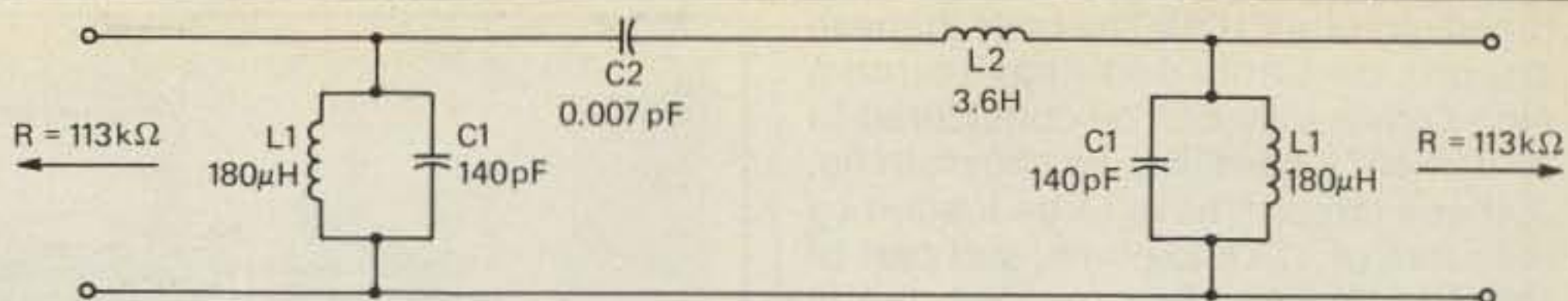


Fig. 3- Constant-K type bandpass filter with component values calculated for a passband of 10 kHz wide and a center frequency of 1 MHz. Note the "impossible" values of the capacitor and coil in the series tuned circuit.

The circuit diagram of this filter is shown in fig. 1. The filter is positioned between i.f. amplifier tubes. A second filter of the same configuration follows the tube on the right. Upon casual inspection one could easily conclude that this filter is of the familiar type to be found in many popular American communication receivers and introduced in the early thirties by James Lamb in his "Single Signal Superhet." These filters feature a sharply peaked response plus a rejection notch that can be moved up and down in frequency by means of "phasing capacitor" C3. But this conclusion would not be correct. The German filter exhibits a real bandpass response, that is to say a flat passband and symmetrical filter slopes at the transitions between pass and stopbands. How is it possible to realize such a response with just a single quartz crystal resonator?

For explanation we turn to an elementary form of bandpass filter, the so called "constant-K type," depicted in fig. 2. This filter consists of two parallel tuned circuits connected by a series tuned circuit. All three circuits are resonant at the same frequency f_0 , the center frequency of the pass band. The circuits are supposed to be ideal (without losses). The filter must be fed from a source with an internal im-

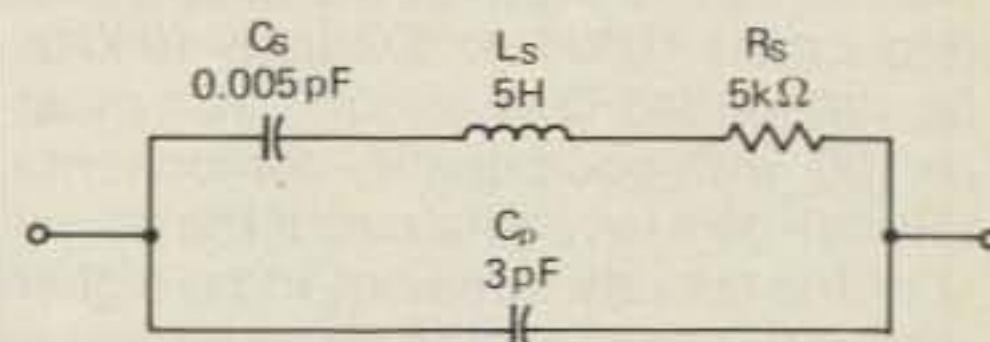


Fig. 4- Equivalent electrical circuit of a quartz crystal resonator. The element values indicated are typical for a 1 MHz crystal.

pedance Z_K and loaded by an impedance Z_K . Z_K has a different value for every frequency in the pass band and stop bands. Because this is almost impossible to realize in practice the filter is used between a source with internal resistance R and also loaded by R. R is taken as the value of Z_K at frequency f_0 .

In fig. 3 a constant-K bandpass filter is shown that has been designed for a center frequency of 1 MHz and a pass band of 10 kHz wide, just as the crystal filter in the "Köln" receiver. The component values for L1 and C1 have been taken equal to L1 and C1 in fig. 1 for the "Köln" filter. Now look at the series resonant circuit L2C2; don't C2 and L2 have "impossible" values? Indeed, especially L2 could never be constructed with a self-inductance of 3.6 henry at 1 MHz. To produce a capacitor of 0.007 pF isn't simple either. But wait, let us take a look at the equivalent electrical circuit of a quartz crystal resonator, as shown in fig. 4. This consists of a series tuned circuit and a parallel capacitor that represents the capacitance of the crystal electrodes. The values for the elements of the equivalent circuit shown in fig. 4 are typical for a 1 MHz crystal. These values are very near to those of the series circuit C2L2 in fig. 3! So it looks like we could replace C2L2 by a suitable quartz crystal and so obtain a bandpass filter at 1 MHz with a 10 kHz wide pass band. But what about the earlier statement that the elements of a constant-K filter were supposed to be without losses? R_s of 5 kilo-ohms in fig. 4 certainly looks like a high loss. But be careful with that conclusion; what really matters is the Q of the series tuned circuit. And Q is equal to the reactance of C_s or L_s at 1 MHz, divided by R_s . And that works out to a Q of 6280. That value is so high that the crystal, acting as the series tuned circuit, can be considered lossless. And how about the losses in the parallel

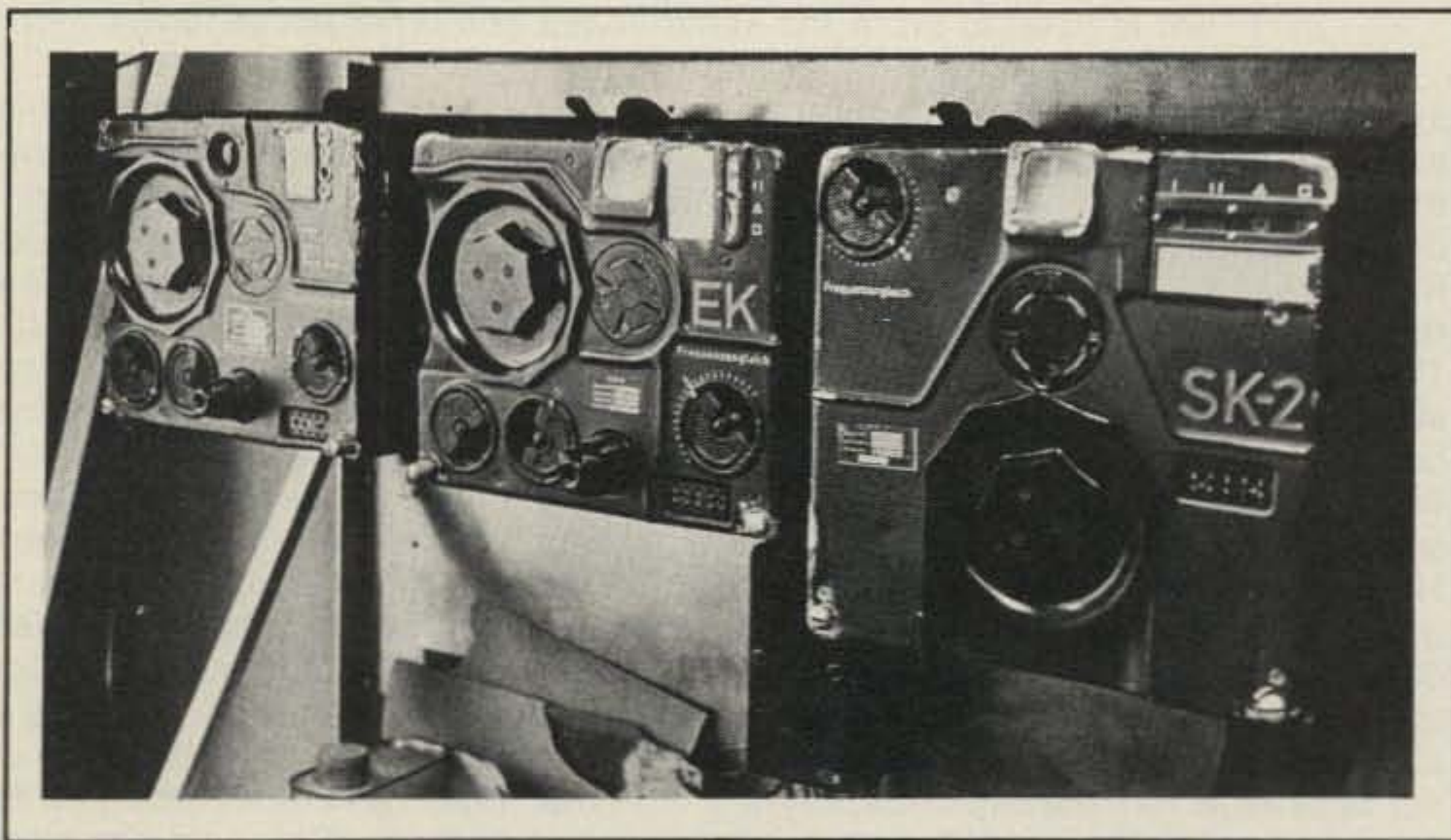


Photo 3- Some units of the FuG 10 aircraft radio set, as it was developed by the German Lorenz factory, part of the ITT concern, in the year 1937. The radio was subsequently manufactured by other firms as well. The remote controlled antenna tuner of this set can be seen in photograph 1; it is the box with the rounded corners at the left on the shelf.

tuned circuits L1C1? The coils in these circuits certainly don't have such a high Q that they can be considered to be without losses. But as shown in fig. 3, these circuits have to be loaded by resistors of 113 kilo-ohms, and part of this loading can be provided by the loss of the circuits themselves. Isn't that beautiful? The loaded Q of the parallel tuned circuits has to be equal to the center frequency f_0 of the filter, divided by the width of the pass band. In our case 1000 kHz divide by 10 kHz. So the loaded Q of circuit L1C1 must be 100. With good quality components this can be easily obtained. If the actual Q of the circuits turns out to be higher than 100, extra loading by resistors (or by the output impedance of the preceding tube and the input impedance of the following tube!) can be provided.

So now that we have seen how the single crystal filter can really work as a bandpass filter let us go back to fig. 1, the filter of the "Köln". We see several extra components, as compared to fig. 3. In the first place the crystal is not connected between the upper ends of the parallel tuned circuits, but between taps on the coils. This is done because it would be very difficult, if not impossible, to manufacture a quartz crystal resonator where the parameters of the electrical equivalent circuit have exactly the values required. So in practice the crystal is measured to find out what the actual values of C_s and L_s are and then the proper tap on the coil is computed.

The required value for C2 and L2 of the series tuned circuit changes with the square of the tap ratio on the coils. If for example the taps were made halfway up the coils then the value of C2 would be four times as big and of L2 four times as small as in case of connections to the top of the coils. So by selecting proper taps on the coils the actual crystal can be matched to the filter. In the "Köln" several taps are available, obviously to cater for manufacturing tolerances in the crystals.

Another new element is trimmer capacitor C3. This is a neutralizing capacitor for the parallel capacitance of the crystal and its holder. Once properly set it needs no further adjustment.

You will also note that the anode of the tube feeding the filter is connected to a tap on the coil. That is obviously done to decrease the loading of the input circuit of the filter by the output resistance of the tube. Undoubtedly the designer had selected this tap in such a way that the correct value for the loaded Q of the input circuit is obtained.

The grid of the tube following the filter is also tapped. From a loading point of view this seems unnecessary as the input impedance of a pentode at 1 MHz is very high. But the tube is controlled by the automatic gain control

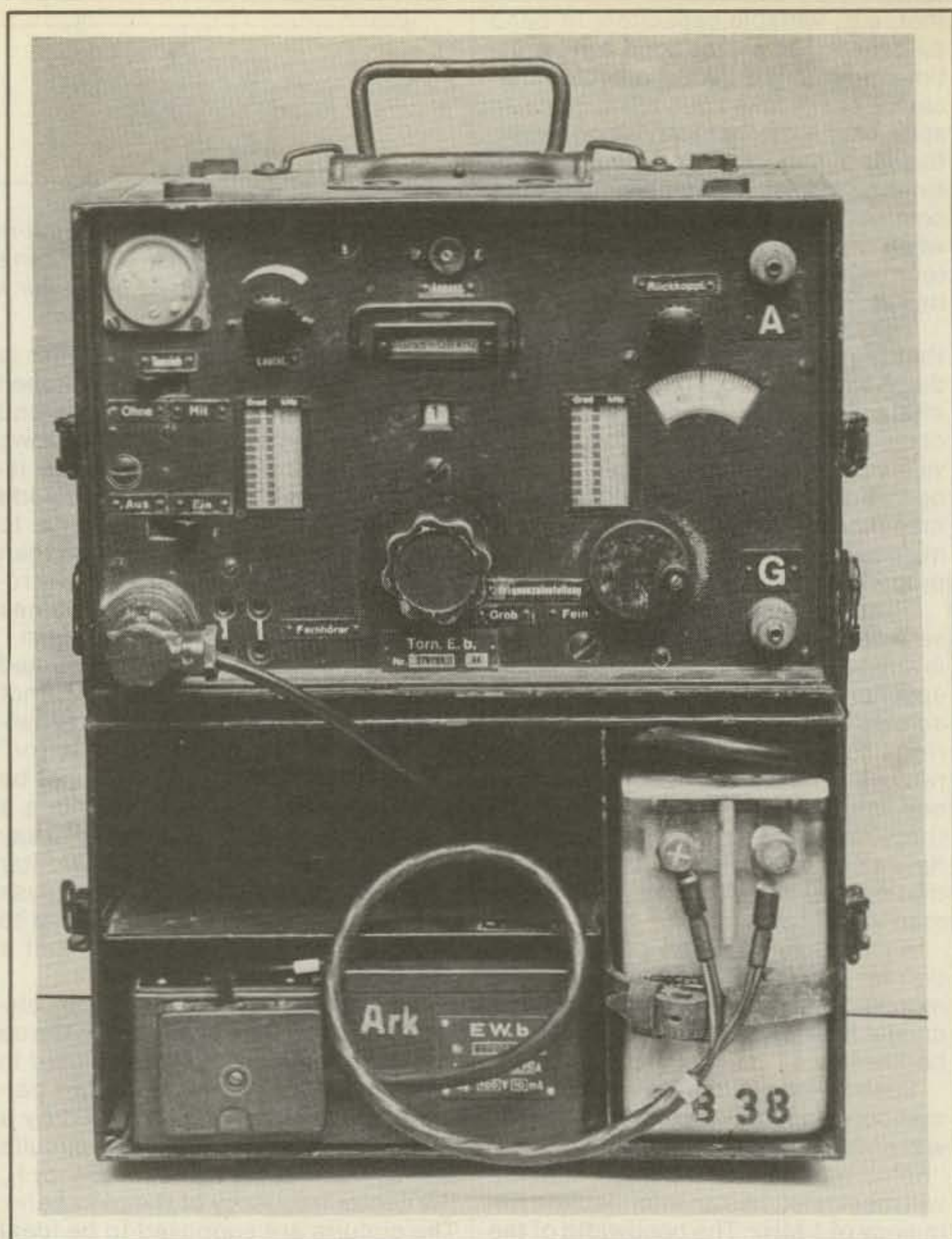


Photo 4— Tuned radio frequency receiver Torn E. b. The lower cabinet houses the 2 v. filament battery and a vibrator power pack for the 90 v.h.t. The empty compartment is used to store the headphones and other accessories.

system. And under influence of the a.g.c. voltage the input capacitance of the tube changes slightly and this could detune the output circuit C1L1 of the filter. Hence the tap. This leaves us with the function of C4 and C5 to explain. They are sections of a two-gang variable capacitor, but a special one; the construction is such that when one section increases in capacitance, the other section decreases by the same amount. Now assume that at a certain position of the capacitor the input and output circuits of the filter have been aligned to the same frequency. The filter then acts as a bandpass filter of 10 kHz wide in our case. Now turn the capacitor, say in such a direction that C4 increases and C5 decreases. This means that the two parallel tuned circuits become detuned from 1 MHz by equal amounts and in opposite directions. Now the whole circuit is no longer a proper bandpass filter. In-

stead what remains is a crystal, acting as a series tuned circuit, connected between two impedances. These impedances become lower as they are detuned farther from 1 MHz. The result is a narrowing of the passband that ultimately approaches the response of the crystal alone, which is a very narrow one. Because the input and output circuit are detuned in opposite directions, the response always remains symmetrical. There you are; a crystal filter where the passband can be smoothly varied between a few hundred cycles and 10 or more kiloHertz by simply rotating a single knob!

In the "Köln" and other receivers as well, two of these filter sections were used in cascade, separated by an i.f. amplifier tube. The sections of the capacitors for varying the bandwidth are in that case combined to a four-gang unit.

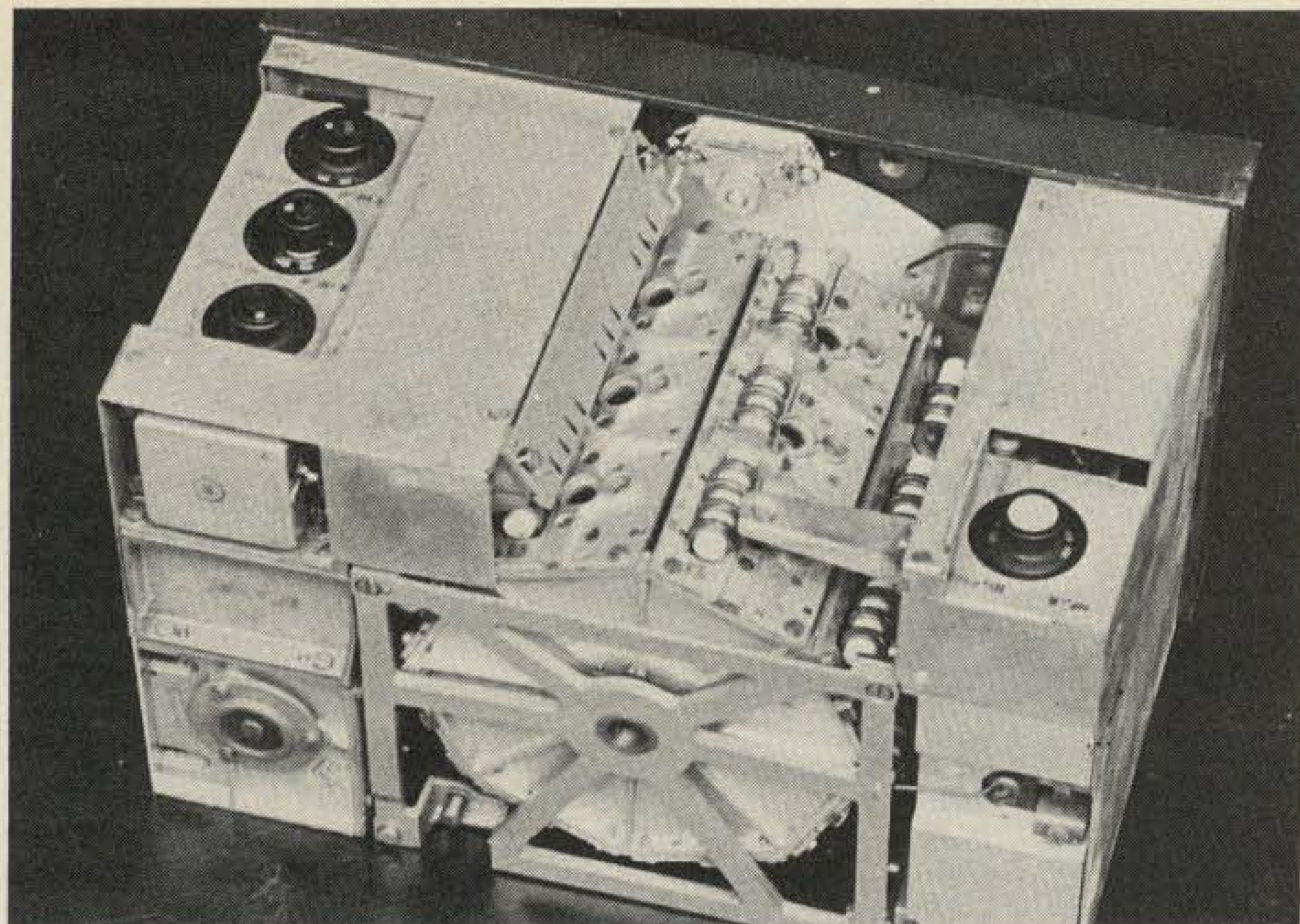


Photo 5- Receiver Torn E b with cabinet removed. Note the bases of the four tubes that disappear completely in their holders. They can be retracted by means of the knob that is part of the molded tube base.

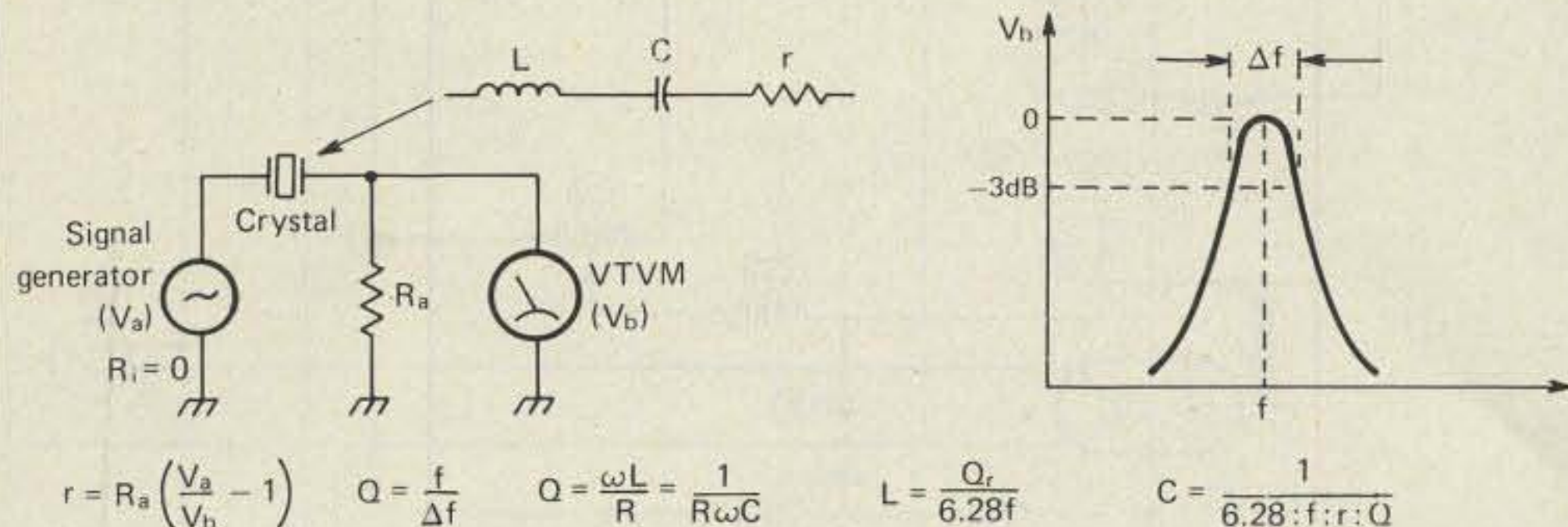


Fig. 5- The parameters of the equivalent electrical circuit of a quartz crystal resonator can be easily measured in this set-up, due to Hans Evers, PA0CX/DJ0SA.

It is a remarkable fact that this beautiful solution to the problem of obtaining a continuously variable i.f. bandwidth in a receiver seems to have been lost with the disappearance of German WW II communication receivers from the scene. The system has been used in some post war German receivers, e.g. made by Siemens, but the system in general was almost forgotten until about a year ago. Credit goes to Hans Evers, PA0CX/DJ0SA, for having it revived in an article in the Dutch amateur radio magazine *Electron* of July 1979. Hans, for many years, has owned a German receiver in which a crystal filter of the type described is used with excellent results. Triggered by an article in a German magazine on the alignment of such filters, Hans finally found out how the filter really worked. The explanation given above is correct and has been proven by Cas

Caspers, PA0CSC, who calculated the response of a filter according to fig. 1 with the values of C_s and L_s of the crystal inserted on a digital computer. The calculated response conforms very closely to the measured one.

It should not be difficult for the homebrewer of today to make a crystal filter according to the old German principle. One only needs to know what the parameters of the equivalent circuit are for a crystal that is to be used in the filter. These can be measured in a set-up shown in fig. 5, thanks to Hans Evers. All that one needs is a signal generator, a v.t.v.m. and a resistor. In order to read small frequency differences with sufficient accuracy an electronic frequency counter is almost a must. From the crystal parameters, the values of C_1 , L_1 and the proper loaded Q of the input and output circuits of the filter can be computed with

formulas that can be found in for instance the ARRL *Amateur Radio Handbook*. For the variable capacitor with counteracting gangs we could probably use two varicaps on which the control voltage acts in opposite ways.

It is perhaps well to explain that the success of these early crystal filters is for a large part due to the fact that the Germans knew how to produce stable high Q coils, using powdered iron cores and such at a time when in other countries air coils were still used as a rule, with a simple powdered iron tuning slug used on others.

Fine coils were not found exclusively in the r.f. and i.f. parts of German receivers. In the variable frequency oscillators of transmitters coils can be found in which silver turns are burned into ceramic coil formers. As a result these oscillators show a remarkable mechanical and electrical stability. According to PA0AOB this technique reduces the temperature coefficient by a factor of 200, as compared to a conventionally wound coil. The same construction techniques were used in the manufacturing process of trimmer and fixed capacitors in tuned circuits.

Now that we know something in general about German radio equipment from WW II days it is getting time to take a closer look at some of these fine radios.

Tornister-Empfänger b

We will use the original German designation of the receiver we are going to discuss now. Photograph 4 shows a front view of the set. You see that the set consists of two units above each other. The cabinets—meant to be carried on the back of a soldier—that house the units are called "Tornister" in German. Actually in photograph 4 you see two half "Tornister", one housing the receiver and the other the power supply. "Empfänger" is the German word for receiver. And the letter "b" in the designation simply indicates which receiver. Mostly the designator was shortened to "Torn E b" and that is what we will use. The Torn E b was created around 1935/36. It was in general use with the German Signal Corps, but also at higher army staffs, police and traffic control authorities. It was a popular set, produced in great numbers and one of the few sets that found their way to amateur service in Europe in post-war stations.

It is a tuned radio frequency (t.r.f.) set with four filament type tubes that were run from a 2 volt battery at 0.2 a. each. So the whole radio consumed about 0.8 a. from the battery. The anode current came from a 90 v. dry battery at a consumption of about 12 ma. It was also possible to generate the h.t. from the 2 v. battery via a vibrator unit and that is what you see in photograph 4. The

vibrator unit is on the bottom shelf of the lower cabinet. Still another possibility was to run the whole set from a 12 volt automobile battery, also with a vibrator for the h.t.

The set covers the frequency band 100-6970 kHz in eight ranges. The actual coverage of each subband is as follows:

Band 1: 97	175 kHz
Band 2: 172	310 kHz
Band 3: 306	552 kHz
Band 4: 541	977 kHz
Band 5: 958	1720 kHz
Band 6: 1685	3030 kHz
Band 7: 2940	4760 kHz
Band 8: 4420	6970 kHz

Photograph 5 shows the inside of the set and fig. 6 the circuit diagram. This is a reproduction of the original diagram from the technical manual for the radio. The receiver has two r.f. amplifiers, a regenerative detector and an audio output stage, producing sufficient to drive two sets of headphones.

There are three tuned circuits of which the variable tuning capacitors are ganged. We also find three sets of eight coils, one set for each subband. The coils with their associated fixed and trimmer capacitors are housed in a coil turret that can be clearly seen in photograph 5. This picture shows several of the features that we mentioned in the previous section. The coil turret is of cast alloy and contains completely screened compartments for each coil. The contacts are supported on cylindrical ceramic bars. The three gang tuning capacitor is also completely screened. You see the shaft bearing on the backside of the capacitor at the lower left. You also notice the bases of the four tubes. The two r.f.s and the detector tube are at the left, the a.f. tube at the right. The tubes disappear completely in the tube holders. They can be withdrawn by means of the circular knobs that are part of the molded tube base. The two r.f. stages and the detector stage are also completely screened. The extensive screening and decoupling leads to an extremely stable set with no trace of undesired feedback between stages.

Let us again take a look at the front (photograph 4). The big knob at the lower center controls the coil turret. Immediately above it the selected subband number is shown in a little window. Left and right of center you see windows that display a table; this gives the frequency that corresponds to the reading of the fine tuning dial that revolves with the tuning capacitor, seen at the right. The table lists

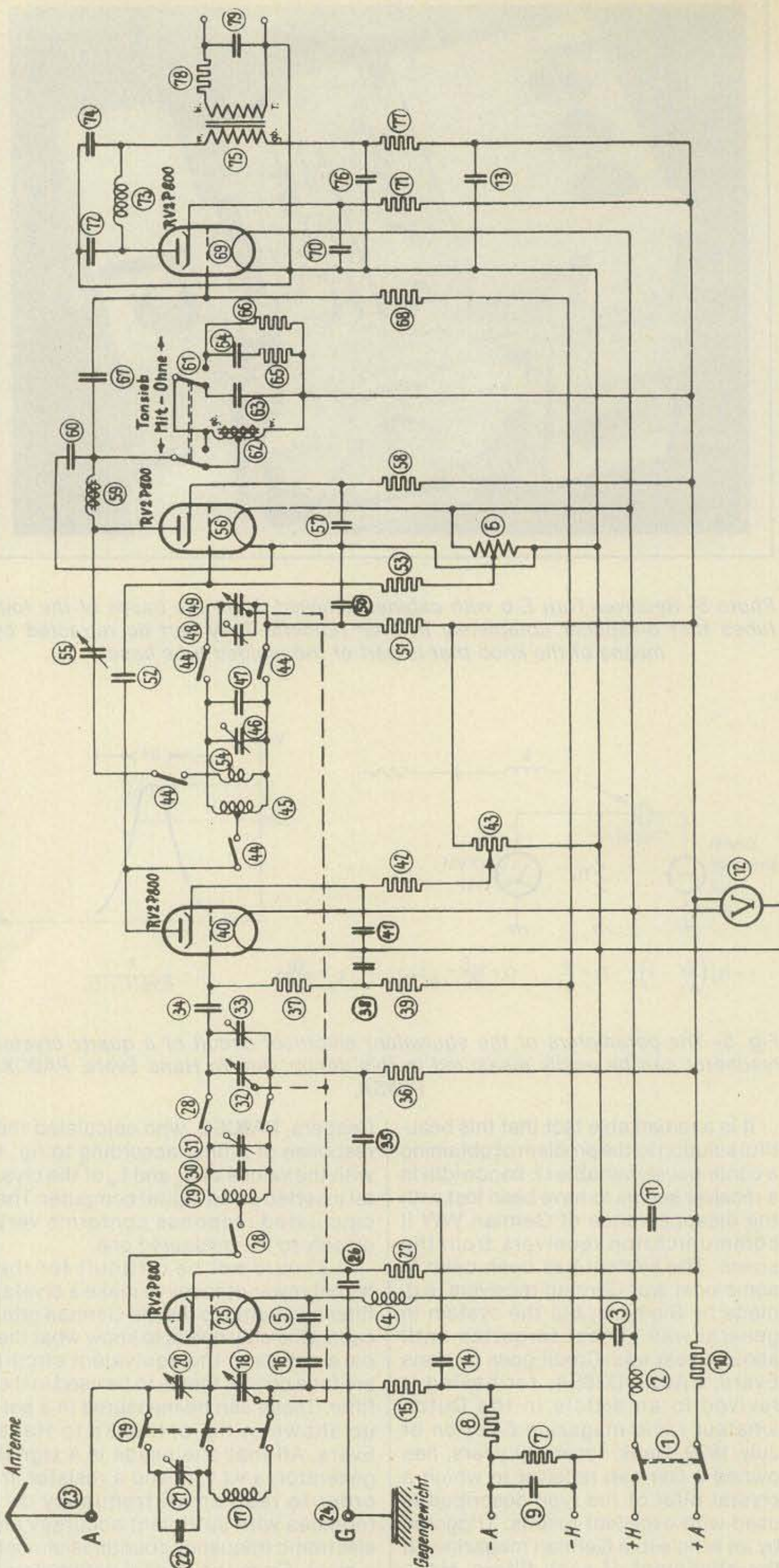


Fig. 6- Circuit diagram of the tuned radio frequency receiver Torn E b, as it appears in the instruction manual for the set.

the frequency in increments of 5 dial divisions. But for a finer reading we can extrapolate between these increments; in a fourth window, immediately above the one that shows the subband number, we read how many kiloHertz correspond to one dial division. For subband 1 this is 0.8 kHz, as you may be able to read from the photograph.

The knob called "Rückkoppl" at top right controls the regeneration of the detector stage, number 55 in the circuit diagram. Any of you who have used a t.r.f. set know that the joy or misery you derive from it is determined in a major part by the action of the regeneration control. The set should slide smoothly into oscillation, without thumb or backlash, that is to say the detector should start and stop oscillation at the same position of the control. These desirable features are dependent upon a number of factors in the circuit, as any of you oldtimers can testify. But the German designers of t.r.f. sets certainly knew the secret of making a fine regeneration control. The one on the Torn E b, or any German t.r.f. set for that matter, is a pure joy to use. Fine control is assisted even more by a slow motion drive on the regeneration capacitor!

The knob with the crank turns the tuning capacitor via a 1:19 slow motion drive. This operates with great precision and with a smooth feel. Nevertheless it was at this point that the author had some criticism on the receiver; at the high end of the frequency band covered by the set near 7 MHz, one revolution of the tuning control changes the frequency by some 200 kHz and this is too much for easy tuning of s.s.b. signals. This criticism is quite unfair, of course, as at the time the receiver was developed s.s.b. was unknown, at least for military applications. Still I found a way of fine tuning the set; as with most t.r.f. sets at high frequencies the regeneration control pulled the receiver tuning somewhat and this could be used as fine control.

The control marked "Lautst" is the gain control. It varies the screen-grid voltage of both r.f. amplifier tubes. This works very well and avoids the possibility of overloading the detector. Top center we find the antenna trimmer with screw driver adjustment. It is marked 20 in the circuit diagram.

For telegraphy an audio filter, tuned at 900 Hz, can be brought into the circuit by means of the switch "Tonsieb." The filter consists of a parallel tuned circuit with coil 62 and capacitor 63. It is very effective on c.w.

Top left on the front panel we find a voltmeter. It reads the filament voltage. Not only is the meter calibrated so that the proper voltage of 2 v. can

be read, the correct voltage reading is also indicated by a red marker! By pushing the button on the meter front the instrument reads the h.t., that should be 90 v. and the correct value is again indicated by a colored marker on the meter face, this time in blue.

Finally we find on the front panel an on/off switch that controls the filament current, a plug for the power cable and sockets for two sets of headphones. And of course two big and easy to use terminals for antenna and ground.

As I already mentioned, Arthur, PA0AOB, gave me the opportunity to use the radio for considerable time in my own shack. Although the design is now over forty years old, the set still performs remarkably. As to be expected the receiver is at its best on c.w. Especially on the 500 kHz marine band it leaves nothing to be desired. But also on the long wave and medium wave broadcast band many more stations were copied than on a modern run of the mill superhet. Quality of the audio is rather limited, but then the set was certainly not meant for music. Selectivity is excellent. In fact on the long and medium wave bands the regeneration control should not be advanced too far, otherwise serious top cut is experienced.

Also on the short wave bands c.w. is

received very well. S.s.b. can be resolved too, but tuning gets a bit tricky there, as already mentioned. Cross and intermodulation forms no problem. Even in Europe's extremely crowded forty meter band, with its many intruding strong broadcast stations, amateur c.w. signals can be easily copied at night, a test that many modern superhets fail. The forty meter band is not within the range of the set according to the official specs, as it does not tune beyond 6970 kHz. Nevertheless, in practice some 30 or 40 kHz of the 7 MHz amateur band is in fact covered.

One is struck by the quiet operation of this t.r.f. set. The input noise is just noticeable on a quiet band. And the background level is steady, no doubt caused by the fact that there is no a.g.c. As a well-known Dutch radio expert stated before WW II: "automatic gain control moves the fading from the signal to the background."

The set is rather small, 36.5 cm wide, 24.5 cm high and 22 cm deep. This is for the receiver alone. Together with the battery and accessories "Tornister" height is 46 cm. But the weight of the complete unit is surprising, 24 kg (52.9 lbs).

(To Be Continued)

COMPACT RETUN

TU-170

\$159.95 buys a terminal unit kit with capabilities beyond your expectations for the price. And

the Flesher Corp TU-170 won't devour your precious space. Wired units are available at \$234.95. Call or write today for our free 1980 catalog of affordable kits, wired units and accessories.



FLESHER CORP

P.O. Box 976 • Topeka, Kansas 66601 • 913 • 234 • 0198

Distributors in Canada and Australia

CIRCLE 46 ON READER SERVICE CARD

In Part II of this expanded series we take up the Lo 6 K 39a receiver. Many of the receivers that have survived the war and time are still seeing service by amateurs throughout the world.

German World War II Communications Receivers

Technical Perfection From A Nearby Past

Part II

BY DICK ROLLEMA*, PA0SE

In Part I of this series, we saw some of the ingenious thinking that went into the design and construction of German equipment used during WW II. We pick up where we left off last time with a discussion of the Lo 6 K 39a short wave receiver. The pictures attest to the fabled methodicism of German craftsmanship, and one can only surmise that the accompanying manuals told of the number of people required to either lift or move some of this equipment. Some of it looks like it should have crane hooks welded to the cabinets.

-K2EEK

Short Wave Receiver Lo 6 K 39a

The receiver that we are going to discuss now must be the ultimate in tuned radio frequency receiver design. But before we start to describe it we will first explain the type designation, just as we did for the Torn E b in the previous section. "Lo" stands for "Lorenz", the firm that designed and built the set. Lorenz was the German branch of the

American ITT concern. The figure "6" means there are six tuned circuits. The "K" means "Kurzwellen," German for short wave. The set came into operational use in 1939, hence "39" in the type number. And the "a," finally, means that capacitors of standard types were used.

The Lo 6 K 39a was used by the German Navy during WW II. Photograph 6 gives you a first impression of this receiver. It cannot be called small, as the Torn E b, with its dimensions of 53.8 cm high, 50 cm wide and 32 cm deep. That is without the shock absorbing feet, on which it was normally fitted for shipborne use. Again, it is built like the proverbial battleship - it was meant for the Navy - and that reflects in its weight, a solid 65 kg (143 lbs). Arthur Bauer, PA0AOB, the owner of the set in the photograph, kindly gave it to me on loan for a practical evaluation and I had to enlist the help of my neighbor, a contractor with bulging muscles, to help carrying the monster up two flights of stairs to my shack in the attic.

I got the original technical manual with the set and the first line in that comprehensive booklet nicely summarizes what it is. In translation it says something like "The short wave receiver Lo 6 K 39a is a five tube tuned radio frequency receiver with six ganged tuning circuits. A sixth tube serves for

frequency checking." The radio covers 1.5-25MHz in eight subbands that cover the following ranges according to the specifications:

Range 1: 1.50-2.135 MHz
Range 2: 2.135-3.05 MHz
Range 3: 3.05-4.33 MHz
Range 4: 4.33-6.16 MHz
Range 5: 6.16-8.74 MHz
Range 6: 8.74-12.40 MHz
Range 7: 12.40-17.60 MHz
Range 8: 17.60-25.00 MHz

In practice there is some overlap between ranges. As you see the subbands cover relatively narrow frequency ranges and that, together with the 1:50 slow motion drive on the tuning capacitor makes for very easy tuning, up to the highest frequencies. But more about that later.

The circuit diagram is shown in fig. 7 in simplified form, as presented in the manual. As you see the input is protected by a neon tube. This already indicates that the radio was designed for operation near transmitters, a situation encountered on board naval ships. The lamp is alight.

There are not less than six tuned circuits! Of these the first three precede the first r.f. tube in the form of a triple tuned bandpass filter. This was no doubt another protection of the input

*v.d. Marckstraat 5, 2352 RA LEIDER-DORP, Netherlands

tube against the strong signals of near-by transmitters. Further tuned circuits precede the second and third r.f. amplifying tubes and the leaky grid detector with regeneration. Each of the six sets of eight coils occupies a separate screened section of a vertically mounted coil turret, clearly visible in photograph 7 which shows the inner works. The turret is rotated via the crank at the bottom of the front panel through a set of gears. The band-switching action by means of this crank is very positive and imparts a sturdy feeling, like the exclusive automobile door we mentioned in an earlier section of this article. The six sections of the tuning capacitor are divided over two screening boxes, with part of the gear train in between. The unit can be seen at the right in photograph 7. As with the coil turret the shaft is vertical.

The dial on the tuning capacitor is directly calibrated in frequency for each of the eight subbands. There is no danger that the wrong frequency scale can be read because of a circular mask with separate windows for each band which rotates with the coil turret thereby allowing only the frequency scale of the selected subband to be read. In photograph 6 this is the middle one of the three windows in the black mask. The mask also clearly indicates the frequency range and the subband number and even in which direction the crank must be rotated to reach the adjoining subbands. In the photograph subband 5 (5.97 - 9.00 MHz) has been selected. Subband 4 can be reached by turning counter clockwise and number 6 by turning clockwise. Another example of German perfection!

The lower window displays a logging scale and the top window has no glass, which makes it possible to enter pencil marks on the dial.

We already mentioned that tuning is made easy through the slow motion drive and the relatively narrow subbands. But it is made even easier by means of a fine tuning control that varies the tuning of the detector circuit (which determines the tuned frequency on c.w. and s.s.b. with an oscillating detector) plus or minus 3 kHz around the frequency selected by the main tuning control. The tuning range of the fine control is independent of the setting of the main tuning capacitor or the frequency range selected. This could only be achieved with a *coil of variable self-inductance* that is changed with the subband in use; it is designated 74 in fig. 7. If a variable capacitor had been used for fine tuning its influence would be dependent on the total capacity in use. Thus the fine tuning range would be much greater on the high frequency end of a subband than on the low frequency end. The variable coils are operated by a big control knob, the

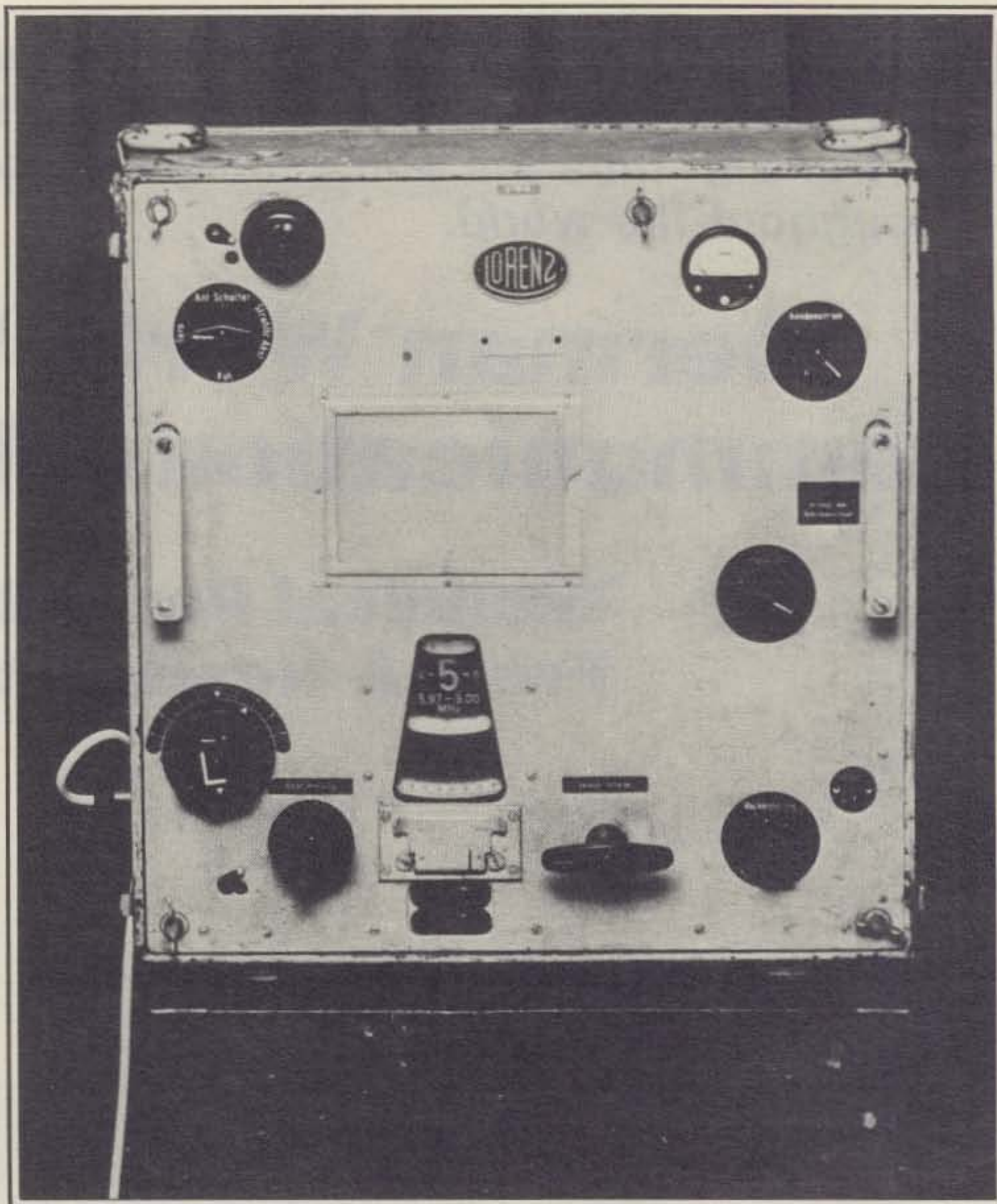


Photo 6- Tuned radio frequency receiver Lo 6 K 39 a. This set features no less than six tuned circuits, all ganged to the tuning control!

outer one of two concentric knobs on the lower left front panel. The inner one marked "L" ("Lautstärke") controls the receiver gain by varying the screen grid voltage of the first two r.f. tubes.

Here, on the subject of gain, we find another of those special measures that makes the operation of this German WW II communication receiver such a pleasure. The impedance at resonance of a parallel tuned circuit is higher when the circuit is tuned to the high end of its tuning range (minimum capacity) than at the low end. This affects the gain of the tube that precedes the circuit. That gain is the product of the mutual conductance of the tube and the impedance of the tuned circuit. The net result is that the stage gain increases when the circuit is tuned from low to high within a subband. As there are three r.f. tubes, each with a tuned circuit following, the effect is aggravated and we would have to adjust the gain control continuously when tuning to keep the gain and signal

handling capability of the set the same. Indeed, this would have been a problem were it not for the ingenuity of the designers of the Lo 6 K 39a, who found a clever remedy. If you take a good look at photograph 7 again you will notice a potentiometer at the right between the boxes containing the tuning capacitor. This potentiometer is coupled to the shaft of the tuning gang by means of a set of gears, so it rotates with it. This pot controls the screen grid voltage of the third r.f. tube (not shown in the simplified diagram of fig. 7) in such a way that the voltage becomes lower when the set is tuned towards higher frequencies, so decreasing the gain. This compensation is so effective that the user does not notice any obvious change in receiver sensitivity when tuning within a subband. Neat eh?

The detector features the already familiar smooth regeneration control by varying its screen grid voltage. The detector drives the a.f. final stage via

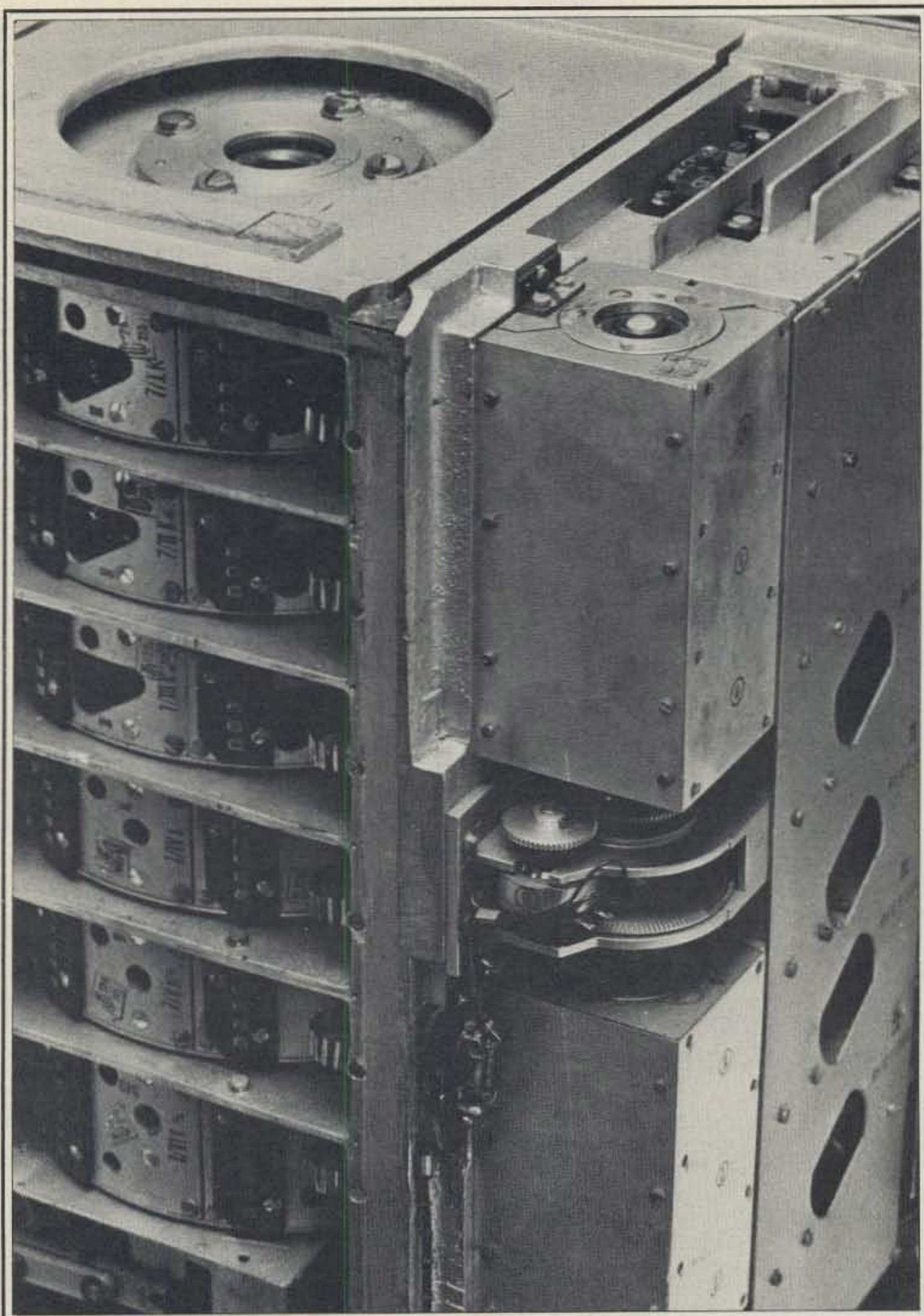


Photo 7- This view from the back of tuned radio frequency receiver Lo 6 K 39 shows the coil turret with six compartments, each of which houses eight coils, one for each frequency range. The two boxes at the right contain the sections of the six-gang variable tuning capacitor. Between the box a pot can be seen that is driven from the gears for the tuning capacitor. The pot varies the screen grid voltage of one of the tubes, in order to keep receiver gain constant when tuning over a frequency range.

an audio filter tuned to 1000 Hz with a 3 dB bandwidth of 200 Hz. Because this is a double tuned bandpass filter its slopes are steeper than for the one in the Torn E b receiver.

The sixth tube is used in a crystal calibrator on 100 kHz.

All tubes are of the same type, an especially designed tube for military applications, a miniature pentode with the type number RV 12 P 2000. This universally used tube has an indirectly heated cathode that takes 0.075 amps at 12.6 volt heater current. The tube

goes top first into a holder that completely envelopes it. In order to retract it a special tool is screwed into its base. Otherwise the bottom of the tube is flush with the panel that carries the holder. A photograph of the RV 12 P 2000 appears later in this article.

As you see in fig. 7 the receiver has a built-in power supply with a double smoothing section. The supply voltage for the detector stage is stabilized by a neon tube.

The Lo 6 K 39a is a sophisticated radio in every respect. This reflects

DON & MIKE'S GOODIES

Cubic - Swan 102BXA	\$999.00
Astro 150	779.00
Astro 100MXA	499.00
Mirage B23 1 watt-30 watt amp	89.95
DSI 5600A w/Ant/Ac	185.00
Robot 800	699.00
Cushcraft A3 Tribander	169.00
AEA Morsematic	169.00
Bird 43, Slugs	Stock
CDE Ham-4 Rotor	169.00
Ham-X	239.00
FDK Palm 2 Handie with BP/AC	149.00
Cetron, GE 572B	34.00
Kenwood Service Manuals Stock	10.00 ea.
Telrex TB5EM	425.00
Telrex TB6EM	540.00
Telrex Monobanders	Stock
Santec HT1200 Synthesized	339.00

Order Your
KWM380 Now!

Old Pricing & Free Goods!

Adel Nibbling Tool	8.95
Janel QSA5	41.95
Sprague 100MFD/450V Cap	2.00
Rohn Tower	20% off dealer
25G, 45G Sections	
Belden 9405 Heavy Duty Rotor Cable 2#16, 6#18	38¢/ft
Alliance HD73 Rotor	109.95
Amphenol Silverplate PL259	1.00
ICOM 255A 2M Synthesized	319.00
ICOM 260A 2M SSB/FM/CW	429.00

Late Specials:

Kenwood TS180S/DFC/SSB ...	Call
ICOM IC2AT/TTP/NICAD ...	229.00
NEW — ICOM IC720 w/AC/mike	Call
Bearcat 220—\$299.00	300—399.00

MASTERCARD • VISA

All prices fob Houston except where indicated. Prices subject to change without notice, all items guaranteed. Some items subject prior sale. Send letterhead for Dealer price list. Texas residents add 6% tax. Please add postage estimate \$1.00 minimum.

MADISON

Electronics Supply, Inc.

1508 McKinney
Houston, Texas 77010
713/658-0268

CIRCLE 63 ON READER SERVICE CARD

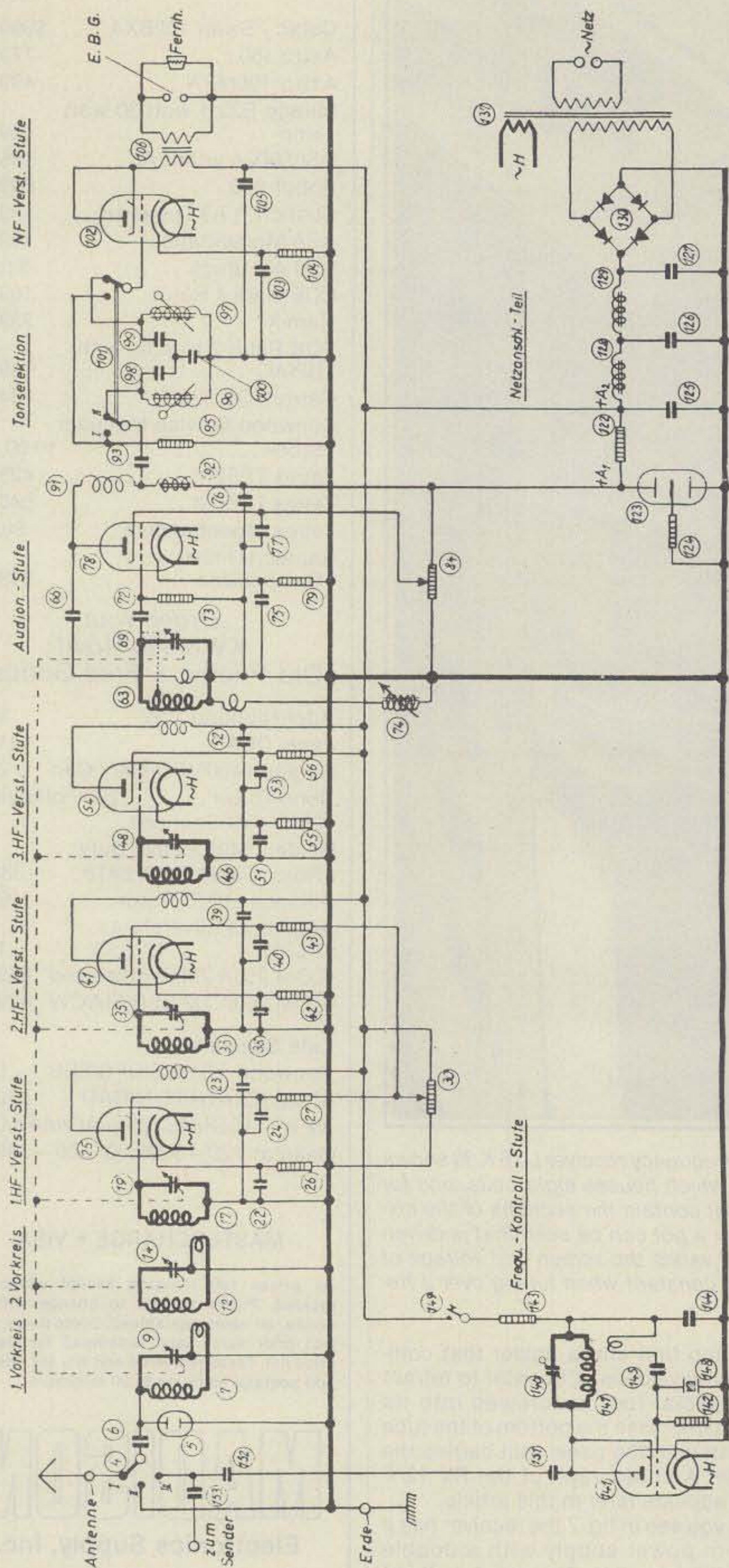


Fig. 7- Simplified circuit diagram of the tuned radio frequency receiver Lo 6 K 39 a.

also in the provision for metering the different stages. Top right in photograph 6 we find the test instrument that features not one, as in the Torn E b, but two pushbuttons. By pushing the yellow button we read the heater voltage and the meter pointer should indicate within a yellow sector on the meter face. The anode voltage can be checked by operating the red pushbutton and the meter should read within a red segment on the meter face. But it doesn't end there. We can also check the *anode currents* of the six tubes. As a preparation to this the controls for gain and regeneration should be turned fully clockwise and the tuning control on "0" (the tuning control effects the screen grid voltage of tube number three, as we saw). Under and to the right of the meter we find a six position switch marked "Anodenstrom" (anode current). It is normally held in an off-position by means of a spring. When we move the switch against the spring into position "I" the meter reads the anode current of tube number 1. If the tube is in normal condition the meter pointer is within a blue sector on the meter dial. The same happens for tube 2 with the switch in position "II". And so on for all six tubes. Speaking of perfection. . .

As could be expected the electrical specification of the receiver is very complete, be it that in the days of WW II some of the electrical characteristics were specified differently from nowadays.

Output is stated as the voltage over a pair of headphones with 5000 ohm impedance at 800 Hz. The receiver noise should produce between 0.2 and 3.0 v, with the gain control at maximum and the detector just in oscillation for maximum sensitivity for c.w. With maximum 0.3 v. receiver noise 2 microvolt input for A1 (c.w.) and 4 microvolt for A2 (m.c.w.) should produce 1 v. output at optimum position of the regeneration control. According to tests made by the author a signal of 0.4-0.8 microvolt generator emf behind 50 ohm internal generator resistance produces a readable c.w. signal.

You probably wonder what sort of selectivity can be expected from a t.r.f. set with six tuned circuits. The specs state the selectivity as follows that at $\pm 0.85\%$ detuning a 10^3 times increase of signal is required to restore the response from a 2 microvolt signal at 4.62 MHz (signal generator modulated with 400 Hz at 30% modulation depth, mode A2, regeneration control set just before oscillation). We would say that 0.85% detuning causes 60 dB attenuation, which certainly is not bad. There are many more interesting points in the specs but we will leave it at that.

The practical evaluation in the author's shack fully confirmed what

would be expected from the specs. The set had been inactive for many years. Owner PA0AOB did not realign the receiver before it was handed to the author. The only thing Arthur did was to clean the moving contacts of the coil turret and capacitor gang with contact spray. Nevertheless the frequency calibration was found to be remarkably correct. The 100 kHz crystal in the calibrator was spot on. Tuning is as easy as can be, even sideband on 21 MHz, thanks to the fine-tuning control. As with the simpler Torn E b, the set is beautifully quiet. As to be expected the set is at its best on c.w. Again no trace of inter- or cross-modulation was found, not even during night hours in the crowded 40 meter band. And not a single spurious signal or birdie was observed, quite normal for a t.r.f. set of course. But it is a reassuring feeling to know that when a signal is heard you can be sure it is a real one on the frequency the radio is tuned to.

The author remembers that at the test equipment department of the electronics firm, where he was employed some 15 years ago, a Lo 6 K 39a was used to check the purity of the output from a signal generator under test.

(To Be Continued)

ERC Promises Up To The Minute State-Of-The-Art Design and Performance

Four Simultaneous Filters in One for Unparalleled QRM Free Reception (SSB & CW)
★ Plus a Special Patented CW Processor ★

The brand new SL-56 Audio Active Filter supercedes our SL-55 in both concept and performance. Consolidation of many components has allowed us to make 13 operational amplifiers (compared to 6 in the SL-55) into a filter guaranteed to out perform any other at a cost only slightly higher than the SL-55. The features of the SL-56 are so advanced from its predecessor that calling it the SL-55A is not justified. Unlike other filters that simply offer a choice of one or two filter types at a time (notch, bandpass, etc.) SL56 provides what is really needed - the simultaneous action of a 6 pole 200 Hz fixed highpass filter and a 6 pole 1600 Hz fixed lowpass filter with a 60 dB notch which is tunable over the 200-1600 Hz range. This 3 filter combination is unbeatable for the ultimate in QRM free SSB reception. Adjacent channel QRM is eliminated on the high and low sides at the same time and does not introduce any hollowness to the desired signal. On CW the SL-56 is a dream. The lowpass, highpass and notch filters are engaged along with the tunable bandpass filter (400-1600 Hz) providing the needed action of 4 simultaneous filter types. The bandpass may be made as narrow as 14 Hz (3dB). Additionally, a special patented circuit follows the filter sections which allows only the peaked signal to "gate itself" through to the speaker or headphones (8-2000 OHMS). Receiver noise, ring and other signals are rejected. This is not a regenerator, but a modern new concept in CW reception. The SL-56 connects in series with the receiver speaker output and drives any speaker or headphones with one watt of audio power. Requires 115 VAC. Easily converted to 12 VDC operation. Coal black cabinet and wrinkle gray panel.



SL-56
Audio Active Filter
(3.5 x 5.5 x 7.5 Inches)


Warranted One Full Year Fully RFI Proof Fully Wired and Tested Available Now
\$79.00 Postpaid in the USA and Canada
Attention SL-55 Owners: The Circuit Board of the SL-56 is Completely Compatible with the SL-55 Chassis. Our Retrofit Kit is Available at \$40.00 Postpaid.




Virginia Residents Add 4% Sales Tax


Electronic Research Corp. of Virginia

P. O. Box 2394 • Virginia Beach, Virginia 23452 • Telephone: (804) 463-2669


Please send all reader inquiries directly








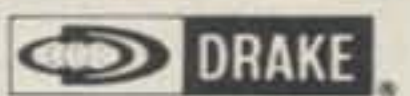




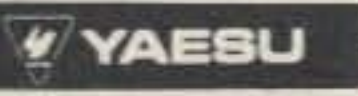
ALLIANCE







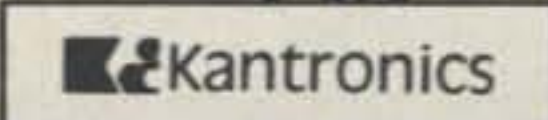
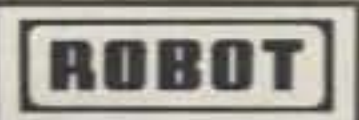
MIRAGE

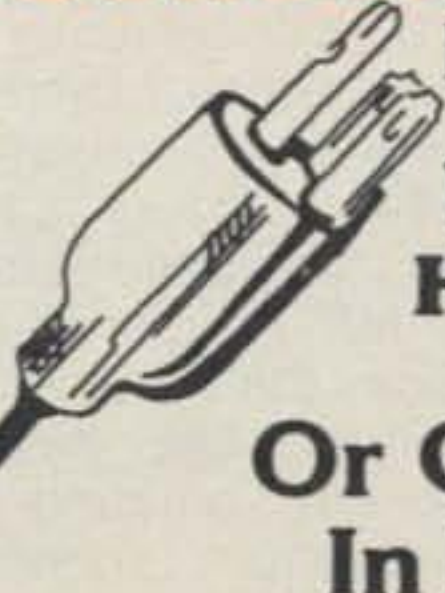




Cohoon Amateur Supply

For New Or Used Equipment

**Write To: 307 McLeans
Hopkinsville, KY 42240**

**Or Call: 800-626-9204
In KY: 502-886-4534**

CIRCLE 35 ON READER SERVICE CARD

Part III of this elongated series concerns itself with the Kw E a superheterodyne receiver which was a basic Telefunken design.

German World War II Communications Receivers

Technical Perfection From A Nearby Past

Part III

BY DICK ROLLEMA*, PAØSE

Part III now takes up with a 1938 design for a superheterodyne receiver. The Kw E a as you will see from the photos is a marvel of mechanical engineering. While PAØSE regales us with the theoretical aspects of the design, one can only imagine how that was transformed into the mechanical beauty we see unfold. Still, the thought of lugging 77 pounds of hardware around leaves a lot to be desired. -K2EEK

Short Wave Superhet Kw E a

The first of the two superheterodyne receivers we are going to discuss is the Kw E a (Kw = "Kurzwellen" = short wave, E = "Empfänger" = receiver, a is serial indicator). This radio was designed by Telefunken and it became operational in 1938.

Photograph 8 gives you a first impression of what it looks like. Photograph 9 shows the receiver out of its cabinet and photograph 10 a rear view.

*v.d. Marckstraat 5, 2352 RA LEIDERDORP, Netherlands

The dimensions of the radio are 69.2 cm wide, 27.4 cm high and 34.6 cm deep. It weighs 38 kg (77 lbs). Not directly a set to take on holidays.

The total frequency span of 1 to 10 MHz is covered in five ranges, as follows: 980-1610 kHz; 1560-2550 kHz; 2470-4060 kHz; 3940-6395 kHz and 6205-10000 kHz. Again the subbands are kept relatively narrow which improves the ease of tuning and the frequency read-out.

Looking at photograph 8 you notice several by now familiar features. Left of the dial the band-selector control above ("Grob" = coarse) and main tuning control with crank ("Fein" = fine) below. The dial features the rotating mask we already met on the previous receiver with a slot that displays only the frequency scale in use. The mask also shows the limits of the selected range and the frequency increment that corresponds to one dial division, 10 kHz on range III, as seen in the photograph. The receiver uses the same filament type tube in all 11 stages. It is the type RV 2 P 800 pentode we also encountered in the Torn E b. The radio consumes 1.6 a. at 2 v. for the filaments and 15-20 ma. at 90 v. anode current. The bottoms of the tubes with extraction knob can clearly be seen in photographs 9 and 10.

The simplified diagram in the in-

struction manual is too complicated to reproduce here. Therefore we present a block schematic diagram as fig. 8.

The mixer is preceded by two r.f. amplifier stages. There are five tuned r.f. circuits that are ganged to the oscillator tuning circuit. The user has the option to use a single or a double tuned circuit between the antenna and the first r.f. tube. Normally one circuit is used. But the manual says that when interference is experienced from a very strong near-by transmitter the second circuit between antenna and first r.f. tube should be brought into operation. The switch for this is the top one of the two controls at the right on the front panel.

The lower one of these controls is an antenna attenuator. Not a resistive one but a variable series capacitor between antenna and input circuit. To avoid detuning of this circuit a second section of the capacitor adds just as much capacitance in parallel with the tuned circuit as the series capacitor detracts. In other words the input attenuator is a differential capacitor. It is called "Ankopplung" (= coupling) on the front panel. There is also a series trimmer in the antenna that compensates for different antenna capacitances. It is set once and for all for a particular antenna and therefore has screwdriver adjustment (top right just

to the left of the antenna connector in photograph 8).

The six sets of coils that have to be switched for the five frequency ranges are mounted in a coil turret. This one is of particular beauty. Photograph 11 shows the turret, taken out of the receiver, which is a simple operation. The turret is moved from one position to the next by means of a Maltese cross mechanism that can just be seen at the extreme left of the turret. But before the turret starts to rotate the contact fingers are lifted from their partners on the turret by means of a camshaft that can be observed in photograph 11 in front of the turret. When the turret has come to rest in the new position, the contact fingers are lowered onto the turret again. The fingers make a slight wiping movement when pushed onto the ring shaped contacts on the turret, thereby removing possible dirt deposits.

The receiver uses the relatively low intermediate frequency of 250.9 kHz. But because five tuned circuits are used ahead of the mixer the image response is sufficiently suppressed (on the order of 80 dB).

The oscillator is of the tuned anode

circuit variety. A coil in the grid circuit is inductively coupled to it. A second coil, coupled to the anode circuit of the oscillator is in series with the coil that forms the r.f. tuned circuit connected to the grid of the mixer tube. In this way the oscillator signal is injected into the mixer.

There are three i.f. amplifier tubes. They are preceded by double tuned i.f. transformers on 250.9 kHz.

The receiver offers the selection of seven different bandwidths, of which four are meant for telephone, the fifth, sixth, seventh and eighth are for c.w. only. The bandwidth in positions seven and eight is identical, but in the eighth position the b.f.o. is switched to the other side of the passband. The bandwidth selector control can be seen in photograph 8 directly under the meter.

The principle of the bandwidth variation is indicated in fig. 8 in simplified form. In positions 1-5 the bandwidth of the i.f. amplifier is changed by varying the coupling between the tuned circuits of the i.f. transformers. By going from position 1 to 5 the coupling capacitors between the tuned circuits are made smaller and smaller. This would also shift the center frequency of the

passband slightly. But this is compensated for by adding extra capacity in parallel with the tuned circuits as the coupling capacitors become less. Also the damping resistors in parallel with the tuned circuits are increased in value as the bandwidth narrows. In position 5 no extra damping is used. In positions 6-8 of the bandwidth control the i.f. bandwidth remains the same but the a.f. bandwidth is reduced. This is done by a tuned circuit that resonates at 900 Hz between the detector and the a.f. final amplifier. In position 6 it is brought into the circuit but the response is broadened by means of a parallel resistor. In positions 7 and 8 the resistor is removed and the bandwidth is at its narrowest.

The b.f.o. is crystal controlled and works at a fixed frequency of 250 kHz, thereby generating a beat note of 900 Hz with the 250.9 kHz i.f. signal. The b.f.o. can be brought into operation by means of a separate switch. It is directly under the bandwidth selector switch. If in position seven interference is experienced the operator can go to position eight. The b.f.o. is now changed from 250.0 to 251.8 kHz, again generating a beat note of 900 Hz but now

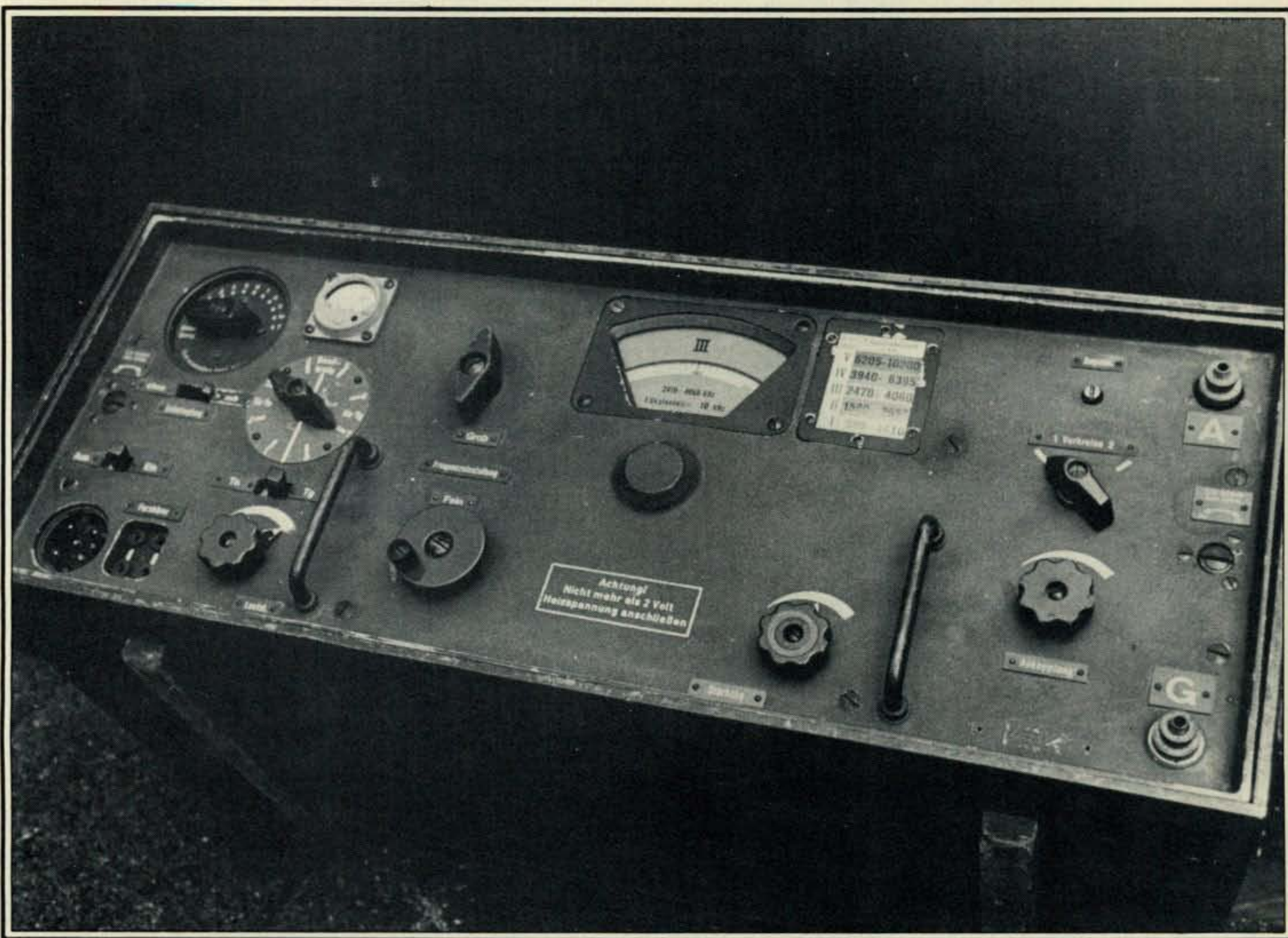


Photo 8- Front view of short wave superheterodyne receiver Kw E a.

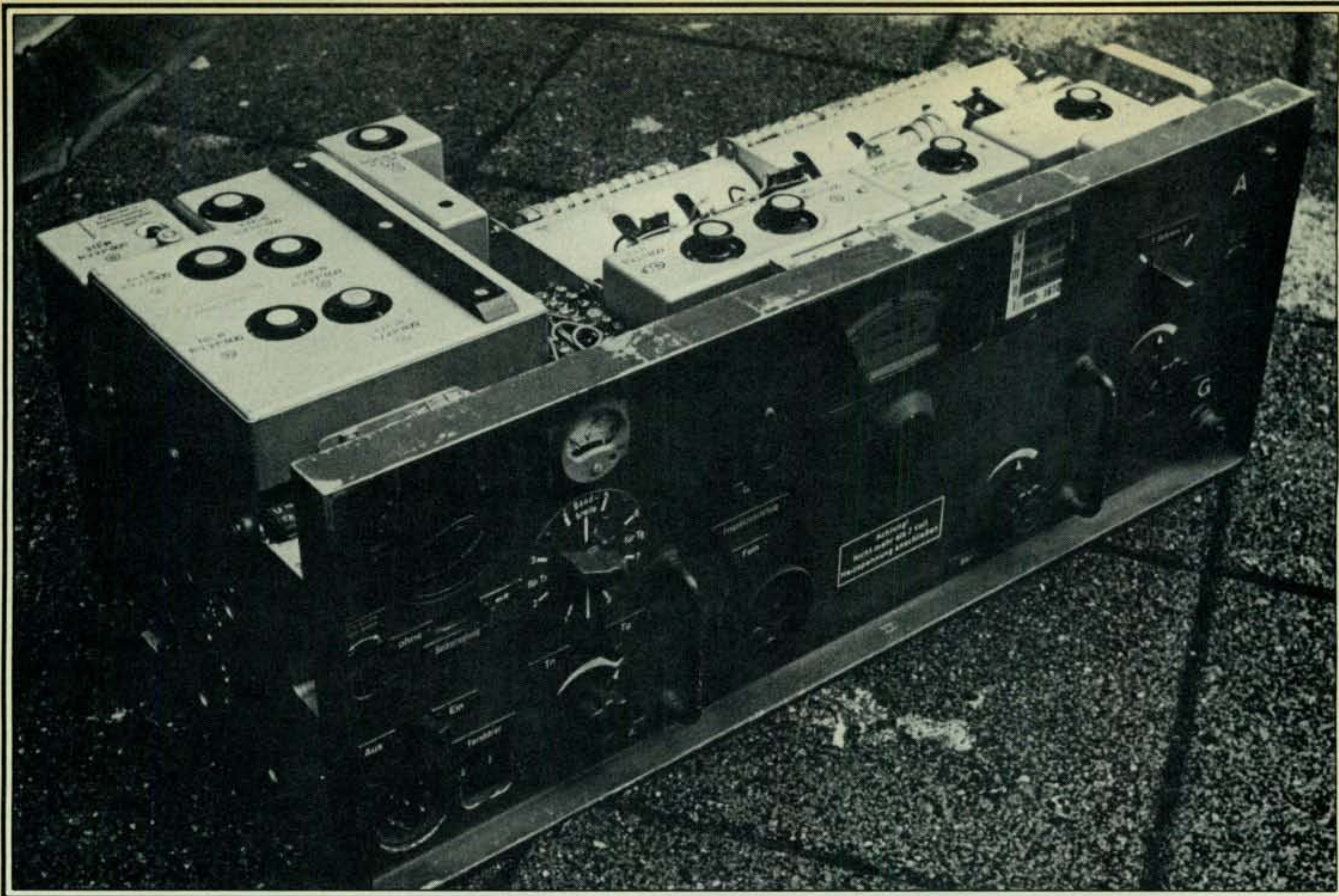


Photo 9- Receiver Kw E a taken out of its cabinet.

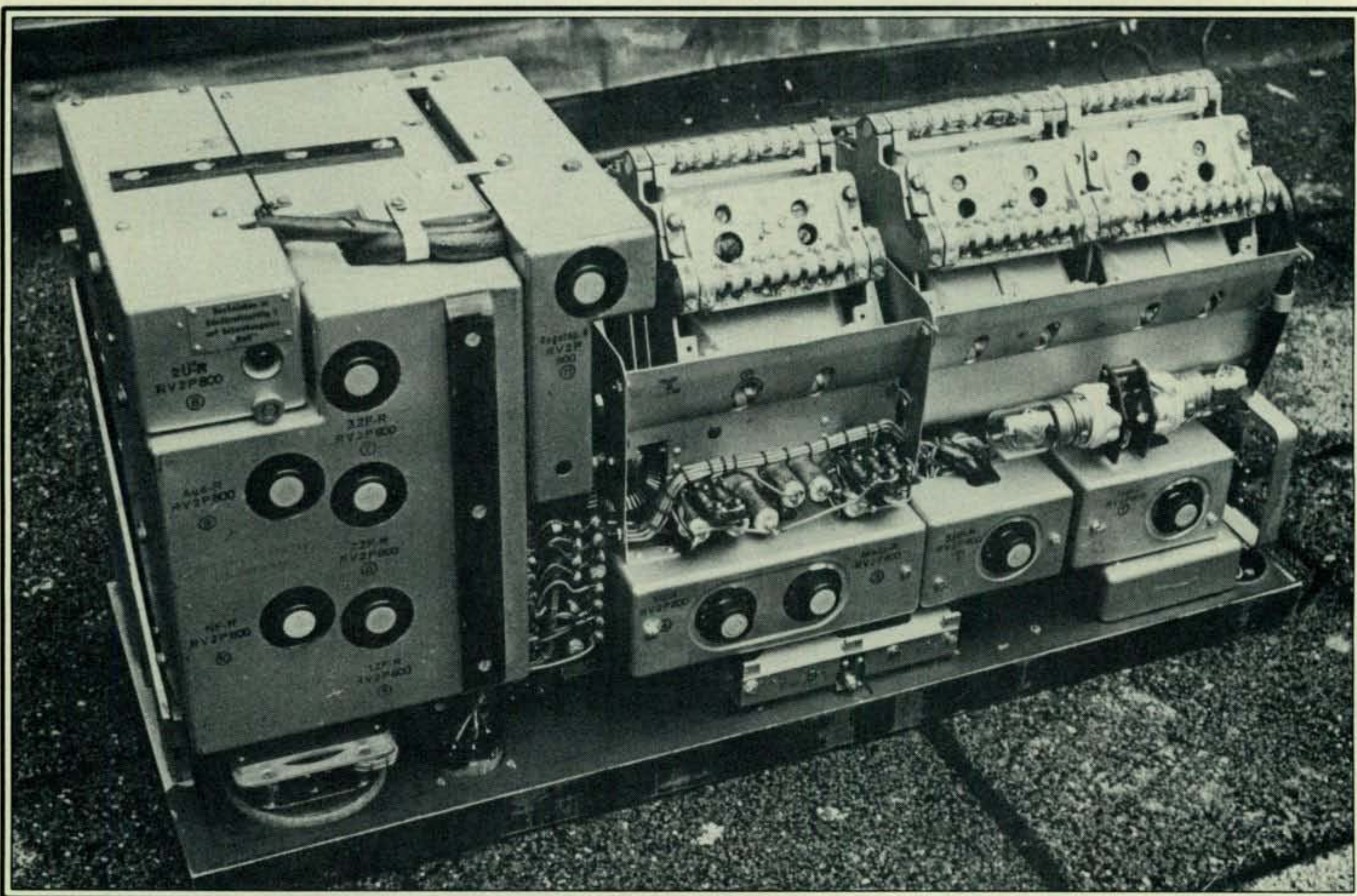


Photo 10- Short wave receiver Kw E a as seen from the rear. The two neon lamps at the right protect the input circuits against high voltages when the set is operated near a transmitter.

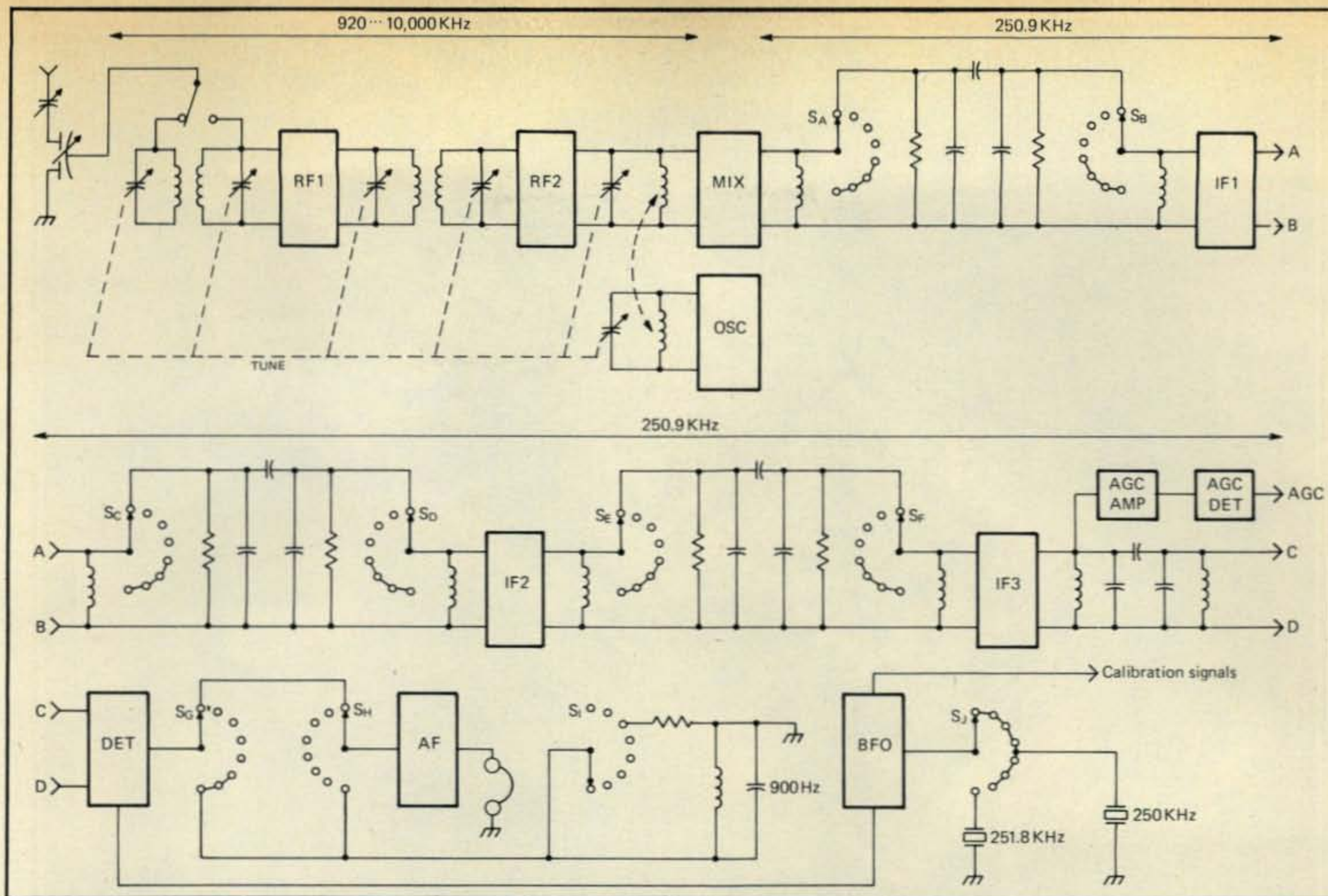


Fig 8- Block schematic diagram of short wave superheterodyne receiver Kw E a.

using lower sideband reception instead of higher sideband in positions six and seven. The b.f.o. has a separate crystal at 251.8 kHz for this.

The detector is of the leaky grid type. Both i.f. and b.f.o. signals are introduced on the control grid of the RV 2 P 800 pentode tube that is used throughout the receiver. The detector tube is coupled to the final a.f. tube by means of the tuned circuit at 900 kHz that we already mentioned. In positions 1-5 of the bandwidth control it is replaced by a RC-type coupling.

According to the manual the set should normally be used with manual gain control. This varies the screen grid voltage of the first and third i.f. amplifier tubes. But in case of fading automatic gain control can be used. There is a separate i.f. amplifier for the a.g.c. It receives the same i.f. signal as the leaky grid detector and it feeds two diodes in a voltage doubling rectifying circuit for the a.g.c. voltage. This is fed to the second r.f. amplifier and the second i.f. tube. The manual gain control is made inoperative when the a.g.c. is switched on and replaced by an a.f. control that is on the same shaft as the manual i.f. gain control. But the i.f. gain can still be controlled manually when using a.g.c. by means of a separate potentiometer that has the same function as the manual gain control for use

without a.g.c. but is only operative in the a.g.c. position. The manual says it should only be used in case of very strong interference.

The combined i.f./a.f. gain control can be seen to the left of the left handle that is used to pull the receiver out of its cabinet. The separate i.f. gain control that only works in case of a.g.c. is to the left of the right handle in photograph 8.

The last item of the Kw E a we will discuss is the metering facility. It is like the one on the Lo 6 K 39 a. The meter is at the top left of the front panel and to the left of it you will notice a switch with 13 positions. In the first the filament voltage is read and in the

SHEET METAL WORKER



An all-purpose sheet metal forming machine. Shears, press brakes, rolls 24" material up to 20 gauge mill steel or equivalent.



PACIFIC ONE CORPORATION
410 Pacific Coast Highway, Newport Beach, CA 92663

CIRCLE 140 ON READER SERVICE COUPON



FREE!
1981
DISCOUNT
ELECTRONICS
CATALOG

JOIN THE PAK!

Send for our Free catalog and become a member of our exclusive Pak. Our members receive Poly Paks' exciting catalog several times a year. We offer: Penny Sales, Free Premiums and Low, Low Prices on a wide variety of Electronic Products such as Computer Peripherals, Integrated Circuits, Speakers, Audio Equipment, Rechargeable Batteries, Solar Products, Semiconductors, and much, much more! Take advantage of our 25 years as America's foremost Supplier of discount electronics.

Over
4.5 Million
Satisfied
Customers

RUSH ME YOUR FREEDISCOUNT CATALOG!

NAME: _____
ADDRESS: _____
CITY: _____
STATE: _____ ZIP: _____

CLIP AND MAIL COUPON TODAY TO:
POLY PAKS, INC.
P.O. BOX 942, CQ5
S. LYNNFIELD, MA. 01940 (617) 245-3828

CIRCLE 94 ON READER SERVICE COUPON

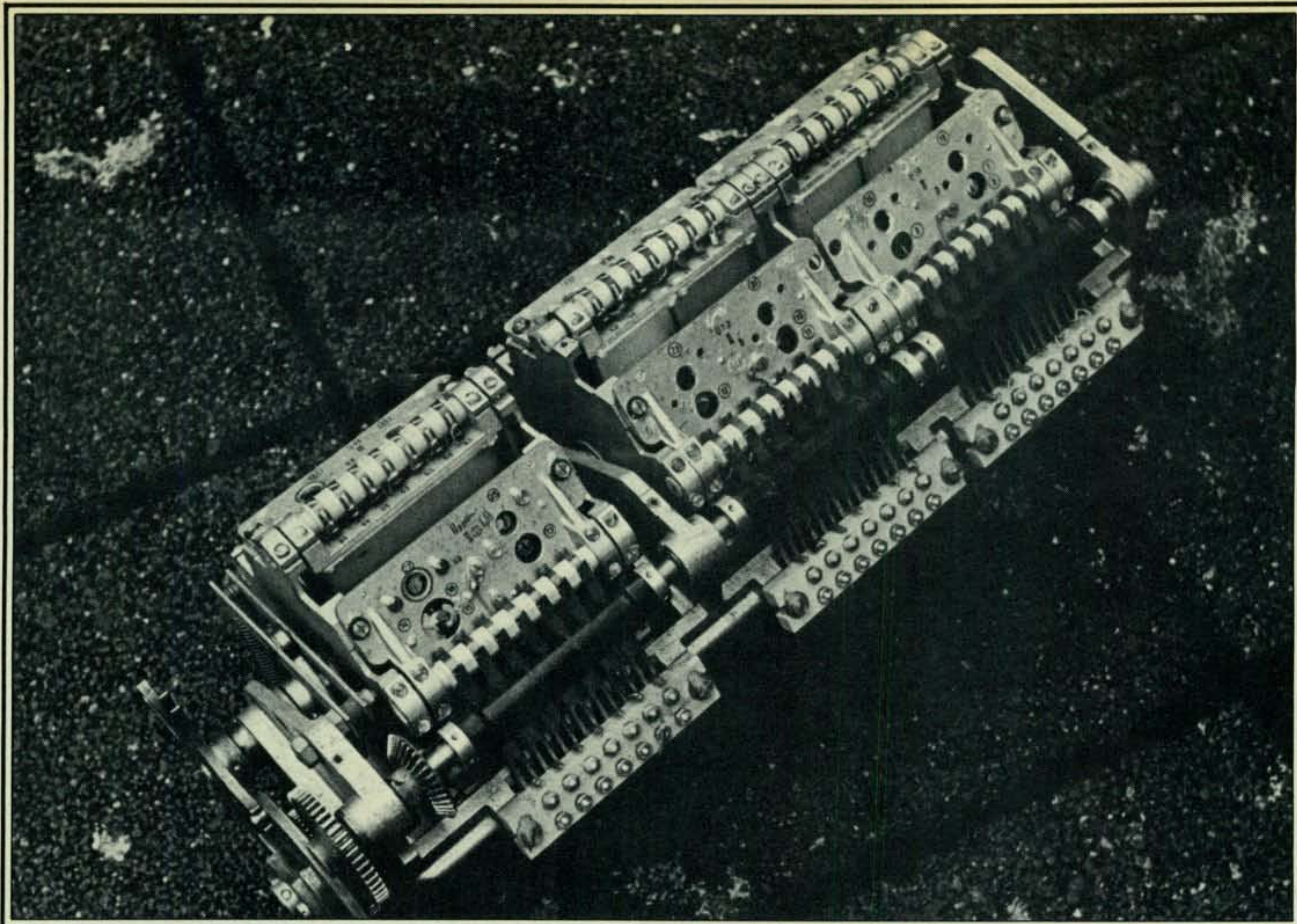


Photo 11- This is the coil turret used in the Kw E a. Note the Maltese cross drive at the left and the camshaft at the front that lifts the contact fingers from the turret contacts before the turret is rotated.

SEE US FOR THE BEST DEAL



ICOM



YAESU



DRAKE

TEN-TEC



KENWOOD

EXPORT ORDERS INVITED (803) 366-7157

800-845-6183



G.I.S.M.O.
2305 CHERRY ROAD
ROCK HILL, S.C. 29730

Service Department
 Call 803-366-7158

second the anode voltage. The voltages should be within a red or blue sector on the meter face for the two voltages. The remaining 11 switch positions are for metering the anode currents of the 11 tubes in the receiver. A black mark on the meter dial indicates the minimum reading for a serviceable tube.

The frequency dial also carries red markers for frequency checking. The calibration signal for this comes from the 250 kHz crystal in the b.f.o. Harmonics of the b.f.o. signal can be fed to the input of the receiver. For this a pushbutton must be operated that can only be reached when the set is out of its cabinet. In case the dial reading is not ok this can be corrected by rotating green encircled adjustment screws on the coil turret.

It is remarkable that the manual for the set does not contain performance specifications. I have not yet had an opportunity to test the receiver in my own shack. But this is going to happen in the future and I am quite convinced that the radio will come up to my high expectations. □

(To Be Continued)

CIRCLE 133 ON READER SERVICE COUPON