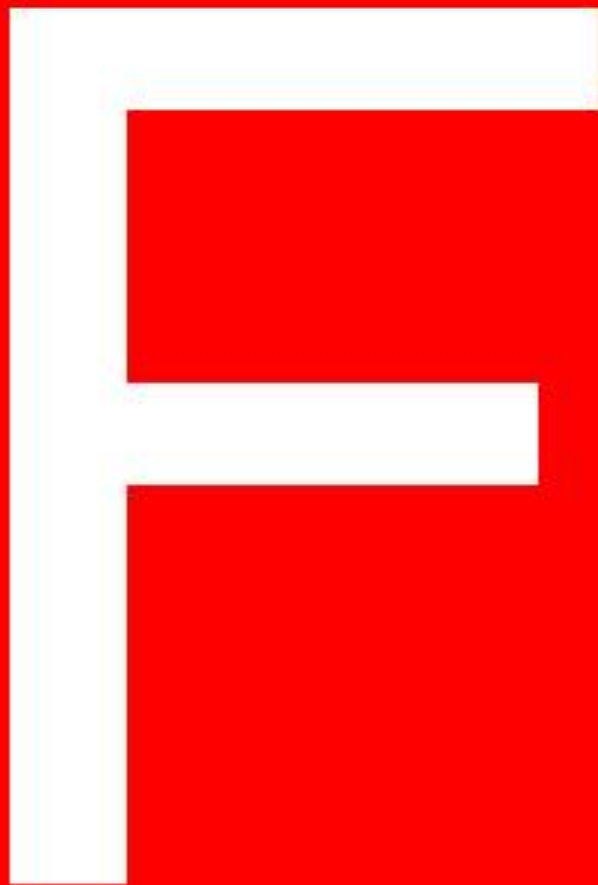


German Line Communication equipment of WW 2



Funksammler

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Foreword

For a long time, the field of collecting communications equipment was dominated by two sorts of people: Collectors that wanted nice looking equipment to put in their displays and Technical enthusiasts that want to analyse and bring back to life this old equipment. Publications on German Communications equipment have been catering to either the collector or to the technical enthusiasts. Publications for the collectors generally show external shots of good condition equipment without giving much information on the workings of the equipment; Publications for the technical enthusiast contain a fair bit of technical knowledge and do not always respect the originality of the equipment. The best information could often be found in original manuals, but those were hard to find and only accessible to those reading German.

In recent years this community has been joined by re-enactors, people that try to mimic historic battles using historic equipment. They want to show the equipment in the correct setting and if possible demonstrate how it works. Increasingly I hear collectors ask “how do I make this work” and technical enthusiasts ask “what is the right way to display this”.

In this volume I am trying to combine the historic, technical and practical information on German Field Line communications equipment. It shows the equipment from the outside; explains what is on the inside and shows it in typical operational setup. It gives information on how to correctly connect and operate the equipment.

With the information in this volume the collectors should be able to identify the items in their collection and check if they are complete and correct, it can aid the technical enthusiast in figuring out how it works and how it might be repaired while the re-enactor should be able to set up their equipment correctly and give a try operating it.

Variations of the basic FF33 field telephone remained in production well into the 1960's, with variants used in railways and industry. It goes beyond the scope of this book to show all these variations but if you do not find it in this book it is probably not a German army WW2 variation (as some unscrupulous sellers are trying to convince the unwary). Likewise the humble leather carrying strap for the telephone has become a collector's minefield with many post-war variations and fakes flooding the market. Although the photographs in this book can be used as a general guide to authenticity, it does not attempt to identify all the detailed features of fakes. It suffices to say that collectors should proceed with extreme caution when purchasing these items.

The subject matter in this volume is limited to what I termed “Field Line Communications equipment”. It shows what could typically be found in a German field army and was used by the fighting troops and their immediate headquarters. I have omitted much of the higher echelon specialised equipment such as Telex equipment and line-of-sight radio beam equipment. I have also omitted Fortress related equipment. Perhaps I will address these in future volumes.

This revised edition has added some peripheral equipment and a number of identified post-war or fake items shown in photographs have been replaced. It goes to show that even after decades of study and collection of this equipment there is still a lot to learn

Acknowledgements

Although I will not mention any names, this work would not have been possible with the help and support of other enthusiasts. Many have simply asked questions; without these questions it would not have been possible to frame this book and I would not have found the motivation to write it. Although the book attempts to answer a lot of your questions, I hope you will keep them coming. I also want to thank those that have pointed out my errors and have provided detailed information. Since I first wrote the book in 2010, detailed research on manufacturers and variations has progressed significantly and I would not have been able to include some of this knowledge without your help. You know who you are; so many thanks and keep pointing out my errors!

Introduction

In modern warfare communication is an essential part of command and control. From the end of the 19th century, technology started to play an increasingly important role in battlefield communication. By the First World War, extensive use was being made of wire communication and the first –relatively primitive- mobile radio stations came into being.

In the interwar years, Germany was bound by the conditions of the Versailles treaty and was prohibited from developing and producing many types of weapons and military equipment including communications equipment. This did however not stop the German military minds from developing new concepts in war: Blitzkrieg using fast armoured units striking deep behind enemy lines. It was quickly realised that reliable communication would be an essential prerequisite for the prosecution of future wars and especially from the early 1930's a fast development of radio and line communication equipment and tactics was commenced.

Whereas wireless communications offer a great flexibility especially suited to the fast moving armies of the Blitzkrieg, it was line communications that were used in preference and wherever the possibility existed. This required equipment and an organisation that could build and move telephone networks at speeds hitherto never imagined. Also the density of communications would be surpassing anything experienced in previous wars.

During the war the communication networks built by the German Armed Forces would reach epic proportions reaching from North Africa to the Polar circle, from the Atlantic coast to the depths of Russia.

A number of variations and accessories were developed so that different functions and roles could be performed by the field telephone equipment. They were not only being used widely by the German Armed Forces, but for many years after the war by some foreign armies and services.

This book gives an overview of the line communication equipment and materials used by the German forces on the mobile battlefield of the second world war. The scope of this book has been limited somewhat, equipment for fixed fortifications and telex type line equipment has not been included.

The aim of the book is to give collectors, re-enactors and those interested in the communication aspects of world war two a relatively detailed account of what the equipment was, what it was used for, how it is constructed and how it was used.

Most chapters have a section on **Development and description** in which the history and working principles are explained. This is followed by a **Construction** section in which key controls and components are identified. Finally an **Operation** section explains how the equipment can be operated.

The book uses a mixture of original German terms and translations; in some cases good English equivalent terms exist, but in many cases the German equipment and their terminology are quite unique. German terms are printed in italics and can be found in a Glossary at the end of the book.

Field Telephones

Introduction

The field telephone is the basic and most frequently used piece of communication equipment on the battlefield. Used from the front line to the highest headquarters, it gave military commanders and unprecedented real time control of operations.

Even though the design principles of field telephone equipment were well understood for many years, much of the equipment from before the 1930's was expensively produced on a small scale. The rapid developments in public phone network technology with which the field equipment was required to interface had led to a great complexity of equipment. The 1930's saw a major re-think based on the following principles:

- **Standardisation:** Standardise tactics and designs for all services
- **Simplification:** Eliminate rarely used functions and create "fool-proof" operation
- **Accessorisation:** Create accessories so that standard equipment can be used to perform different functions
- **Ease of production:** Use of materials and techniques that suit mass production
- **Portability:** Create light weight, small size, robust equipment
- **Reliability:** Eliminate potential faults and weaknesses due to misoperation and effects of climate and weather
- **Speed:** Maximise the speed with which telephone reliable communications can be built and changed

The new field telephone unit, telephone switchboard and auxiliary equipment were introduced into service in 1933 and subsequent years would become the mainstay of German field communication. They would remain in production with only minor changes until the end of the war and beyond; of the *FF 33* field telephone originally developed by Siemens in 1933, over 1.6 million examples were made by 27 different manufacturers.

FF 33 Field telephone

Development and description



Figure 1: Armeefernsprecher Alter Art

The development of field telephone equipment started in the late 19th century and by the time of the First World War the basic design features of field telephones were well established with the *Armeefernsprecher Alter Art* and the later *FF 16* and *17* models. “*FF*” stands for “*Feld Fernsprecher*” or field telephone. These telephones were locally powered by a battery (this mode of operation was called “*OB*” or “*Ortsbatterie Betreib*”).

Locally powered networks were commonplace during the early years of the telephone but in the beginning of the 20th century, public networks increasingly used central powered systems (the power for the microphones is provided over the phone line from a central power supply). In Germany this was called a “*Zentralbatterie Betrieb*” (*ZB*) system. For field use however, locally powered telephones remained the norm of many years.



Figure 2: FF 16

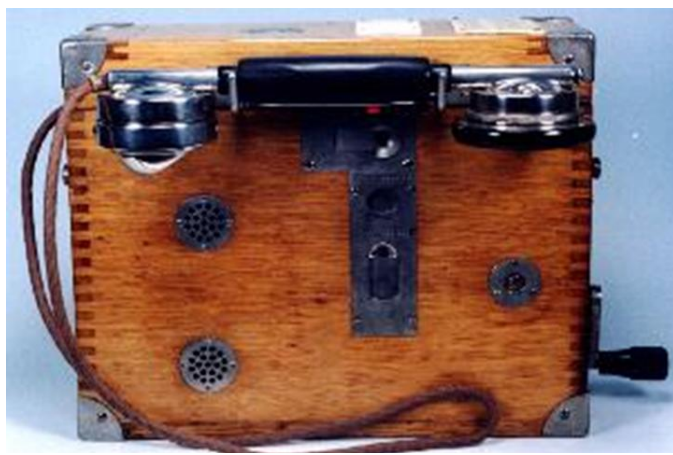


Figure 1: FF 26

As public telephone systems developed with a variety of operating principles, additional features were found to be necessary such as an automatic end-pulse when the handset was replaced, ability to connect a dialling disk etc. This resulted in the rather complex *FF 26* model.

When the Nazi's came to power, a rapid expansion of the armed forces was anticipated and so in 1933 the *Feldfernsprecher 33* was developed, essentially a "back to basics" model modernised to suit mass production. The earlier wood was replaced by a rugged moulded bakelite housing.



Figure 2: Early FF 33 phone. Note the plated metal parts

The components of the field telephone (bell, generator, microphone transformer and connections etc.) were placed on a alloy frame which could be lifted out of the housing giving easier access for maintenance. Complicated components such as buzzers, end-pulse switches, external battery connections etc. were omitted to keep production and operation as simple as possible.



Figure 3: Connection panel

from rain and dirt, a rubber seal on the edge of the lid allowed the lid to be closed on the cables. Two rotating metal covers closed off holes in the side of the housing for the generator handle and the two connection sockets for the interconnection cord. A bracket on opposite sides of the housing allowed a carrying strap to be connected.

To avoid the battery of an OB system from discharging unnecessarily the battery is normally switched off and will only work when a microphone switch is depressed. To avoid the batteries from short circuiting when two or more OB phones are used in a single circuit, the microphone circuit is not directly connected to the phone line, but via a microphone transformer ("*Sprechspule*").

Connections for the handset, headset and the telephone cables were accessible on the top panel of the telephone, with the battery being accessed via a hinged lid connected to the top panel.

The bakelite housing cover could be closed over the top panel to protect the telephone



Figure 4: Battery

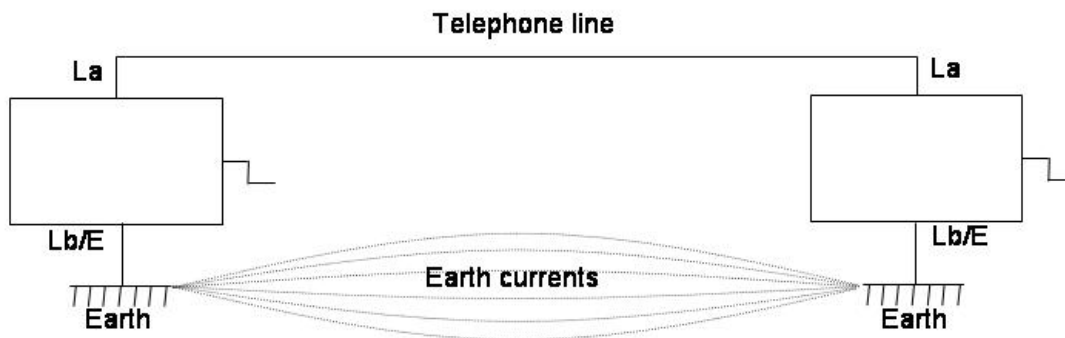


Figure 5: Current flow in a one line system

The FF 33 telephone has two line terminals marked “La” (“*Leitung a*” or line a) and “Lb/E” (“*Leitung b / Erde*” or line b / earth). The German army often used single wire connections with the other terminal connected to earth.

The upside is that a single cable connection only uses half the wire required for a double connection, making it cheaper and easier to build; the downside is that the return current flows through the earth, making it easier to intercept. For this reason telephone connections within 3 km of the front line had to be executed as double cable connections.



Figure 6: New microphone and green markings

serial number.

Sometimes during 1939 the type of microphone used in the FF 33 handset was changed. The lower impedance microphone required a different microphone transformer. New FF 33's can be recognised by a green stripe on the writing tab on top of the bakelite lid. The new microphones also have a green cross marking. Also around this time the finish of metal part was changed from a lacquered alloy to black painted steel.

Between 1940 and 1942, the alloy of the chassis was replaced by steel. These models can be recognised by an “E” for *Eisen* stamped after the

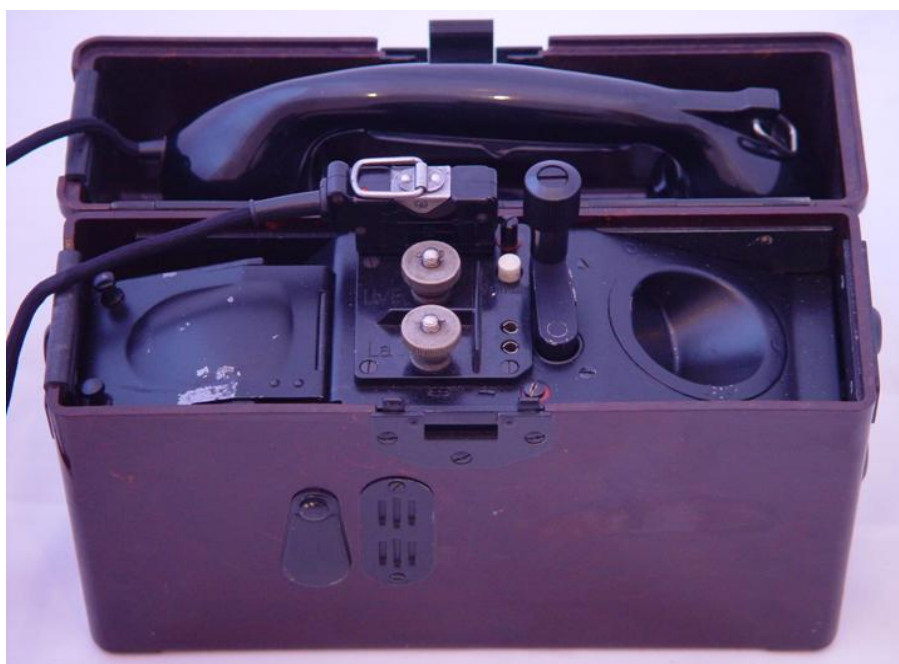


Figure 7: Model 1939 FF33. Note black painted metalwork

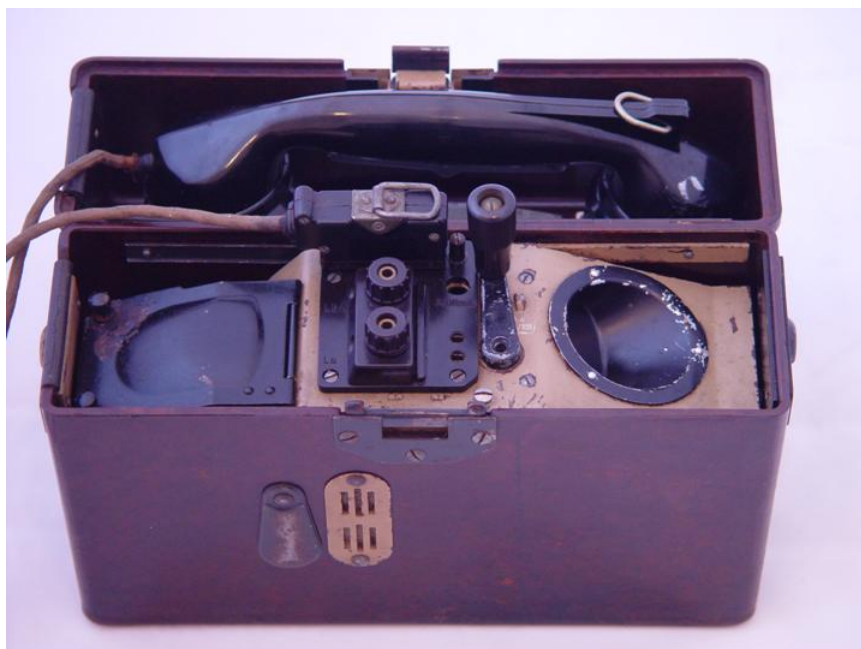


Figure 8: Late war 1943 model FF 33. Note changed line connections and the yellow painted metalwork

In 1943 the *FF 33* was slightly modified again to simplify production. The stamped metal frame was lightened by and spot welded rather than riveted. The bracket to hold the crank handle in place when stored was replaced by a simple stamped notch. The inside side covers were

omitted. The line terminal contacts were changed to a new type using less metal. Towards the end of the war, "*Dunkelgelb*" (dark yellow) paint was increasingly used to paint metal components.

The *Kriegsmarine* (the German Navy) had use for a special version of the *FF 33* equipped with the Navy four pin headset connection. The Navy headsets were



Figure 9: Kriegsmarine version of the FF 33

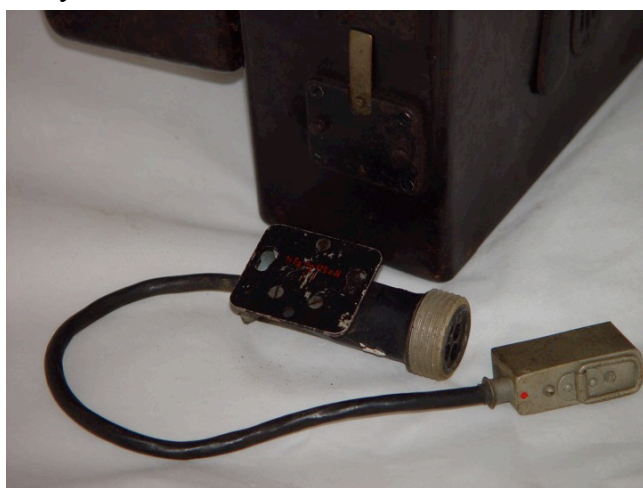


Figure 10: Kriegsmarine headset adapter cable

designed for use in high noise environments and would keep the hands free. In these headsets, the Navy four pin socket was placed on the outside of the bakelite housing.

A short adapter cable connected this outside plug to the normal five pin socket inside. A different microphone transformer was required for use with the navy headsets, to distinguish the navy modified *FF 33*'s they were marked with a yellow stripe on the writing tab.

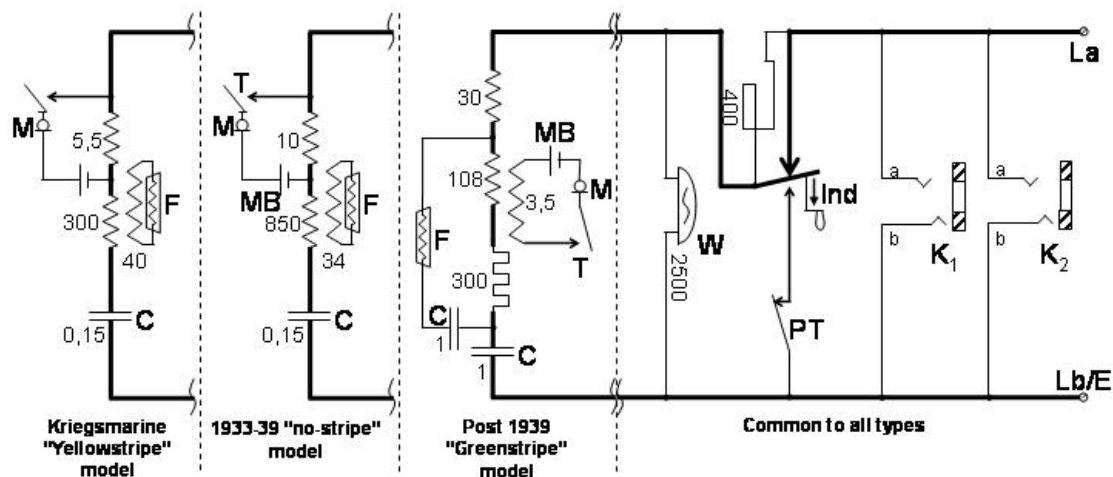


Figure 11: FF 33 Schematics

The schematics show the different variations of the *FF 33*. The key difference is in the microphone transformer, whose resistance values are shown. Note how the microphone circuit has moved to the secondary side of the transformer on the “Greenstripe” model.

Some of the *FF 33* Manufacturers identified to date are:

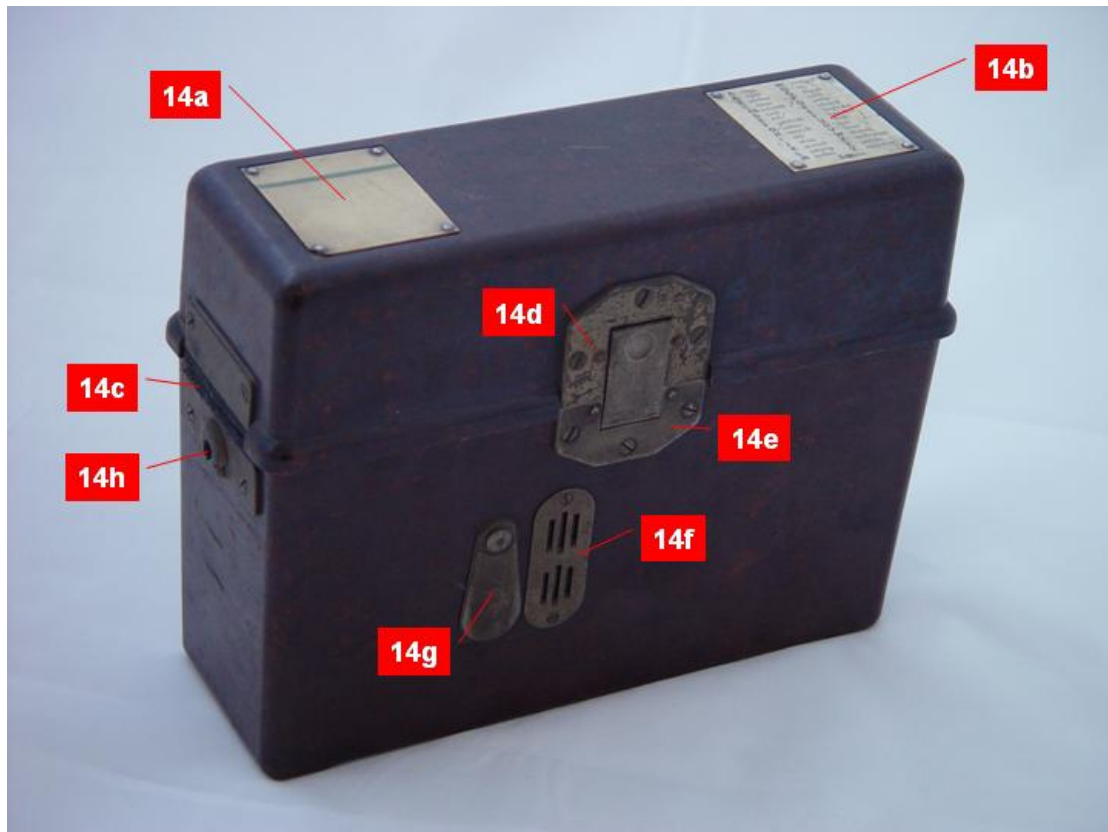
Germany			
1	RB&Co	Richard Bosse und Co.	Berlin
2	BSN	Lumophon-Werke Brückner und Stark	Nürnberg
3	DTW	Deutsche Telefonwerke und Kabelindustrie	Berlin
4		P. Hauser&Co	München
5	HW	Heliowatt Werke Elektrizitätswerke AG	Berlin und Schweidnitz
6	ErKa/RK	Rudolf Krüger Telegraphen Bauanstalt	Berlin
7	N&K	Neufeldt und Kuhnke	Kiel
	Hagenuk	Hanseatische Apparatebau-Gesellschaft Neufeldt und Kuhnke	
8	CL	Carl Lorenz Ag.	Berlin
9	M&G	Mix und Genest	Berlin
10		Radio H. Mende & Co.	Dresden
11	MT	F. Merk Telefonbau	München
12	NTT/TN/ bxf/ea	Nationale Telefon- und Telegraphenwerke	Frankfurt/Main
		Telefonbau und Normalzeit GmbH	
13	FR/ber	Telefonfabrik Friedrich Reiner	München
14	SSS	S. Seidl und Söhne,	Furtwangen
15	SA/dej	Siemens Apparate und Maschinen	Berlin
16	FS	Ferdinand Schuchhardt, Berliner Fernsprech- und telegraphenwerk AG	Berlin
17	SABA	Schwarzwaldler Apparatenbau Anstalt	Villingen-Schwenningen
18	St&Co	Stöcker&Co	Leipzig
19	SAF	Süddeutsche Apparate-Fabrik	Nürnberg
20	VBT	Vereinigte Bayerische Telefonwerke	
Austria			
21		Eumig, Elektrizitäts- und Metallwaren-Industrie-Gesellschaft	Wien

German Field Line Communication Equipment of WW2©

22	KuS	Kapsch und Söhne	Wien
23	bvx	Schrack-Ericsson Elektrizität AG	Wien
24	VTT	Vereinigte Telefon- & Telegraf-Werke	Wein
Czechoslovakia			
25	MK/fsb/fsc	Mikrofona Brüeder Knotek	Prag/ Wal Meseritsch
26	TW	Telegraf-Werkstätten, Prag-Gbell	Prag
		Ostmark-Werke Wien (Werk Prag-Gbell)	
France			
27	STE	Société des Téléphones Ericsson S.A.	Paris

Construction

Figure 14: FF 33 front view



14a Writing tab (details like the station name or the station name on the other end of the line could be written on this tab with pencil)

14b Alphabet tag
 14c cable rubbers
 14d top lock
 14e bottom lock
 14f Bell sound passages

14g Interconnection socket cover
 14h Carrying strap brackets

Figure 15: FF 33 casing



15a Overview schematic
 15b Wiring diagram

15c Handset spring
 15d Mounting brackets

15e generator crack hole and cover

Figure 16: FF 33 handset



- | | | |
|-------------------------|------------------------------|-----------------------|
| 16a 5-Pin plug | 16e Microphone cap | 16i Speaker cap |
| 16b Cable | 16f Microphone cap lock ring | 16j Microphone switch |
| 16c Microphone contacts | 16g Speaker contacts | |
| 16d Microphone | 16h Speaker | |

Figure 17: FF 33 telephone unit



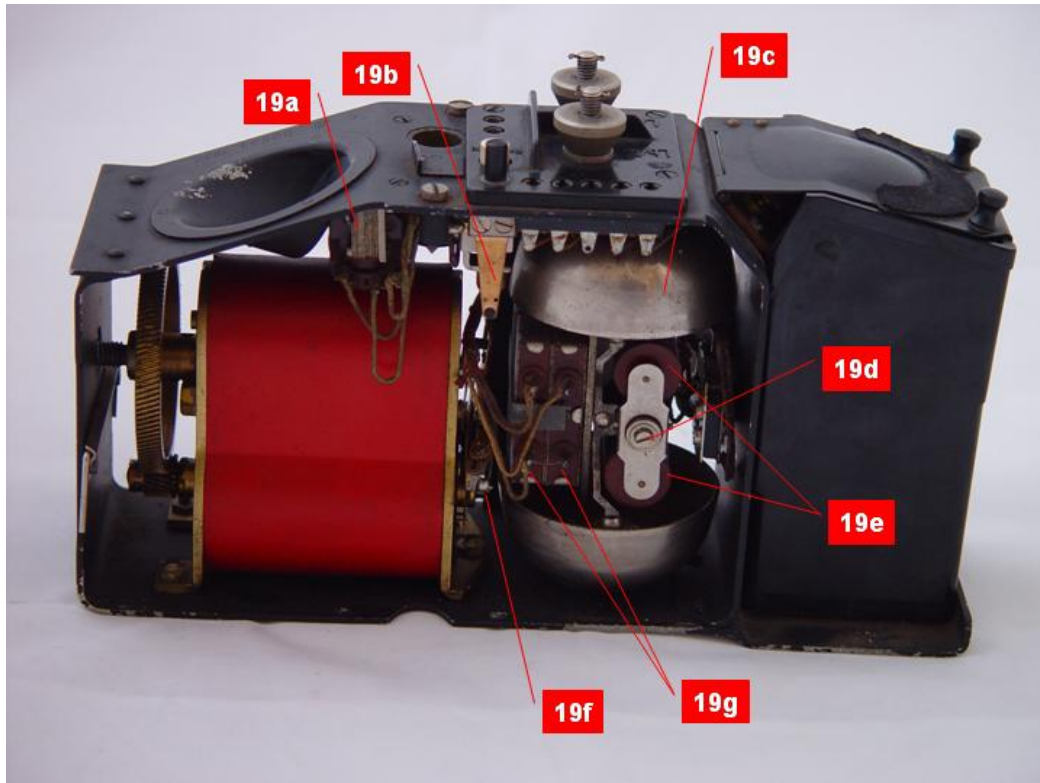
- | | | |
|----------------------------|---|-----------------------------------|
| 17a Battery lid | 17g Lb/E connection | 17l Battery box |
| 17b 5-Pin handset socket | 17h La connection | 17m Interconnection cable sockets |
| 17c Handset socket pin | 17i 2-Pin headset socket | 17n Bell sound passages |
| 17d Test button | 17j Generator crank storage | 17o Removable side panel |
| 17e Recess for handset | 17k Manufacturer, serial number and date area | 17p Side panel locking pin |
| 17f Housing locking screws | | |

Figure 18: FF 33 unit internal front view



- | | | |
|-----------------------|-----------------------------------|--------------------------------|
| 18a Battery box | 18d Microphone transformer | 18f Wiring loom |
| 18b Battery terminals | 18e Interconnection cable sockets | 18g Ringtone generator |
| 18c Battery spring | | 18h Generator crank connection |

Figure 19: FF 33 unit internal back view



- | | | |
|---|---|---|
| 19a Microphone transformer | 19d Bell yoke | frequency ringing current
flowing through the speaker
coil and the speaker) |
| 19b Test button contacts | 19e Bell coils | |
| 19c Bells (When the top screw is
slackened, the bells can be
rotated to adjust) | 19f Generator switch | |
| | 19g Capacitor blocks
(preventing the low | |

Figure 20: FF 33 accessories typically carried



- | | | |
|----------------------|-------------------------------|--------------------------|
| 20a Carrying strap | 20d Battery (Element d) | 20g Interconnection cord |
| 20b Connection lug | 20e Earth pin | |
| 20c Hook for handset | 20f Earth pin carrying sheath | |

Operation

The minimal equipment needed to operate the field telephones are two *FF 33* (or compatible) phones, two wires and two 1.5 V batteries.

- Place the phone on a suitable surface, take the generator handle from its storage and connect it to the generator.

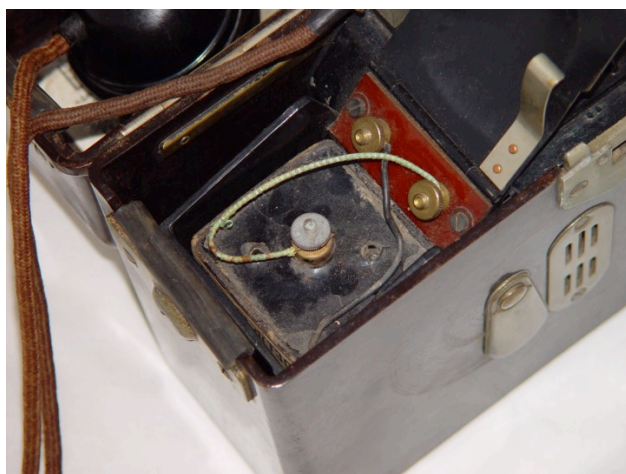


Figure 12: FF 33 Battery connection

- Connect the batteries the battery terminals (polarity is not critical).
- Connect one wire between the “La” connections of both phones and the other between the “Lb/E” connections. The normal mode of transmission by the German Forces was a single wire with return via earth; in this case the “Lb/E” terminal would be connected to an earth pick on each side.
- Uncoil the handset lead and place all the wires and leads on the

rubber strips

- Close the lid and place the handset crosswise on top of the telephone. Alternatively the phone can be hung from a nail or tree branch using the carrying strap. In this case the handset is hung from the hook on the carrying strap.



Figure 13: FF 33 connected and ready to use. Note the generator handle attached through the side and the connected carrying strap. The phone could be hung from the shoulder or a branch and the handset could be hung from the hook visible on the strap.

When the generator handle of one phone is cranked, the bell of the other phone should ring. The bell of the own telephone can be tested by depressing the white test button while turning the crank (a single telephone can also be tested in this way by shorting the La and Lb/E terminals).

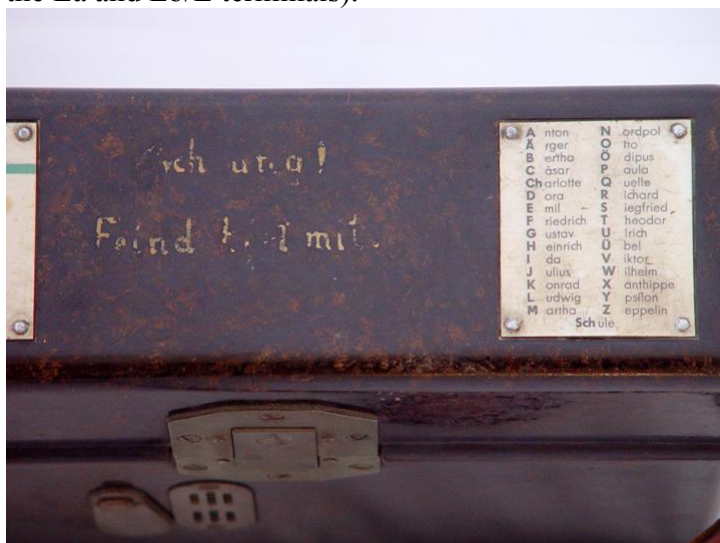


Figure 14: Alphabet table and painted warning "*Feind hört mit!*"

When speaking in the handset the microphone switch has to be depressed. The voice should be heard back in the own handset and should be heard through the handset on the other end of the line. Both parties can depress the microphone switch and speak and listen simultaneously as with normal telephones.

When using field telephones it must be assumed that the message can be overheard by the

German Field Line Communication Equipment of WW2©

enemy (“*Feind hört mit!*”), so messaging discipline is required by using appropriate codes for names and locations. For weak signals and noisy backgrounds the spelling alphabet printed on the top of the lid can be used to spell out messages.

On ending the telephone call the receiver shall be replaced and the generator should be cranked with three short movements. This “calling-off” procedure is particularly important when connected via telephone switchboards.

The signal will grow weaker as the line connection between telephones gets longer. The maximum range will depend on type of cable and how the connection is built. The following table gives an idea of the ranges achieved between two *FF 33* field telephones.

	Line lying on ground	Line suspended high	Double line
Light field cable	3 – 5 km	10 -20 km	-
Heavy field cable	10 - 12 km	50 - 60 km	30 -40 km
Long range cable without Pupin coils	-	-	40 - 48 km
Long range cable with Pupin coils	-	-	100 - 120 km



Figure 15: Two FF 33's connected by the interconnection cable

FF 33 field telephones can be interconnected via the interconnection sockets on the side to form a makeshift telephone switchboard. Each *FF 33* comes equipped with an interconnection cable that can be placed between two local phones. When so connected, the two separate field telephone lines can communicate. Several field telephones can be interconnected in this way.

SB Zusatz 33 End-Pulse generator

Development and Description



Figure 16: FF 33 with SB Zusatz

One type of telephone network in use at the start of the 20th century was the “*Schlusszeichen Betrieb*” (SB) or End-pulse system. This system was used where it was important that the switchboard connections could be reused for the next caller as soon as the previous call had ended. Apparently not all callers applied the correct manual calling-off procedure at the end of their call so that the switchboard did not get a signal that the call had ended. By using the automatic end-pulse system, this switchboard was always notified as soon as the handset was replaced.

The earlier *FF 26* field telephone had a built-in end-pulse switch but the simplified *FF 33* omitted this functionality. The field telephone could however be used in SB networks using the “*SB Zusatz 33*”.

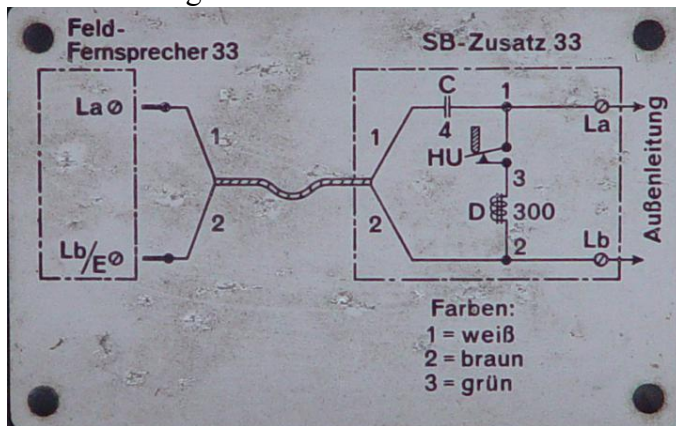


Figure 17: SB Zusatz schematic

The system works by letting a small DC current flow over the telephone line. When this current is interrupted, the “end-pulse” is generated in the telephone switchboard. Apart from a switch, the *SB Zusatz* contains an inductance coil and a capacitor to isolate this DC current from the normal telephone signal.

Construction

Figure 27: SB Zusatz exterior

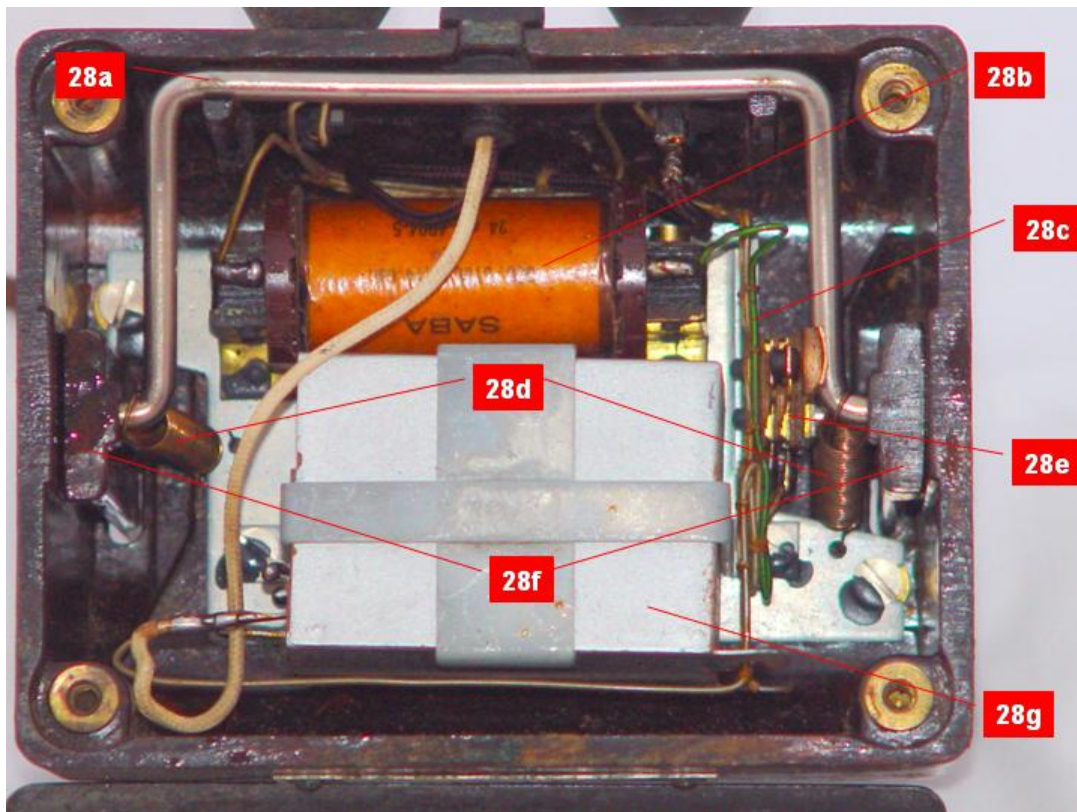


33a End pulse switch arms
33b clamp

33c La line terminal
33d Lb line terminal

33e Connection cable to FF 33 telephone

Figure 28: SB Zusatz interior



28a End-pulse switch arm
suspension
28b Inductance coil

28c Wiring loom
28d Switch arm return spring
28e End-pulse switch contacts

28f Switch arms
28g Capacitor

Operation

End-pulse systems are no longer in use so the unit can not be used in practice. When the SB system was still current, the *SB Zusatz* 33 could be used with a *FF 33* field telephone.

- Connect the two wire connections of the *SB Zusatz* to the line connections of the *FF 33*: white to “La” and brown to “Lb”.
- Connect the telephone line to the “La” and “Lb” terminals on the side of the *SB Zusatz*.
- Close the lid of the field telephone, clamp the *Zusatz* on top of the lid of the



Figure 18: Connecting the SB Zusatz

FF 33 and place the handset on top of the *Zusatz*.

When a call is received, the *FF 33* will ring as normal. Lift the handset from the *SB Zusatz* and depress the microphone switch to speak. When the call has ended, replace the handset on the *SB Zusatz*. This will automatically break the connection in the switchboard.

When making a call, turn the generator crank and wait until the switchboard operator acknowledges the call. Tell the operator who you wish to speak to and conduct your conversation as usual. When the call has ended, replace the handset on the *SB Zusatz*.

Ferntastgerät Ftg.b

Development and Description

In some cases the FF33 could be used to remotely key a wireless transmitter. Because the origin of wireless signals could be located by an enemy using Radio Direction Finding equipment, transmitters were often placed some distance away from the headquarters they were serving. To allow seamless communication of radio signals from the headquarters, remote keying or *Ferntastung* was used; the Morse key used for transmitting the signal was placed near the receivers in the headquarters, linked to the remote transmitter via a *Ferntastgerät*. The *Ferntastgerät* consisted of two FF 33's, a remote connection unit or *Fernanschlußgerät Ftg.b* with a morse key, a local connection unit *Ortsanschlußgerät Ftg.b* at the transmitter site, connected by a three core cable plus an earth connection.



Figure 30: FF 33 with *Ferntanschlußgerät Ftg.b*

The *Ferntastgerät Ftg.b* was typically used with the 100 W.S. transmitter, a similar setup was used with the 15 W.S.E.b. Other *Ferntastgerät* types were used with larger transmitters, but these no longer made use of the FF 33.

The FF 33's were used for communication between the radio operators at the local and remote sites, they could not be used for remote voice transmissions (*Fernbesprechung*). The morse key at the remote location was connected with a pair of wires to the keying relay in the 100 W.S.; this keying relay amplified the weak remote signal from the morse key to operate the transmitter. With the 15 W.S.E.b an external keying relay had to be added as this transmitter is not fitted with an internal relay like the 100 W.S.

The remote station could be placed up to 1200 meters away from the transmitter. Up to four spools with 300 meter 3-core cable could be linked with special 3-core connectors.



Figure 31: Complete Fernstastgerät Ftg.b setup with 100 W.S. Transmitter

The *Fernanschlußgerät* and *Ortsanschlußgerät* each have three cable terminals colour coded red, white and blue. The red wire, together with the earth connection forms the connection between the two FF 33's while the white and blue wires carry the signal from the morse key. Both connection units are connected by a single core rubber cable to the FF 33.



Figure 19: *Fernanschlußgerät* Ftg.b (left) and *Ortsanschlußgerät* Ftg.b (right)

An instrument on the *Fernanschlußgerät* allows the keying current to be monitored.

Construction

Figure 33: Fernastgerät Ftg.b



33a Fernanschlußgerät
 33b Terminals (red, white and blue)
 33c Connection for Morse key
 33d Keying current instrument
 33e Clamp for placement on FF

33f Connection cable to La on FF33
 33g Morse key
 33h 3-core wire connector
 33i Ortsanschlußgerät

33j Terminals (red, white and blue)
 33k Connection to morse key input on transmitter
 33l Connection to La on FF 33

Operation

Choose a suitable position for the transmitter location, up to 1200 meters away from the headquarters.

- Place the *Fernanschlußgerät*, one FF 33 and the morse key at the headquarters location, place the *Ortsanschlußgerät* with the second FF 33 at the transmitter location.
- Place the *Fernanschlußgerät* on top of the cover of the FF 33 and connect the cable to the “La” connection on the FF 33. Connect the “Lb/E” connection via a short piece of wire to the earth stake. Take the FF 33 headset and close the lid of the FF 33, taking care that the cables are passing through the rubber cable transit. Place the headset on top of the *Fernanschlußgerät*.
- Connect the three-core cable to the connectors on the *Fernanschlußgerät*, each wire to the appropriate coloured terminal
- Tie off the three-core cable to ensure adequate pull relief and unroll the cable spool, mounted on a *Rückentrage*, towards the transmitter location. Use a three core cable connector to connect a second, third and fourth 300 meter length of cable as required.

- At the transmitter location, place the *Ortsanschlußgerät* and the second FF 33 next to the 100 W.S. transmitter. Connect the rubber cable of the *Ortsanschlußgerät* to the La connection of the FF 33 and connect the Lb/E connection to the earth stake via a short length of wire. Take the FF 33 headset and close the lid of the FF 33, taking care that the cables are passing through the rubber cable transit. Place the headset on top of the FF 33.
- Tie off the three core cable to ensure adequate pull relief and connect the three-core cable to the connectors on the *Ortsanschlußgerät*, each wire to the appropriate coloured terminal
- Test the telephone connection as described in the FF 33 section.
- Using a local morse key plugged into the 100 W.S., the radio operator tunes the 100 W.S. as per normal operating procedure. The radio operator unplugs his local morse key and plugs in the two prong plug from the *Ortsanschlußgerät* in the *Ferntaste* socket on the 100 W.S. Once the transmitter is ready to transmit, this is reported over the telephone line to the remote operator at the headquarters.
- The remote operator at the headquarters can now transmit messages using his morse key. He can monitor the keying current on the instrument on his *Fernanschlußgerät*. If the instrument does not move, all connections need to be checked
- The local operator at the transmitter can monitor the transmission and adjust the transmitter if required.
- If any problems arise, the operators can contact each other via the FF 33 as per normal procedure.

Table phone *Tischfernsprecher 38*

Development and description

Similar in functionality to the *FF 33* with *SB Zusatz 33* the *Tischfernsprecher 38* was developed as a neater desk version of the field telephone. To minimise the cabling required on the desk itself, a single cable leads to a separate battery/connection box, which can be placed under the desk or hung on the wall.



The *Tischfernsprecher 38* can be used in central and local battery systems, as well as end-pulse networks. In addition, an external bell could be connected which could be placed in another room so that important calls would not be missed. These features make it a telephone more

Figure 20: *Tischfernsprecher 38*

suited to higher staff and administration functions bound to offices and barracks, less so as a field telephone.



Figure 35:
Tischfernsprecher 38
terminal unit

The Terminal unit has the following connections:

MB	Two “ <i>Mikrofon Batterie</i> ” or microphone battery connections
La/OB/SB	“ <i>Leitung a / Orts Batterie / Schlusszeichen Batterie</i> ” or line a / local battery / end pulse battery: This connection was to be used in local battery or end pulse systems, also when the <i>Tischfernsprecher 38</i> is connected to another field telephone
La/ZB	“ <i>Leitung a / Zentral Batterie</i> ” or line a / central battery. This connection was to be used for central battery networks
Lb/E	“ <i>Leitung b / Erde</i> ” or line b / earth:
W2	Two “ <i>Wecker 2</i> ” or Bell 2 connections: an external bell could be connected to these terminals.

The telephone unit itself consists of a bakelite base plate on which all components are mounted. On the back side connection terminals to the battery/connection box, handset and optional headphone are placed together so that all leads can be neatly led outside through a rubber seal. The bakelite top lid pivots open and is locked closed with two spring loaded hooks.

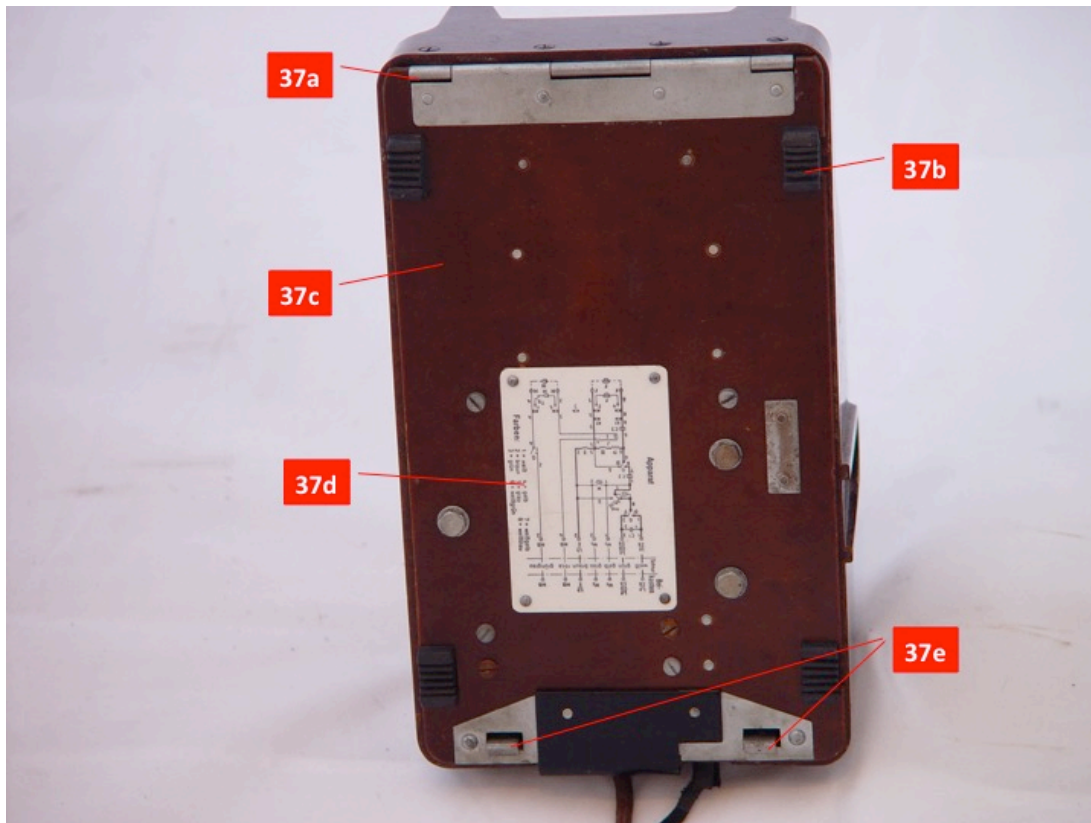
Construction

Figure 36: Tischfernsprecher 38 overview



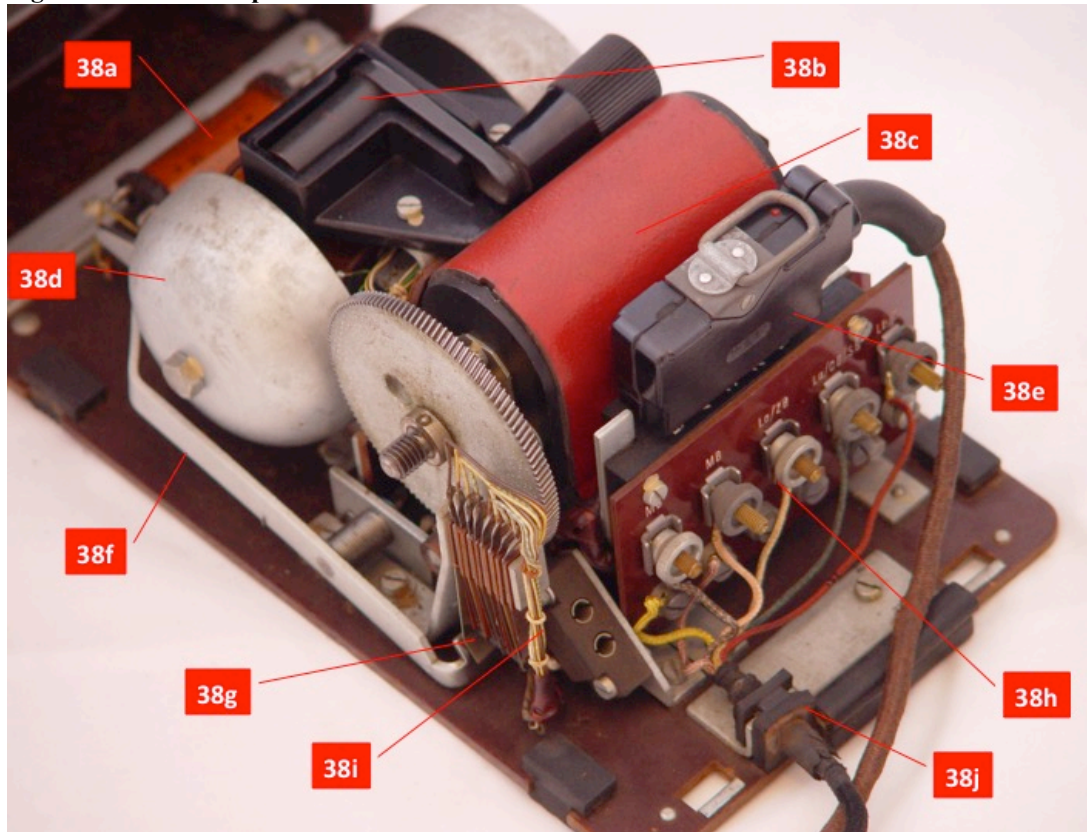
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|----------------------|--------------------------|--------------------------------------|
| 36a Handset | 36e Generator crank | 36i Terminal box terminals |
| 36b End pulse switch | 36f Manufacturer plate | 36j Terminal box battery compartment |
| 36c Alphabet tag | 36g Rubber cable transit | |
| 36d Bakelite housing | 36h Connection cable | |

Figure 37: Tischfernsprecher 38 underside



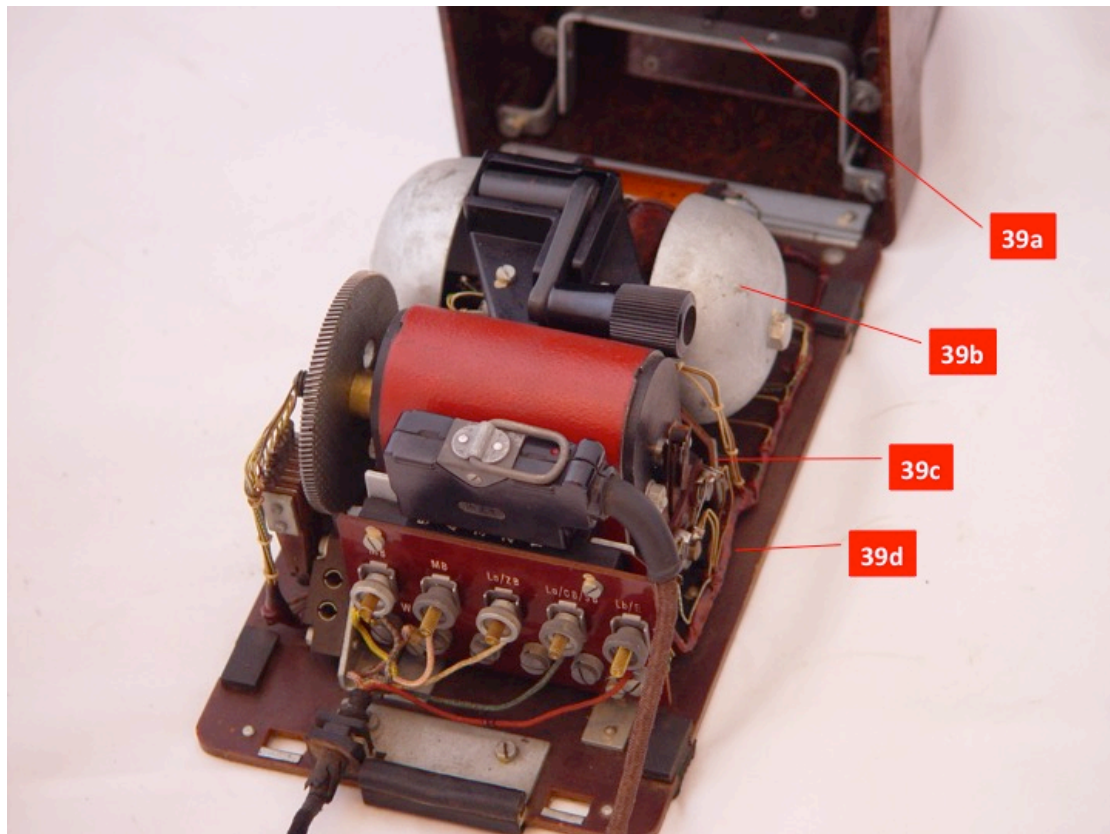
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|--------------------|------------------|-------------------|
| 37a Housing swivel | 37c Bottom plate | 37e Housing Locks |
| 37b Rubber feet | 37d Schematic | |

Figure 38: Tischfernsprecher 38 interior view



- | | | |
|---|-------------------------------|--|
| 38a Microphone coil | 38d Bell assembly | 38h Connection cable termination panel |
| 38b Storage recess for generator crank handle | 38e Handset connection plug | 38i Headset connection socket |
| 38c Ring tone generator | 38f End pulse switch lever | 38j Connection cable transit |
| | 38g End pulse switch contacts | |

Figure 39: Tischfernsprecher 38 interior view



- | | | |
|--|----------------------|-----------------|
| 39a End pulse switch suspension in top cover | 39b Bell assembly | 39d Wiring loom |
| | 39c Generator switch | |

Operation

- Open the *Tischfernsprecher 38*, plug in the handset, remove the generator handle from its storage recess and closing the unit again, taking care that the cables pass through the rubber seal.
- Place the handset on the telephone unit and connect the generator handle.
- Open the battery compartment of the battery/connection box and connect a 1.5 V battery to the “MB” terminals.
- Close the battery compartment and connect the telephone line to the required terminals. For connection with another *Tischfernsprecher 38* or and *FF 33* use the “La/OB/SB” and “Lb/E” terminals.
- Connect an extra bell if required to the “W2” connections.
- Place the battery/connection box in a convenient place and the telephone unit on the desk with the Alphabet and writing tabs facing the user.

Operation is identical to a normal *FF 33* field telephone so crank the generator handle to call the other end of the line and depress the microphone switch in the handset while talking.

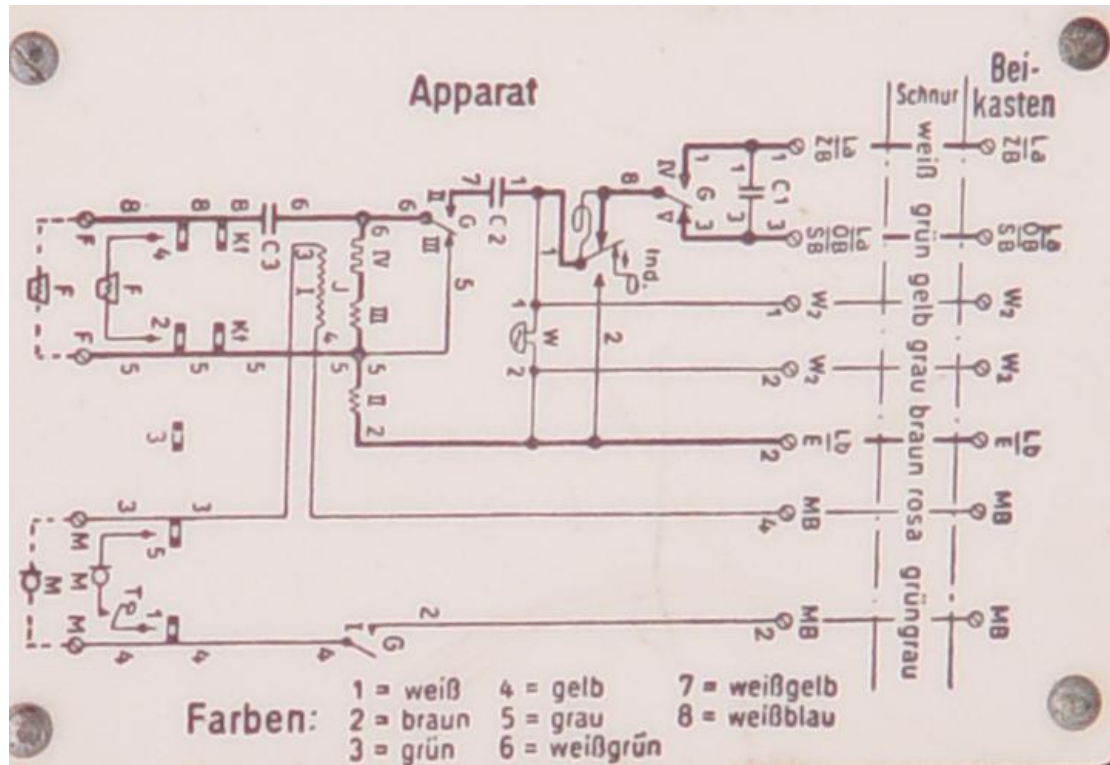


Figure 40: Tischfernsprecher 38 schematic

Amtsanschießer 33

Development and description

As explained in the previous section, the *FF 33* was a “no frills” piece of equipment, which consequently did not have any provisions for connection to public telephone networks. To enable this functionality, a separate unit was developed, the *Amtsanschießer 33*.



Figure 41: *Amtsanschießer 33* in leather carrying case

The *Amtsanschießer 33* could be used as an independent telephone unit, or could be connected between a field telephone line and the public network. It contained an end-pulse switch and a dialling disc, allowing connection to most public networks then in use.



Figure 42: *Amtsanschiesser 33*

German Field Line Communication Equipment of WW2©

With a housing made of sturdy bakelite, a dialling disk set at a comfortable angle, a “hook” to place the handset on top and connections on the backside the unit is shaped like a classic desk telephone.

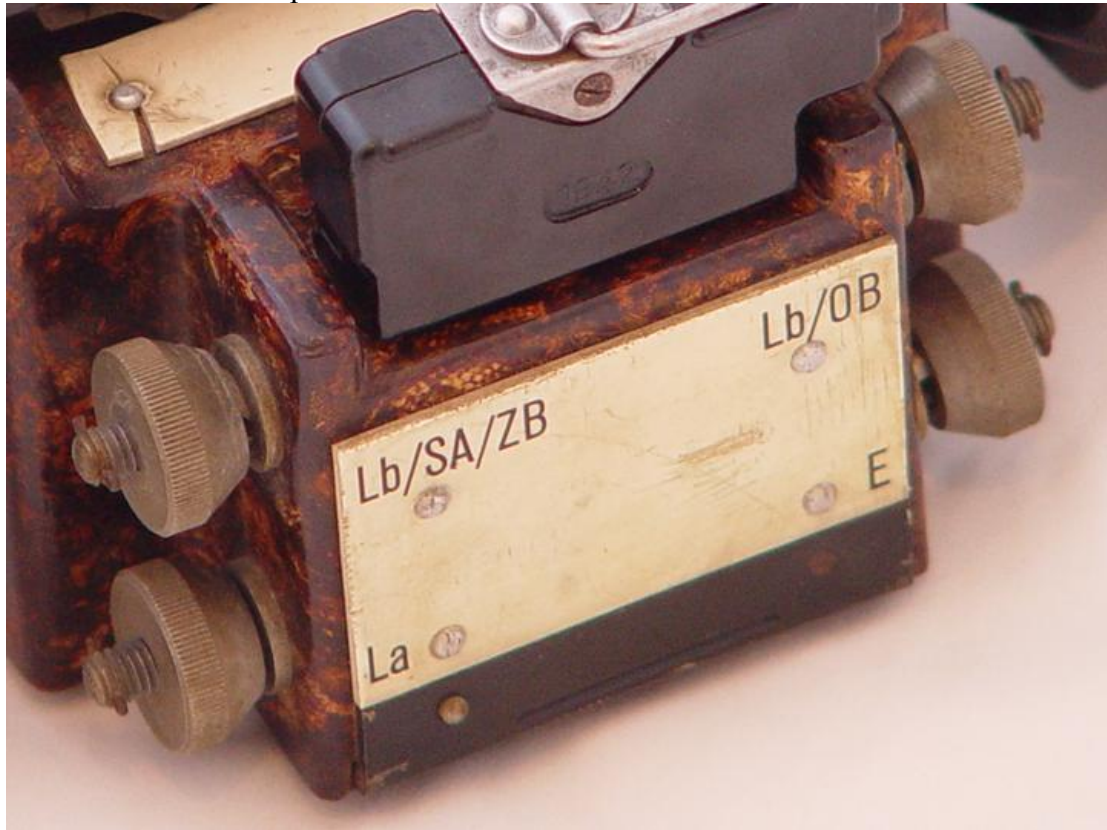


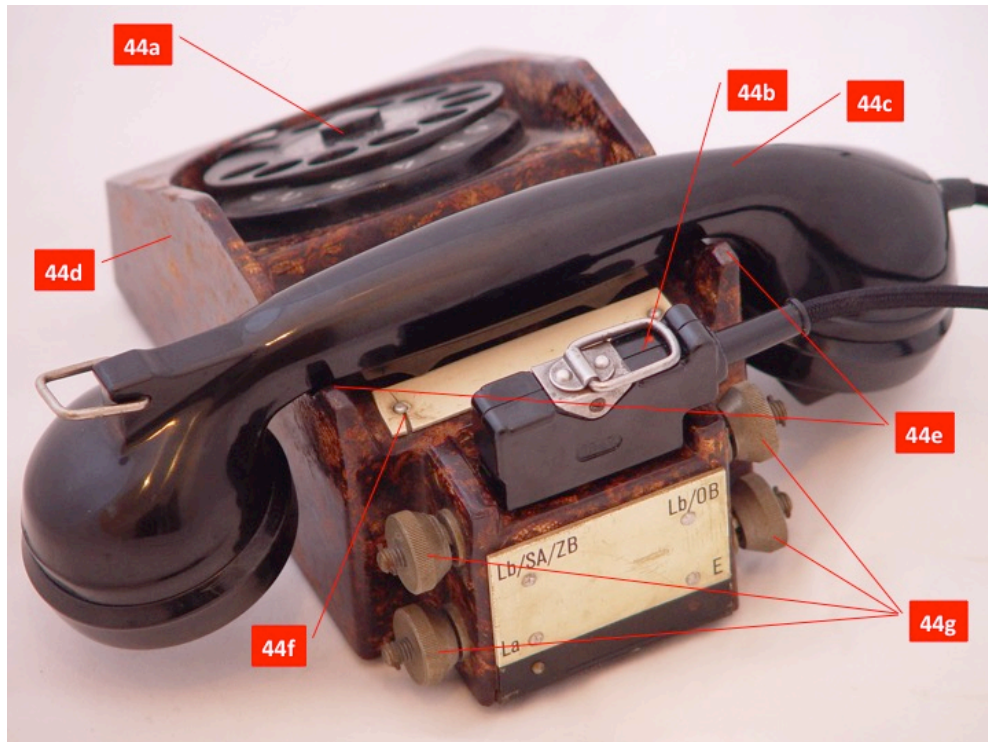
Figure 43: Amtsanschließer connections

The *Ambstanschießer 33* has four line connection terminals:

La	<i>Leitung a</i> or line a: This connects to the terminal of the automatic public network that carries the positive voltage
E	<i>Erde</i> or earth: This terminal was only used when a connection to a “Earthed System” network was made. In the 1930’s this system was already rare and being phased out.
Lb/OB	<i>Leitung b / Ortsbatterie</i> or Line b / Local battery: This terminal was only used when connecting to a “SB” (<i>Schlusszeichen Batterie</i>) network. This type of network would automatically free up the connection in the switchboard when the end-pulse switch was depressed. This type of network is no longer in use.
Lb/SA/ZB	<i>Leitung b / Selbsanschlussbetrieb / Zentral Batterie</i> or Line b / Self connecting network / central battery: This connects to the negative terminal of the automatic public network.

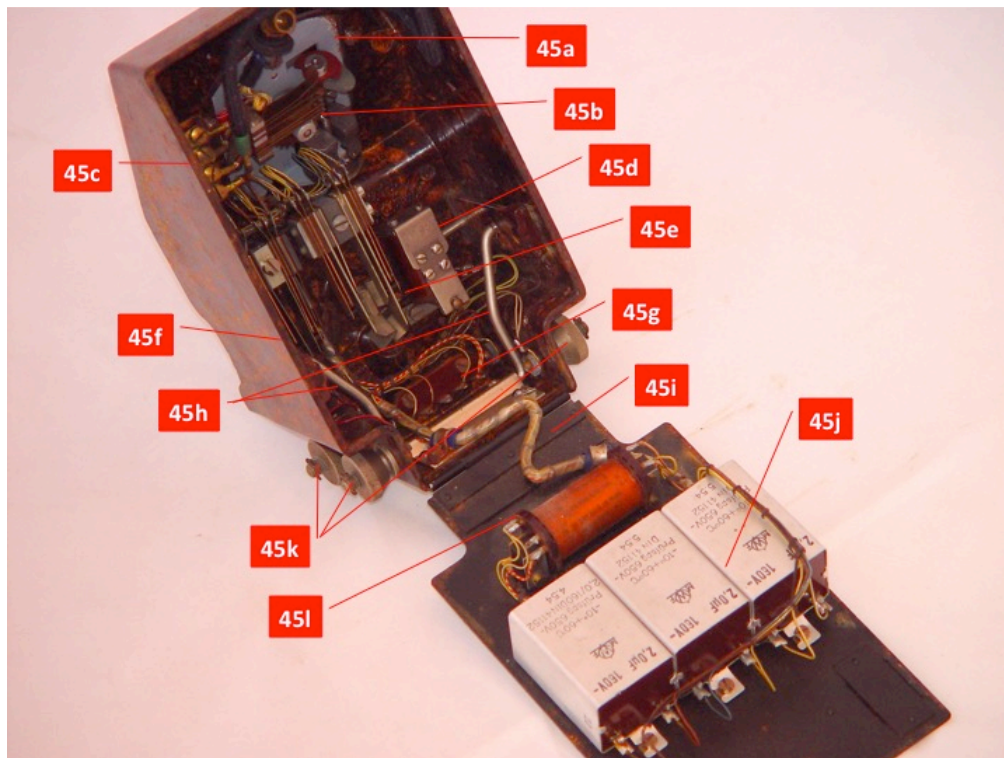
Construction

Figure 44: Amtsanschließer external view



- | | | | | | |
|-----|---------------|-----|--------------------|-----|------------------|
| 44a | Dialling disk | 44d | Bakelite housing | 44g | Line connections |
| 44b | Handset plug | 44e | End-pulse switches | | |
| 44c | Handset | 44f | Writing tab | | |

Figure 45: Amtsanschließer internal view



- | | | | | | |
|-----|--------------------------------|-----|--|-----|------------------------|
| 45a | Dialling disk unit | 45e | Contacts for inductor and interconnection cord jacks | 45i | Wiring loom |
| 45b | Dialling disk pulse contacts | 45f | End-pulse contacts | 45j | Capacitor blocks |
| 45c | Dialling disk connection strip | 45g | Handset connection strip | 45k | Line connection screws |
| 45d | Buzzer | 45h | End-pulse switch suspension | 45l | Microphone transformer |

Operation

If your public phone network supports “pulse dialling”, the *Amtsanschließer* should work as a normal phone. Most modern networks however use “tone dialling” so a pulse to tone converter might be required.



Figure 46: Amtsanschliesser 44 ready for use. Note instruction leaflet in front

- Connect the “La” and “Lb/SA/ZB” terminal to the public phone line.
- Connect a handset from a field telephone to the *Ambstanschließer* and place the handset on top of the unit.

To make a call, lift the handset and dial the required number using the dialling disk. Depress the microphone switch in the handset while speaking. When the handset is replaced on top of the unit the connection will be broken. The *Ambstanschließer* is now also ready to receive calls. When a call is received the buzzer will make a rattling sound. When the handset is lifted, connection will be made.

When the *Ambstanschließer* is to be used to interface between a field and public line:

- Place a FF 33 field telephone next to the *Ambstanschließer*.
- Establish the field connection as described in the Field Telephone section.
- Unplug the handset from the field telephone and plug this into the *Amtsanschließer*.
- Plug the interconnection cord (*Vermittlungsschnur*) into the one of the jacks on the side of the *FF 33* field telephone.

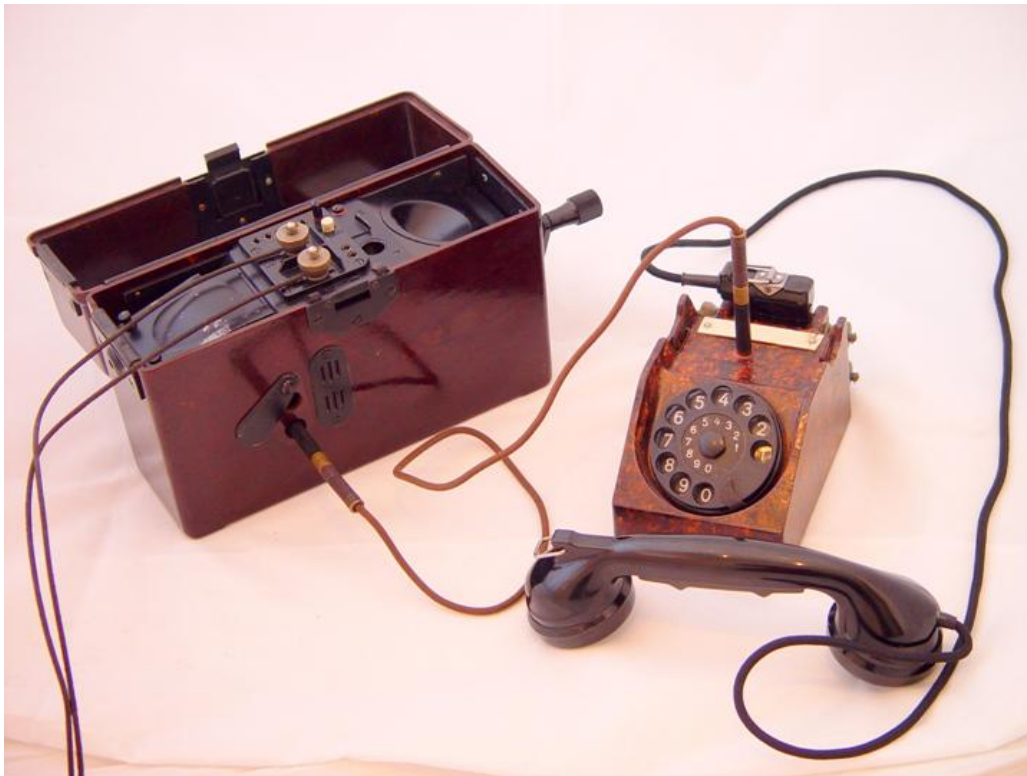


Figure 47: Amtsanschließer connected to FF 33

When a call is received from the public line operate the *Amtsanschließer* as described above. Establish connection over the field telephone line. When both connections are established, place the other end of the interconnection cord into the jack on top of the *Amtsanschließer*. The person on the far end of the field telephone line can now talk via the public network.

When the call is ended, the person on the far end of the line turns the generator crank which will cause the buzzer in the *Amtsanschließer* to rattle. Disconnect the interconnection cord and replace the handset on top of the *Amtsanschließer*. The placement of the interconnection cord jack on top of the *Amtsanschließer* is such, that the handset can not be replace accidentally when the connection is in use.

When a call is received from the field telephone network the procedure is similar but the order in which the connections are made is reversed.

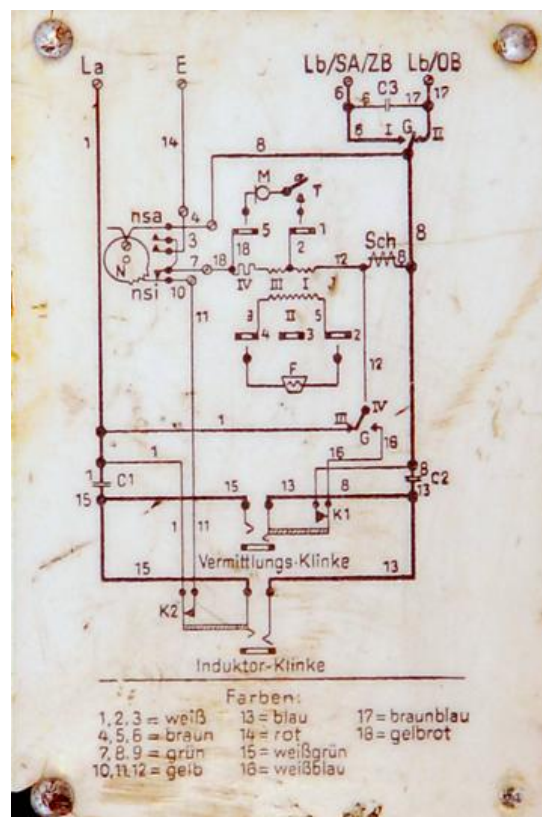


Figure 48: Amtsanschließer schematic

OB Fernsprecher 43

Development and Description

As the war was dragging on and the situation of the German industry was deteriorating, the production of field telephones was simplified. Not only were some simplifications to the *FF 33* made, but it was also concluded that a large proportion of field telephones were used in fixed positions where demands on weather protection, portability and connectivity were minimal



Figure 49: OB Fernsprecher 43

direction to the phone, dispensing with the five pin plug. The *Prüftaste* and two prong plug for the earphone were also omitted. This telephone became known as the “*OB Fernsprecher 43 für ortfesten Betrieb*” (local battery phone 43 for fixed station use). Other than the changes described above, standard *FF 33* components were used.

The *OB Fernsprecher 43* can be recognised by the red tag in place of the *FF 33* Alphabet plate and its Spartan exterior lacking all metal components of the *FF 33*. The only known maker is Mix&Genest (rsm).

In 1943, a cheap and basic telephone was developed aimed at inside use at fixed positions. Weather protection, carrying facilities and the interconnection cable jacks were omitted and the metal frame was replaced by a simple pertinax plate on which all components and connections were mounted. The handset cable was connected

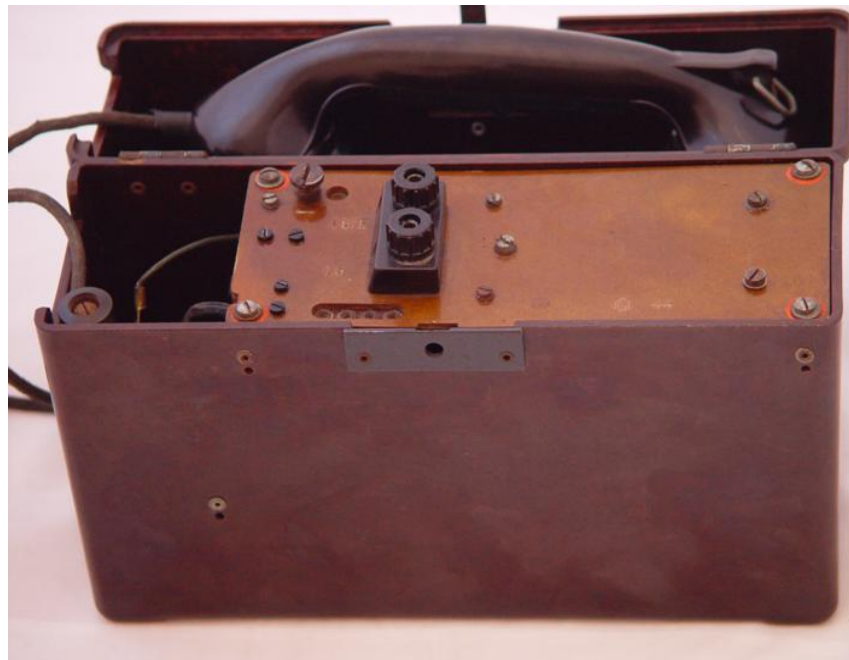
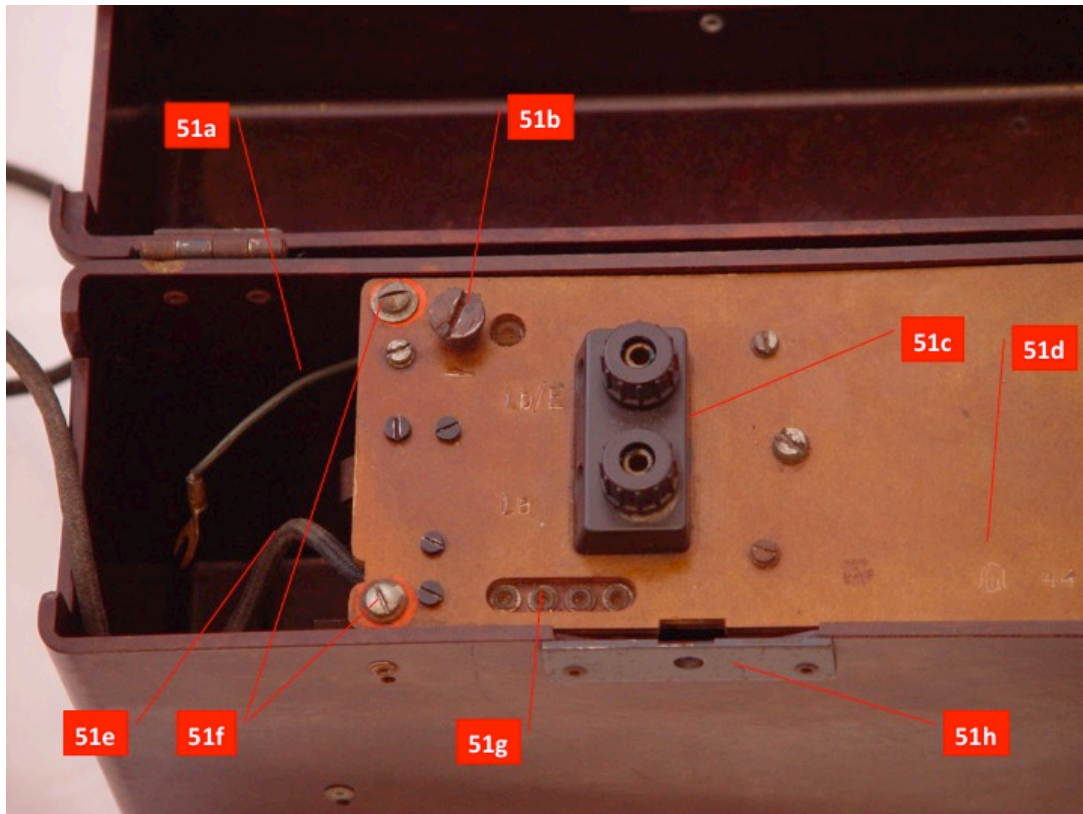


Figure 50: OB Fernsprecher 43 with lid opened

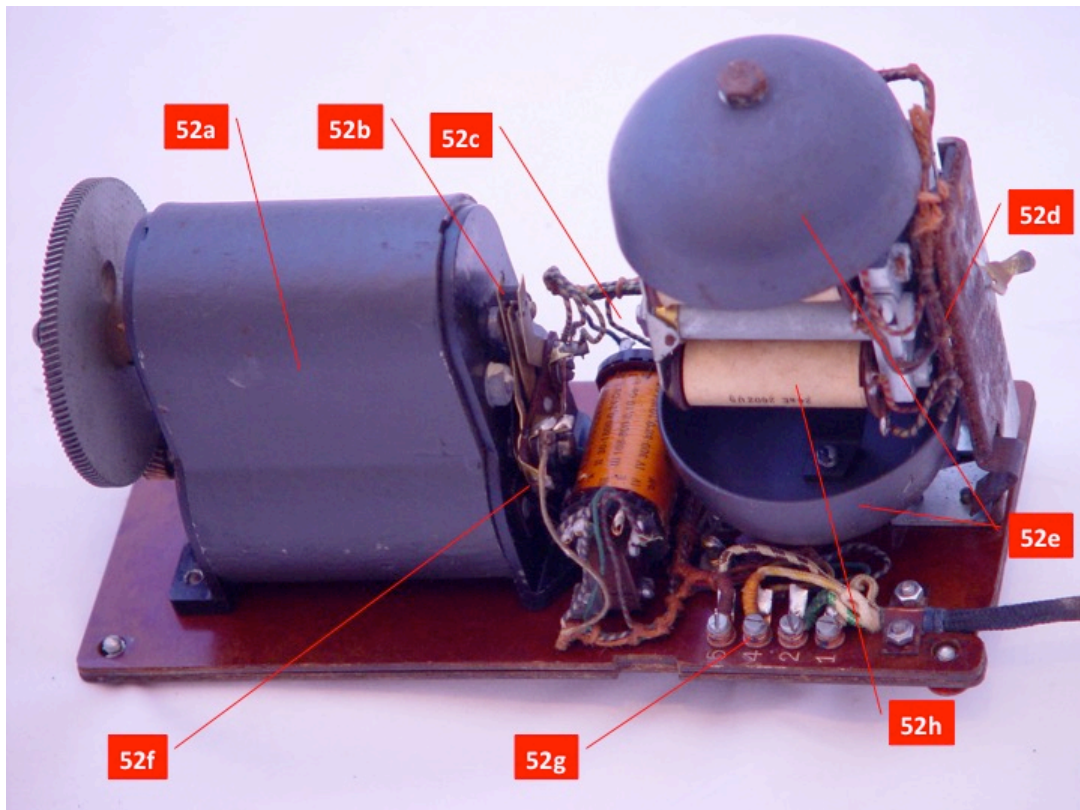
Construction

Figure 51: OB 43 top panel



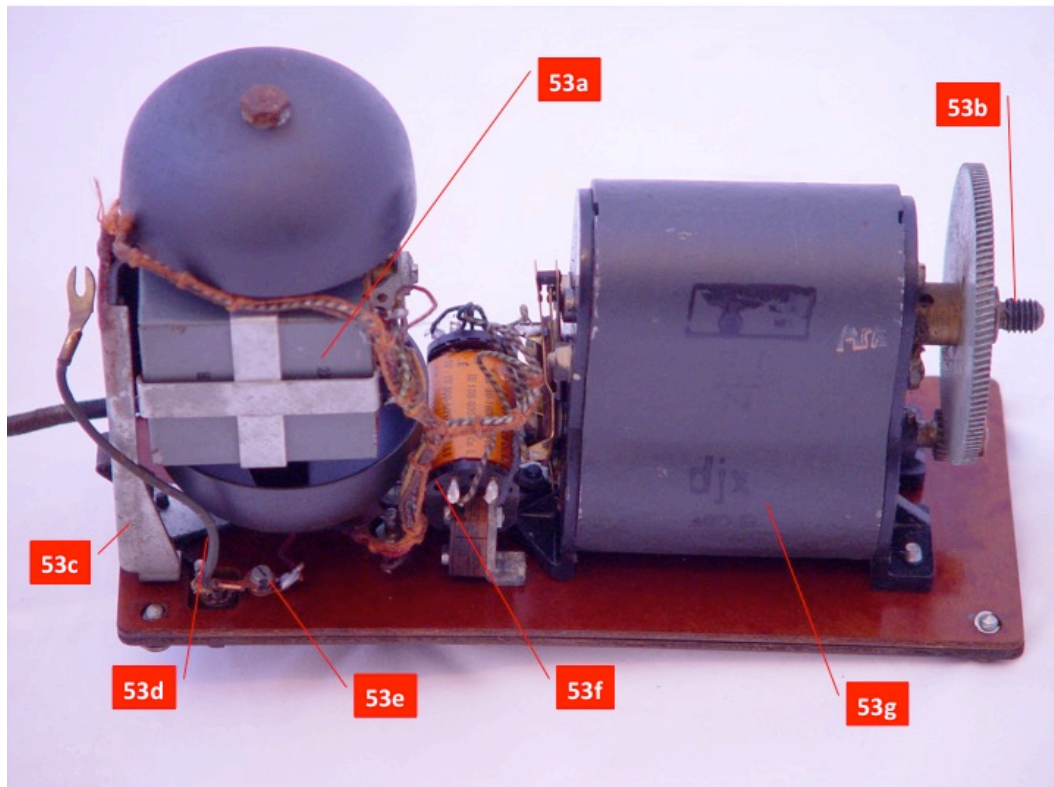
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|--------------------------|------------------------------|-------------------------------|
| 51a Battery connection + | 51d Maker markings | 51g Handset connection screws |
| 51b Battery connection - | 51e Handset cable | 51h Bottom lock |
| 51c Line connections | 51f Top panel locking screws | |

Figure 52: OB 43 internal view



- | | | |
|-------------------------------|----------------------------|------------------------|
| 52a Ring tone generator | 52d Wiring loom | 52g Handset connection |
| 52b Generator switch contacts | 52e Bell assembly | 52h Bell coils |
| 52c Bell yoke | 52f Microphone transformer | |

Figure 53: OB 43 Internal view



- | | | |
|--------------------------------------|--------------------------|--------------------------------|
| 53a Capacitor block | 53d Battery connection + | 53g Maker marking on generator |
| 53b Generator crank connection | 53e Battery connection - | |
| 53c Mounting frame for bell assembly | 53f Wiring loom | |

Operation

Operating the *OB Fernsprecher 43* is exactly as the FF 33 field telephone.



Figure 54: OB Fernsprecher 43 ready for use

Erdsprech Gerät

Development and Description

One disadvantage of field telephone connections is the cable can easily be damaged by artillery fire. This was a common occurrence in forward areas, requiring a dangerous trip by a repair crew to find and repair the break in the cable. Until repaired, no connection could be made with normal field telephones.



Figure 55: Erdsprechgerät

From the telephone interception experience in the First World War, it was learned that telephone conversations could be picked up amplifying the currents flowing through the earth. The same principle can be used to bridge breaks in telephone lines. Instead of amplifying the received signal (as is used in interception equipment), the *Erdsprechgerät* boosts the telephone signal into

the telephone wire by a factor 200, creating enough signal to bridge a gap of up to 5 meters in the telephone cable. Alternatively, the *Erdsprechgerät* could be used on long lines or lines with a high attenuation, where normal *FF 33* telephones could no longer work.

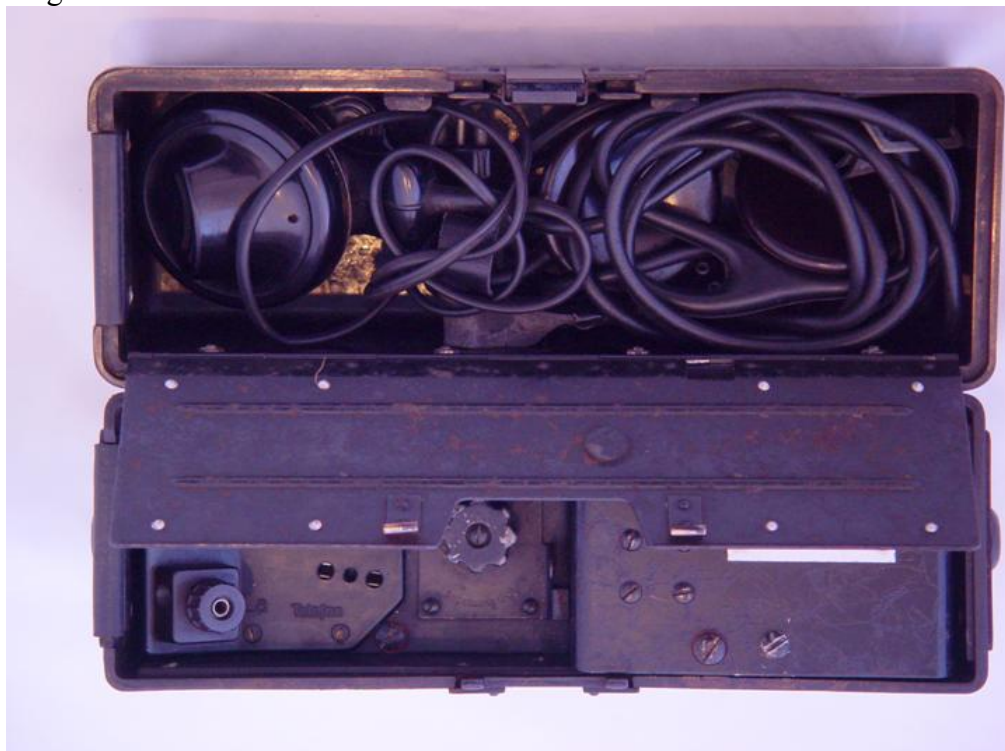


Figure 56: Erdsprechgerät storage in lid for headset and microphone

German Field Line Communication Equipment of WW2©

Instead of a battery to power the microphone, the *Erdsprechgerät* uses a DC generator to generate about 14 Volts microphone voltage which is fed to a powerful microphone. The speech signal of high amplitude is injected into the broken line via a matching transformer. On the other side, a sensitive headset is used to receive the signals. The matching transformer with three settings can be used to optimise the signal

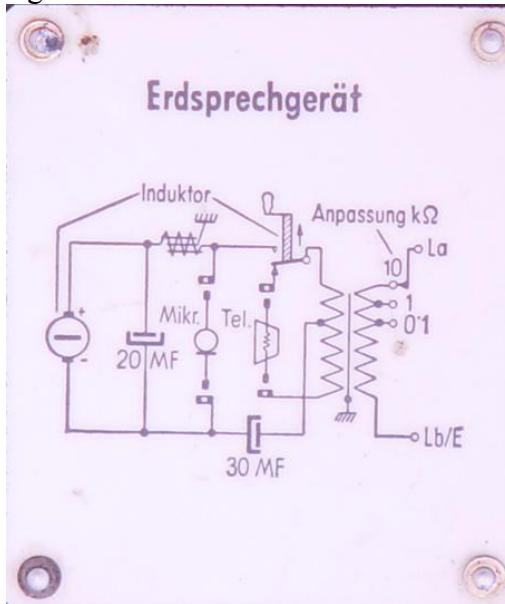


Figure 57: *Erdsprechgerät* schematic

operation practices than normal field telephones. With the *Erdsprechgerät*, the generator handle has to be turned continuously during operation. One disadvantage of the *Erdsprechgerät* is that it can relatively easily be overheard by the enemy, so "**Feind hört mit!**".

An earth pin and a 20 m length of single core telephone cable complete the *Erdsprechgerät* set.

To distinguish the *Erdsprechgerät* from a normal *FF 33* the side of the unit and the writing tab are clearly marked "*Erdsprechgerät*" and on early versions, a white band is painted on the housing.

The control panel was different from the normal field telephone with connection jacks for the cable (marked "La" and "Lb/E" as with the *FF 33*), connection jacks for microphone and headset and a matching switch. Instead of a handset, a separate microphone and headset were used, which could be stored in the lid of the housing. The *Erdsprechgerät* does not have a ringing generator nor bell, requiring different

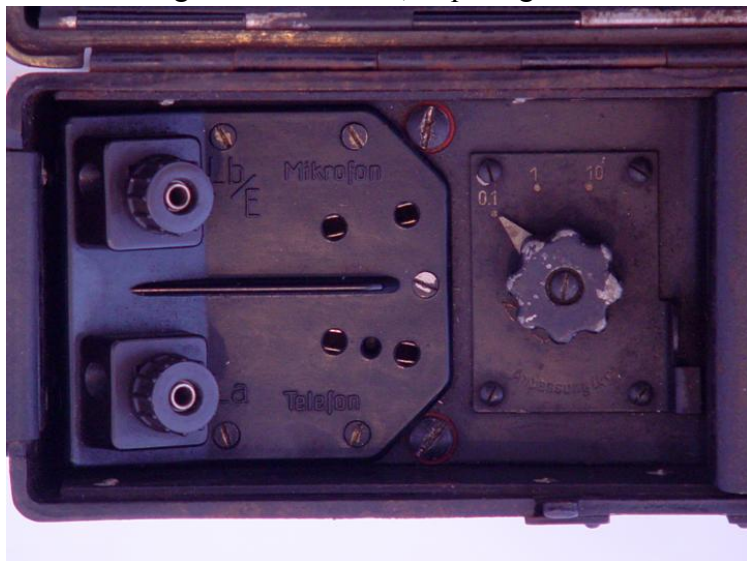
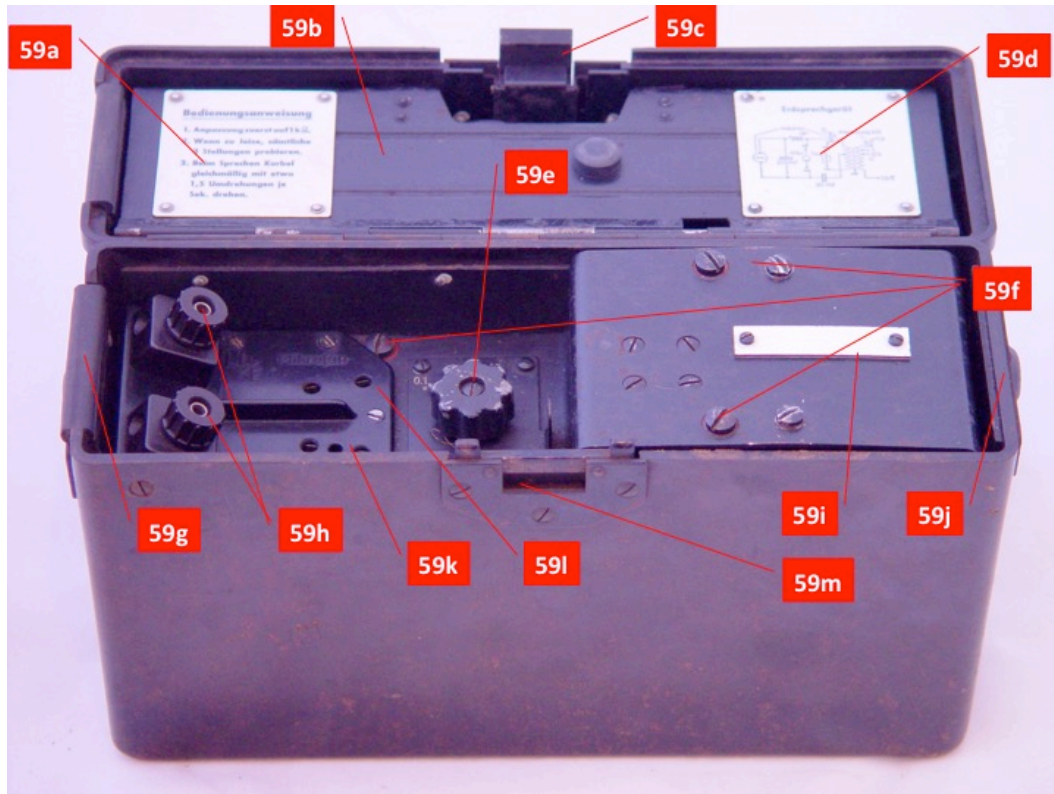


Figure 58: *Erdsprechgerät* control panel

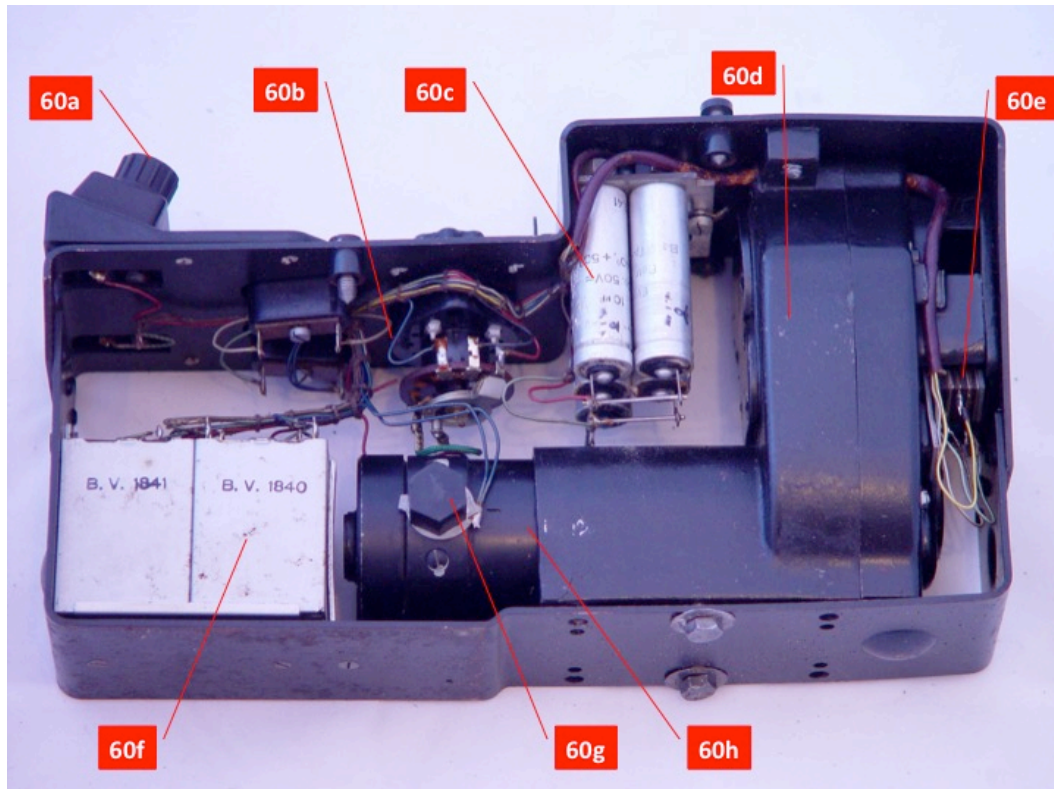
Construction

Figure 59: Erdsprechgerät top view



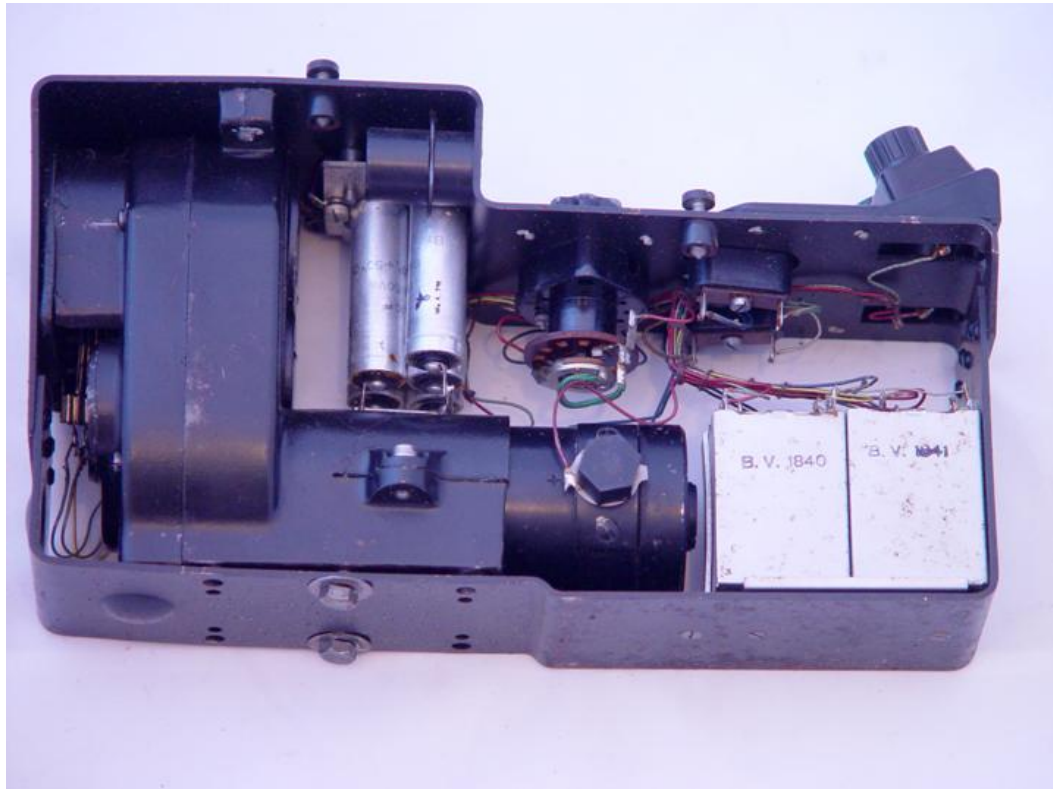
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|--|-------------------------------|---------------------------|
| 59a Operating instructions | 59e Matching switch | 59j carrying belt slot |
| 59b Lid to Headset storage compartment | 59f Lock screws | 59k Headset connection |
| 59c Upper lock | 59g Cable transit rubber | 59l Microphone connection |
| 59d Schematic | 59h Line connection terminals | 59m Bottom lock |
| | 59i Small writing tab | |

Figure 60: Erdsprechgerät inside view



- | | | |
|-------------------------------|--------------------------|-------------------------|
| 60a Line connection terminals | 60d Generator gearbox | 60g Generator brush cap |
| 60b Matching switch contacts | 60e Generator contacts | 60h Generator |
| 60c Capacitors | 60f Matching transformer | |

Figure 61: Erdsprechgerät internal view



see view 1 for components

Figure 62: Erdsprechgerät headset and microphone



62a Headset plug
62b Microphone plug
62c Microphone

62d Headset headband
62e Headset "Dfh.g"

62f Headset adjustable chinstrap

Operation

To create a connection, two *Erdsprechgeräte* complete with headsets and microphones, two earth pins and 2 lengths of 20 meter single core telephone wire are required. It is assumed that a standard field telephone connection with a single wire and earth pins is already in existence and that the wire has been broken with both ends lying in or on the ground with a gap of up to 5 meters. If a broken two-wire telephone connection has to be bridged, the two wires are connected in parallel to the *Erdsprechgerät*.



Figure 63: Erdsprechgerät with generator crank, headset and microphone connected

- Place the earth pin about 10 meters from the *Erdsprechgerät* and connect to the “Lb/E” connection of the *Erdsprechgerät* using a suitable length of single core cable. If the operating position is surrounded by barbed wire, make sure the earth pin is placed about 10 meters outside the barbed wire enclosure.
- Prepare another short length of wire to connect the “La” terminal of the *Erdsprechgerät* to the telephone wires. About 20 cm of the cable insulation is stripped, so that it can quickly be connected to the terminals of the telephone line or lines.
- Connect the generator handle to the generator through the hole in the side of the casing.

When the normal telephone connection is broken due to the effects of enemy artillery fire, immediately switch over to the *Erdsprechgerät* connection:

- Connect the prepared “La” wire to the telephone wire; in case of a two-wire connection, connect the prepared “La” wire to both telephone wires in parallel.

To operate the *Erdsprechgerät*, two men are usually required: one to turn the generator and another to speak and listen and take notes. The unit can be operated by a single person in emergencies, with one hand used to crank the generator and the other to hold the microphone to the mouth.

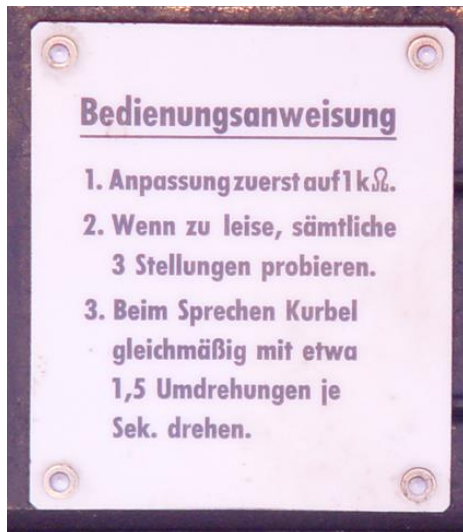


Figure 64: *Erdsprechgerät* operating instructions

To speak, turn the generator with a constant 1 – 1.5 turns per second. The microphone is to be held no more than 2 cm away from the mouth.

To listen, the headset is to be worn by the operator. Release the generator crank (this allows the generator switch contact to switch on the headset). Initially set the matching switch to the “1” position. Once a signal is received, the alternative positions should be tried to find the position which gives the loudest reception.

Only one station can speak at the time while the other should be listening, so the two stations will have to agree operating practices beforehand, for example that station A always calls station B first. Since it is also not possible

to “ring” the other station, fixed operating times should be agreed.

After the normal telephone line is interrupted and the *Erdsprechgerät* is connected, station A will start calling station B by turning the handle 1 -1.5 times per second and for example calls: “Here station A, here station A, station B please come in, over, over....”. After this station A will listen for a reply. If no reply is received after two minutes, the matching switch is to be tried on another setting and the calling procedure repeated.

After station B has received the call, it will start turning the generator crank and will for example reply: “Here station B, here station B, I read you bad/good/load and clear. Best reception is at position 1 or 10, do you read station A? Over, over....”



Figure 65: *Erdsprechgerät* ready for use

When the connection has been established, normal conversation can resume. Because the signal is less secure than even normal telephone connections, secure communication protocol should be used by using codenames etc. “*Feind hört mit!*”.

Field Telegraph equipment

Introduction

Telegraphy is essentially a digital form of communication where letters and numbers are replaced by a sequence of code. This code can be transmitted by switching a DC current on/off or can be modulated so that a tone is switched on/off or changed in pitch.

An example of telegraph code is Morse code, in which each letter is replaced by a sequence of short and long pulses (dots and dashes). Another example is the 5-bit Baudot telex code, where each letter is represented by a sequence of ones and zeros, for example 01011 representing the letter “J”.

This chapter primarily discusses equipment that could be encountered in the “Field”, i.e. could be encountered by front-line troops, Baudot-type telex equipment will not be considered. This specialised equipment which was generally too bulky and fragile for field use could primarily be found at headquarters and message centres.

Sutel 40 Wire Telegraph

Development and Description

Due to the proximity of the trenches of the First World War, the security of telephone lines were easily undermined. Especially single wire connections, where the return current flows through the earth are susceptible to eavesdropping. But even two-wire connections can induce stray currents in the earth, which could be picked up by increasingly sensitive monitoring equipment. In 1915, the then Captain A.C. Fuller invented a telegraph device using DC current. Because DC current does not induce stray currents in the earth, it was impossible to intercept the signal, even on single line connections it is virtually impossible to tap into the earth currents. The Fullerphone, as the device became known, can be used simultaneously with a telephone on the same line over distances far exceeding that of normal telephone connections. During experiments, communication distances exceeding 1000 Km were found to be possible.



Figure 66: British Fullerphone Mk IV



Figure 67: Sutel 40 DC wire telegraph

Although DC telegraphy was widely used by the British and Commonwealth armies, little is known about its use by the German army. The German device was called a “*Summer Telegraph 40*” or Sutel 40 for short. The “40” denotes that it was introduced in 1940, no earlier versions are known.

The working principle of the Sutel 40 is based on switching-on and –off of a DC current through the connection between the two stations. This current needs to be detected and transformed into an audible signal. The Fullerphones use an electromechanical buzzer to chop the line current flowing directly through a set of headphones; the German device uses an electronic oscillating circuit with a *RV2,4T3L* Triode valve to tone in the headphones. The line current is used to change the voltage on the control grid of the Triode, switching the oscillator on and off.

A Morse key is used to switch a 9 V battery voltage on and off. When depressed, the oscillator will generate a tone in a set of headphones of the sending unit and the current will start flowing through the telephone line to the receiving unit causing the oscillator at the receiving end to generate a tone as well.



Figure 68: Sutel 40, opened lid showing the stored Morse key and headphones

German Field Line Communication Equipment of WW2©

The unit uses two 4.5 Volt *Ba4,5KZT5* batteries (the same as used in the Enigma machine).

The unit is built in the same bakelite casing as the standard field telephone and can be distinguished by red markings on the writing tabs and a red band around the casing. A small Morse key and a set of headphones complete the set.

The DC wire telegraph has four wire terminals



Ltg	La	“ <i>Leitung a</i> ” or Line a of the telephone connection
	Lb/E	“ <i>Leitung b / Erde</i> ” or Line b / Earth of the telephone connection
Feldspr.	La	“ <i>Leitung a</i> ” or Line a connecting to La terminal of the FF 33
	Lb/E	“ <i>Leitung b / Erde</i> ” or Line b / Earth connecting to the “Lb/E” terminal of the FF 33

The advantage of the Sutel 40 is its security. A drawback is that the operation requires two trained operators who should be able to read and write Morse code.

Figure 69: Sutel 40 connection panel

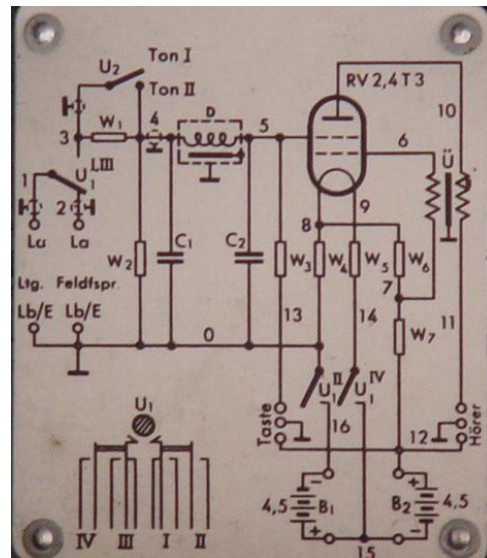
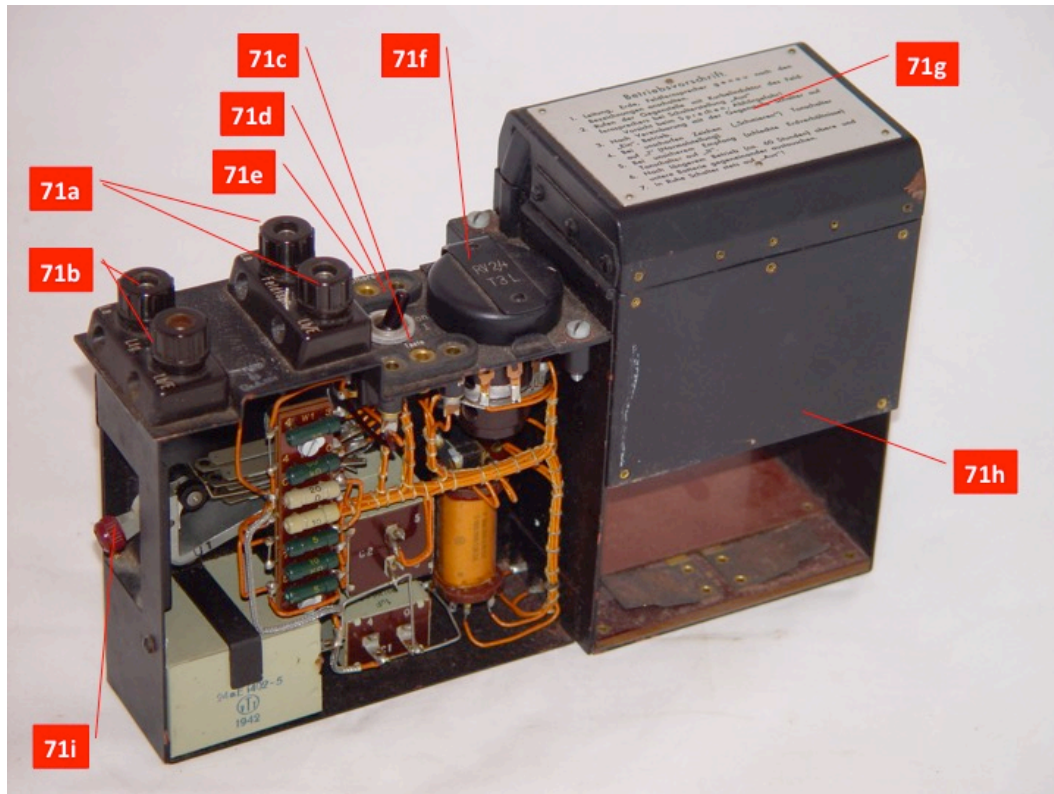


Figure 70: Sutel 40 telegraph schematic

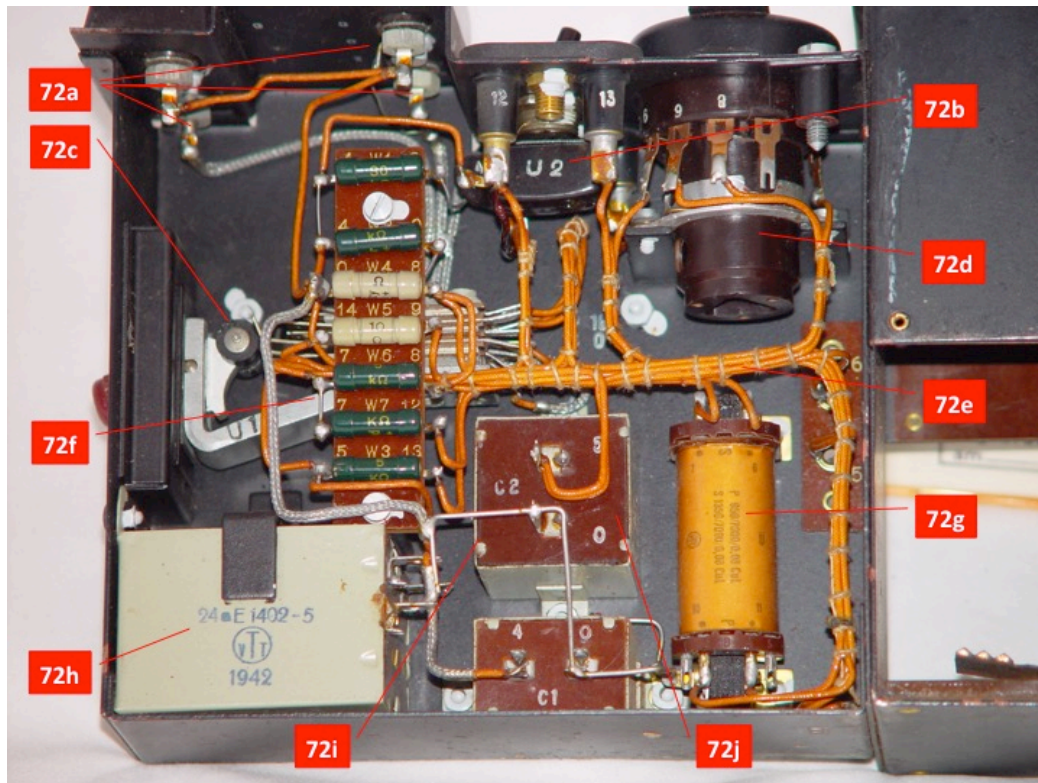
Construction

Figure 71: Sutel 40 telegraph



- | | | |
|------------------------------|---|-------------------------|
| 71a Connection to FF33 | 71e Morse key connection | 71h Battery compartment |
| 71b Line connections | 71f Radio valve housing | 71i On-off switch |
| 71c Headphone connection | 71g Battery compartment lid with operating instructions | |
| 71d Switch for pitch control | | |

Figure 72: Sutel 40 internal view



- | | | |
|--|-------------------------|----------------------------------|
| 53b Connections to outgoing line and field telephone | 53d On-off switch | 53g circuit board with resistors |
| 53c Pitch control switch | 53e Radio valve housing | 53h Output transformer |
| | 53f Wiring loom | 53i Filter Inductance coil |

Operation

To set up a DC wire telegraph connection, two Sutel 40's and two *FF 33* field telephones are required.

- On each end, connect the telephone wires to the “*Ltg La*” and “*Ltg Lb/E*” terminals; connect the “*Feldspr La*” and “*Feldspre Lb/E*” terminals to the corresponding terminals of the *FF 33* field telephone.
- Remove the Morse key and headphones from their storage compartments and connect the Morse key to the “*Taste*” terminal; the headphones to the “*Kopfhörer*” terminal.
- Ensure that the power switch is on “*Aus*” (Off).
- Open the battery lid and insert two *B 4,5KZT5* batteries on top of each other, the first one with the battery contacts pointing down, the second with the battery contacts upwards. Close the battery lid. The installation is now ready for use.

To establish contact, use the *FF 33* field telephone to call the other party by turning the generator crank. Establish voice contact. Beware that the voice communication is not secure: “*Feind hört mit!*” Once contact has been established, switch the Sutel 40 on by moving the switch to the “*Ein*” position.

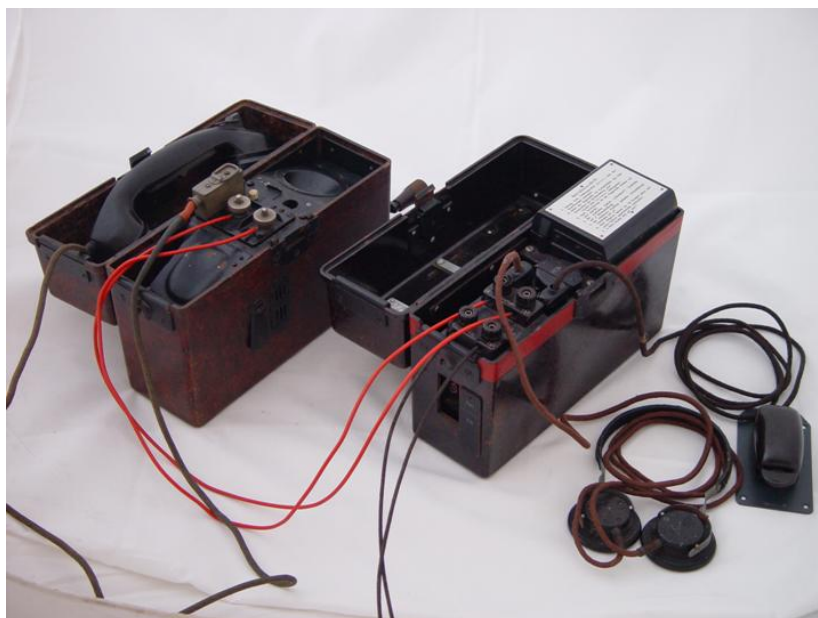


Figure 73: Sutel 40 set up with FF 33



Figure 74: B4,5KZT5 battery

Set the tone switch in the “*Ton I*” position (“*Ton I*” is the default switch position). To send message, use the Morse key to key the message. Morse code in a clear tone will be heard in the headphones of the sending station. Only one station can send while the other listens.

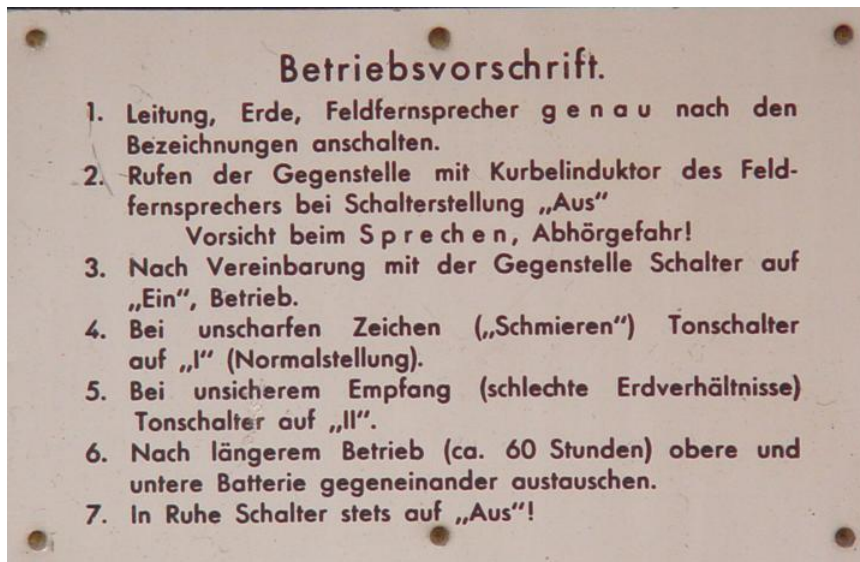


Figure 75: Sutel 40 operating instructions

At the receiving station the tone will also be heard. If the tone is unclear (“smudged”) the tone switch should be set to the “Ton I” position. When the signal drops away (due to bad connection or earth leakage), switch the tone switch to the “Ton II” position.

When the connection is finished, always switch off the DC wire telegraph to the



Figure 76: Sutel 40 ready to use

“Aus” position to avoid the batteries from draining. After 60 hours of operation, switchboard the top and bottom batteries. In the off position, the *FF 33* field telephones can be operated as normal.

Feld Fernschreiber

Development and Description

In 1929, Dr. Ing. Rudolf Hell applied for a patent for “a device for electric transmission of written characters”. Rather than using a Morse- or digital Baudot code to encode the letters, Hell represented each letter (or actually symbol) in a 7 by 7 grid, basically scanning the symbol column by column and transmitting it as a series of shorter and longer pulses.

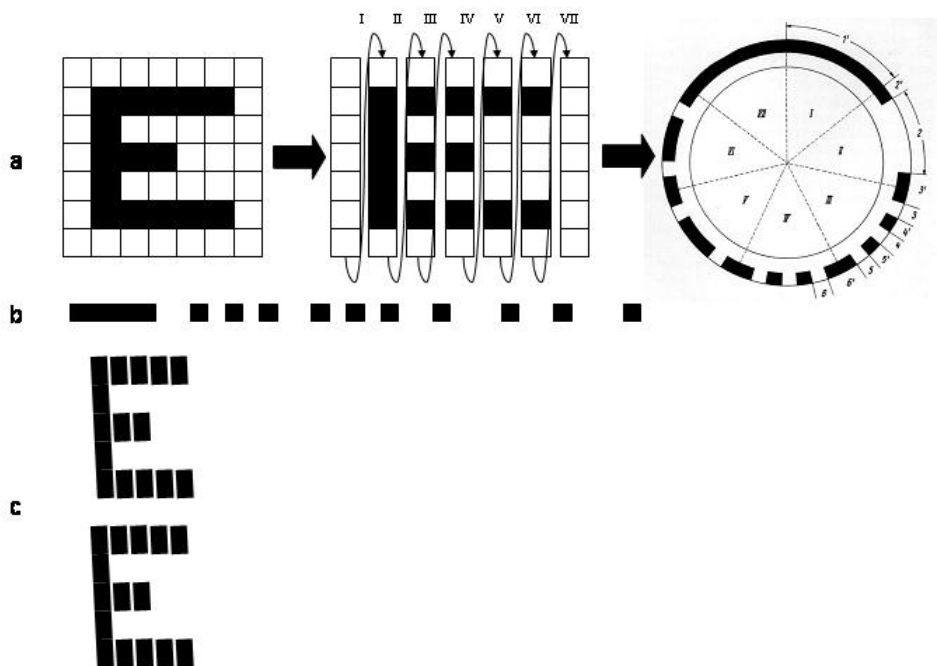


Figure 77: Principles of the Hell code

For example:

- a) Shows how the letter “E” is placed in the 7 x 7 grid, how the coding sequence is formed and how “E” is represented on the coding cylinder
- b) Shows the pulse sequence for the letter “E” which can be transmitted.
- c) Shows how the letter is received and printed onto a paper strip

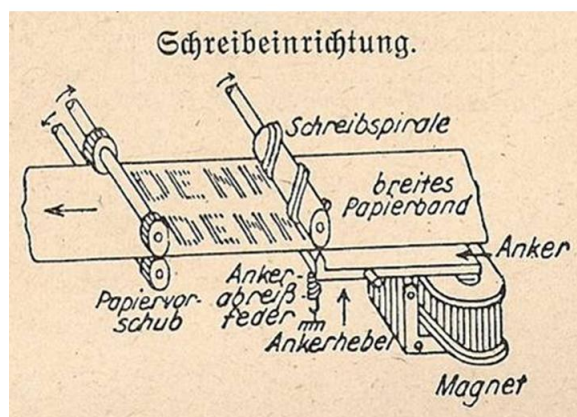


Figure 78: Printing unit principles

In 1932 Hell demonstrated a second key feature of the *Feldfernschreiber*: a helical worm wheel printing system which allowed the symbols to be printed on a strip of paper. In this system a worm wheel is wetted with ink and is turning just above a 15 mm wide paper strip which is moving at a right angle under the wheel at one seventh of the speed of the worm wheel. A strip under the paper pushes the paper upwards against the worm wheel in time with the pulses of the transmission. Each time that the paper and worm wheel touch, ink will be transferred onto the paper. For example the long pulse of the letter “E” will thus result in a vertical stripe, followed by three short

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stripes next to it etc. (due to the constant movement of the paper the letter will appear slightly slanted). In fact the helix winds around the worm wheel twice, resulting in two simultaneous contact points which causes the letter to be printed twice, one above the other.

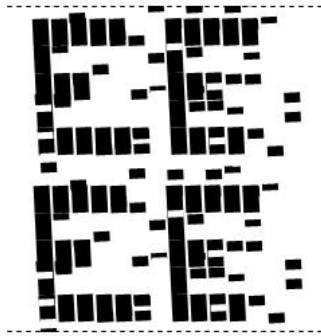


Figure 79: Interference

There are two major advantages to the Hell system. First of all, it is very robust against interference. Interference causes the symbols to become smeared or fuzzy. Since the human brain is very good at pattern recognition, most people will still recognise the fuzzy characters, especially when placed in the context of a word. This clever use of this human capability allowed the Hell system to function with bad signal to noise ratios.

The second advantage of the Hell system is that transmitter and handset do not have to be synchronised. If a symbol starts printing late in relation to the position of the worm wheel, the letter will “run off” the bottom of the paper strip but at the same time it will appear again at the top. Because of the double printing of each symbol, there will always be a complete symbol printed on the paper. Speed differences between the transmitter and handset will result in the text to slant upwards or downwards. The operator can quite simply adjust the engine speed to make the text run horizontal again.

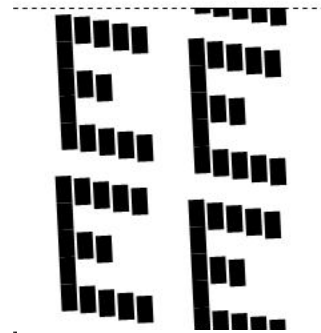


Figure 80: Loss of synchronisation



Figure 81: Siemens-Hell-Feldfernsehreiber

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When the design of the system was optimised by Dr. Ing Rudolf Hell, the Siemens firm prepared the system of mass production with the *Siemens-Hell-Feldfernschreiber* developed in 1933 with the first machines entering military service in 1935.

The *Feldfernschreiber* is consists of five main parts:

1. Code generator with keyboard
2. Printing system
3. Motor system
4. Base unit with gear system, paper storage and paper drive mechanism
5. Amplifier

The code generator consists of a coding cylinder, where each symbol is represented by areas of conducting and insulating material. The cylinder rotates with a speed of 2.5 revolutions per second, allowing a communication speed of 2.5 symbols per second. An interlocking mechanism allows a single key on the keyboard to be depressed in synchronisation with the turning cylinder. When a key is depressed, the related contact will be pressed against the rotating cylinder resulting in the electrical



Figure 82: Keyboard and code generator

pulse sequence of the selected symbol.

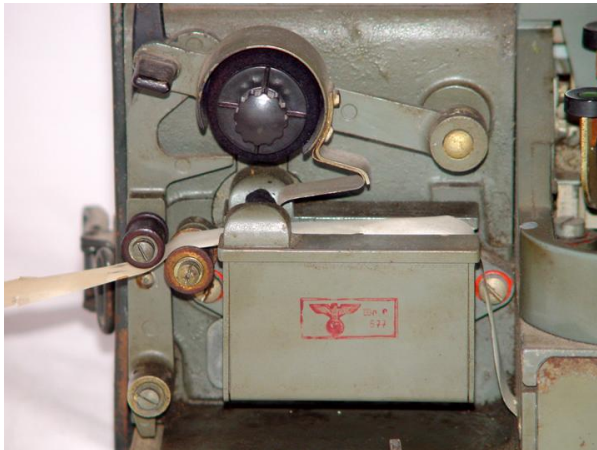


Figure 83: Printing unit

The printing system consists of a worm wheel which is wetted by an ink roll. A paper strip is passed between this worm wheel and a contact strip underneath. The contact strip is pushed upwards by an electromagnet in time

with the pulses, pushing the paper against the worm wheel and printing the symbol as described before.

The Motor system consists of a 12 V DC electromotor which is turning at a constant 3600 revolutions per minute. An electromechanical governor ensures that the motor speed can be tuned slightly so that two machines can be synchronised. The motor also drives a generator supplying 150 V to the amplifier. To allow the governor to work, the “natural” speed of the motor is designed to be much higher than 3600 rpm, so it constantly needs to be braked to run at the correct speed. The motor contains



Figure 84: Motor unit

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an extra field winding, the “regulator field” to bring it down to the correct speed. When the speed rises, the governor contact will close and the regulator field will be powered. This will cause the motor to decelerate quickly until the governor contact opens, causing the motor to speed up again. To avoid the governor contacts to wear quickly, an electronic regulator valve is used to drive the regulator field.

The motor drives the code generator, the printing system and the paper supply via a gear system so that they are always perfectly synchronised on a single machine: The writing on the transmitting machine itself will always be perfectly horizontal on the paper strip.

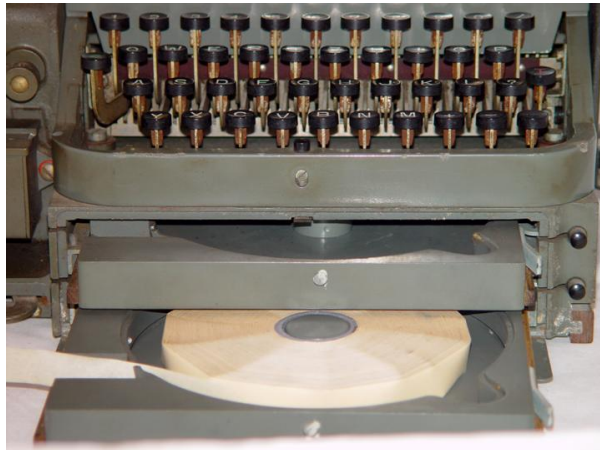


Figure 85: Keyboard unit with paper drawers constant speed between the worm wheel and contact strip.

Paper rolls are kept in two paper drawers situated under the keyboard. The 15 mm wide paper strip passes through a slit to the printing system where the paper is fed with a



Figure 86: Amplifier unit

The Amplifier unit contains a 900 Hz oscillator, an amplifier, a rectifier and a regulator for the motor speed control. The Figure below shows the *Feldfernschreiber* connected to a wireless receiver and how the principle signals are amplified and rectified to drive the electromagnet in the printing system.

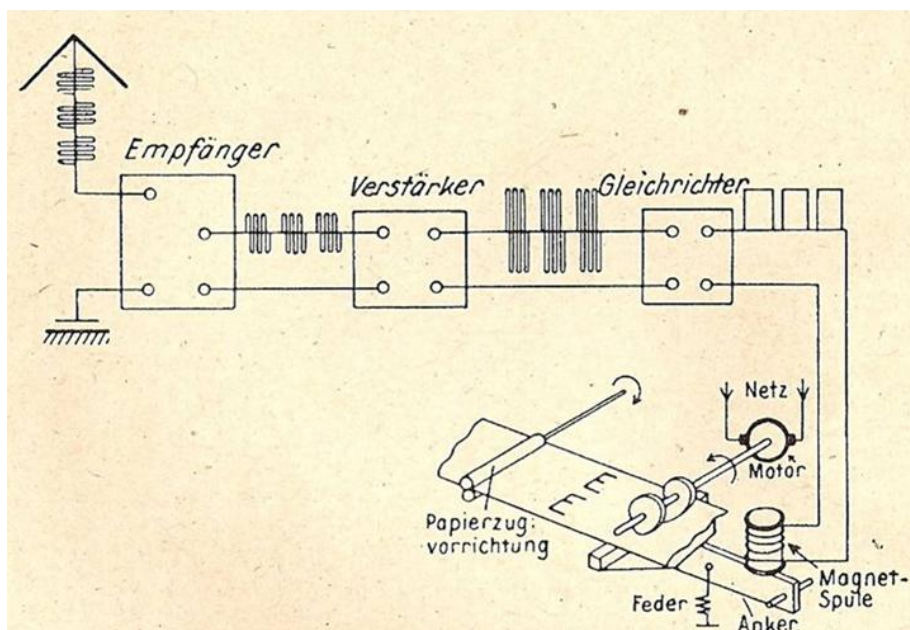


Figure 87: Operating principles of the amplifier (connected to a radio receiver)

In the schematic in figure 57, “G” is the coding cylinder, the 900 Hz signal is modulated by the symbol pulses and send to a phone line via a transformer. At the same time the signal is fed (via an adjustable gain control called “*Verstärkung*” and another transformer) to the first stage of the amplifier. The output of this amplifier is fed to another transformer which allows the signal to be monitored via a headset (“*mithören*”). The signal is then rectified (filtering out the 900 Hz tone) so that just the symbol pulses are fed to the second stage amplifier, which in turn drives the electromagnet of the contact strip in the printing system (14).

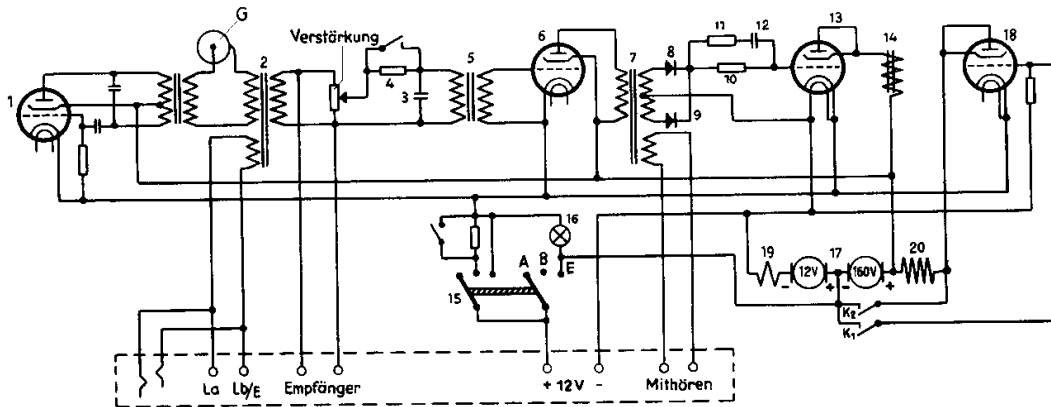


Figure 88: Feldfernschreiber circuit diagram

Mechanically the *Feldfernschreiber* contains two main units in one box:

- 1) The Keyboard unit comprising the code generator, printing system, motor, gearbox and paper supply:



Figure 89: Keyboard unit

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The keyboard unit can be pulled out of the box by about 8 cm to allow easy access to the keyboard, printing unit and speed control. Two paper trays are placed under the keyboard, normally hidden from view behind a lid. Left of the keyboard is the printing unit which is screwed against the gear housing with two screws. The motor is placed on top of the gearbox housing. The governor can be controlled by turning to top end of the motor unit, a graded scale allows for precise adjustment.

2) The Amplifier unit which unites all electronics, controls and terminals:



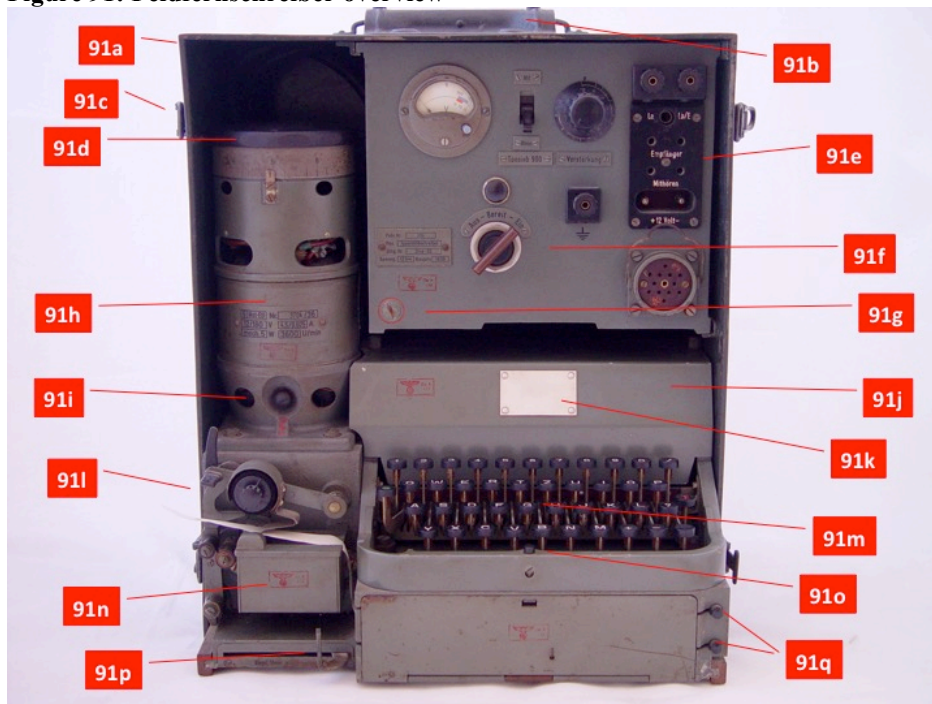
Figure 90: amplifier unit

- More or less centrally placed on the front panel has the main operating switch (“Aus / Bereit / Ein” or Off / Standby / On) with a control light placed over it.
- Top left sits a voltage instrument to check the 12 V supply voltage and the 150 V anode voltage for the amplifier.
- Next to the instrument is a “Tonsieb 900” or 900 Hz filter switch (“Mit / Ohne” or With / Without) which allows for filtering of the amplifier input signal.
- Next to the filter switch is the “Verstärkung” or amplification control knob which allows the signal strength going into the amplifier to be controlled.
- Top right of the control panel sits a bakelite termination panel. Two telephone line terminals (“La” and “Lb/E” as with a *FF 33* field telephone”), a jack for a telephone interconnection cord, a two-pin jack for a “Empfänger” or radio handset, a two-pin jack marked “Mithören” (headphone connection) and finally the two-pin male power supply jack marked “+ 12 Volt -”.
- Bottom right sits a round 12 Pin jack, which allows for the connection of accessories such as a transmitter keying unit or a calling unit.

One locking screw holds the amplifier unit in place, undoing this allows the unit to be pulled out of the box for access to the electronic valves.

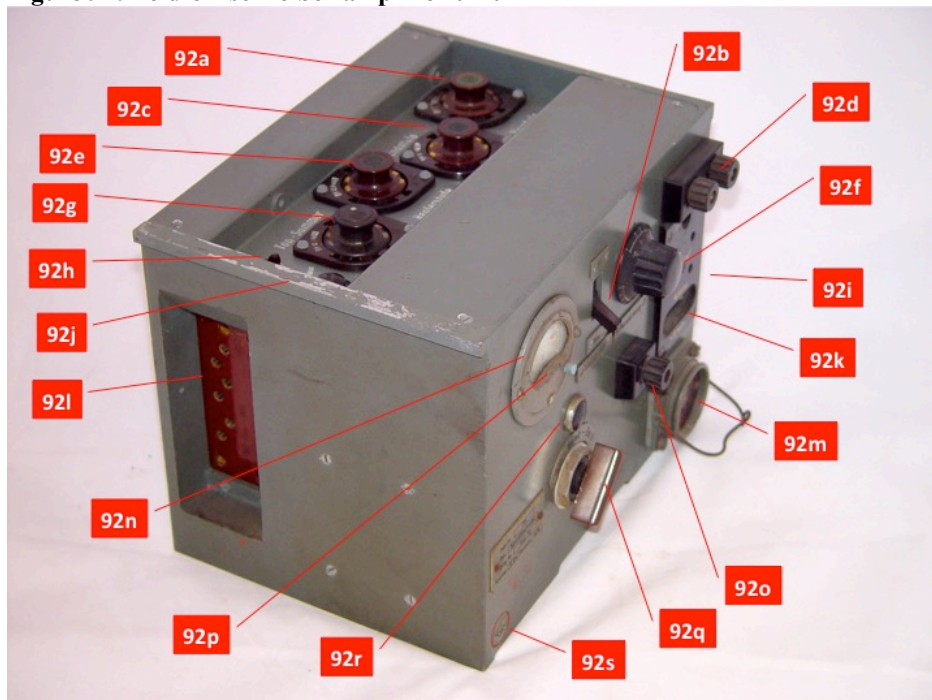
Construction

Figure 91: Feldfernschreiber overview



- | | | |
|---------------------------------|-------------------------------|---------------------------------|
| 91a Outer casing | 91g Amplifier unit lock screw | 91m Keyboard |
| 91b Carrying handle | 91h Motor unit | 91n Printing unit |
| 91c Locking handle for lid | 91i HV brush cover | 91o Paper compartment release |
| 91d Speed adjustment | 91j Coding unit cover | 91p Keyboard unit slide lock |
| 91e Electrical connection panel | 91k Writing tab | 91q Paper drawer release button |
| 91f Main switch | 91l Ink roll lock mechanism | |

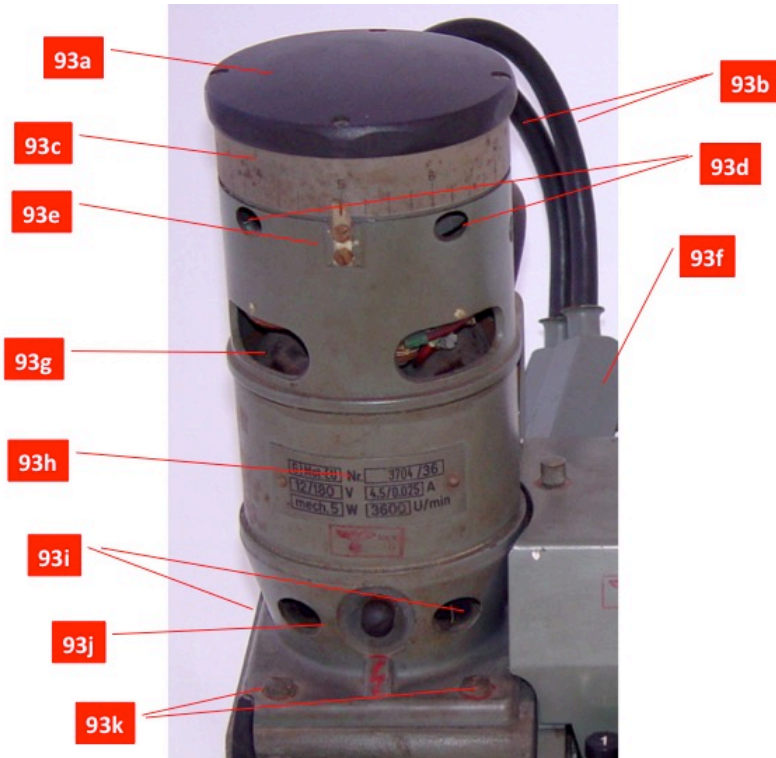
Figure 92: Feldfernschreiber amplifier unit



- | | | |
|---------------------------------|---------------------------------|--------------------------------|
| 92a First stage amplifier tube | 92g Oscillator tube | 92m Auxiliary equipment socket |
| 92b Filter switch | 92h Power supply filter switch | 92n Volt meter |
| 92c Second stage amplifier tube | 92i Electrical connection plate | 92o Earth connection |
| 92d Line connection terminals | 92j Fuse | 92p HV test button |
| 92e Motor speed regulator tube | 92k Power supply socket | 92q Main switch |
| 92f Amplification control | 92l Keyboard unit connections | 92r Standby light |

92s Locking screw

Figure 93: Feldfernschreiber motor unit

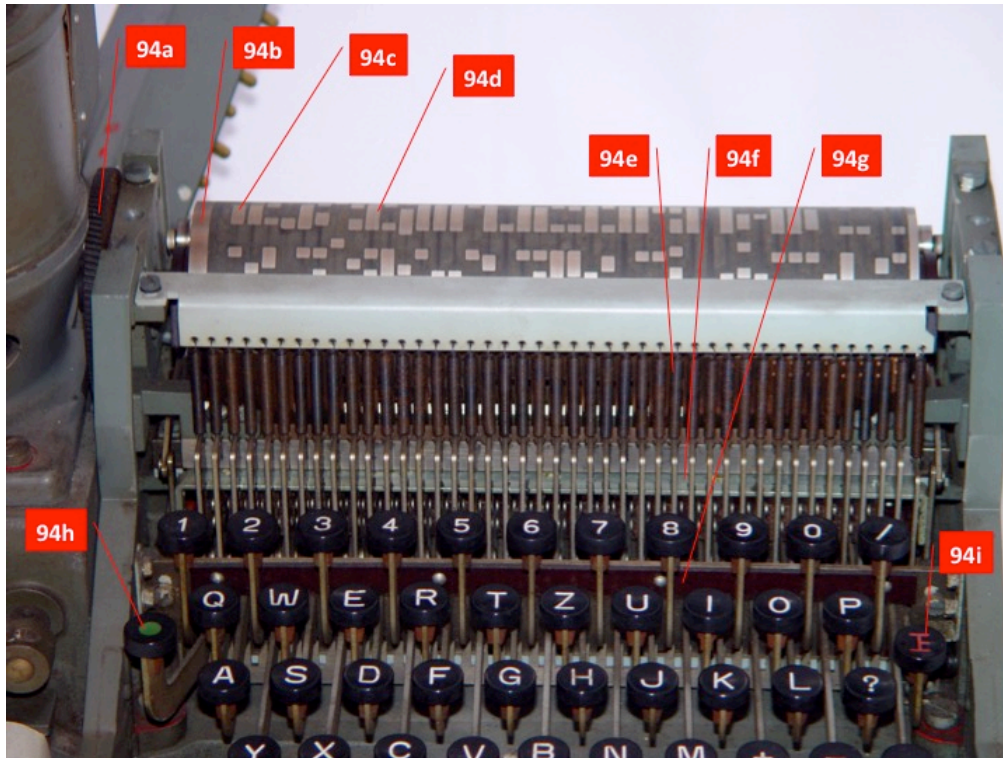


93a Speed adjustment wheel
93b Connection cables
93c Speed scale
93d Ventilation holes

93e Speed scale dial
93f Connection plugs
93g Access to LV brushes
93h Date plate

93i Ventilation holes
93j HV brush lock screw
93k Motor unit mounting screws

Figure 94: Feldfernschreiber keyboard and coding unit

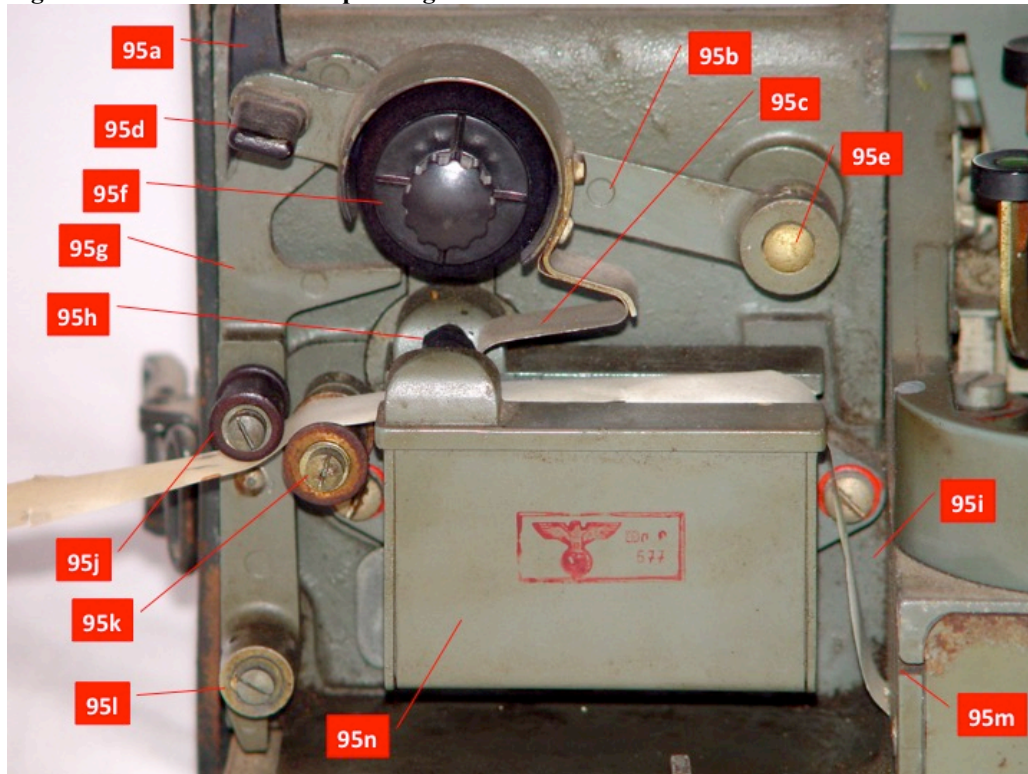


94a Code wheel driving gear
94b Code wheel mass contact
94c Isolated area
94d Conducting area

94e Key return spring
94f Contact and locking mechanism
94g Key

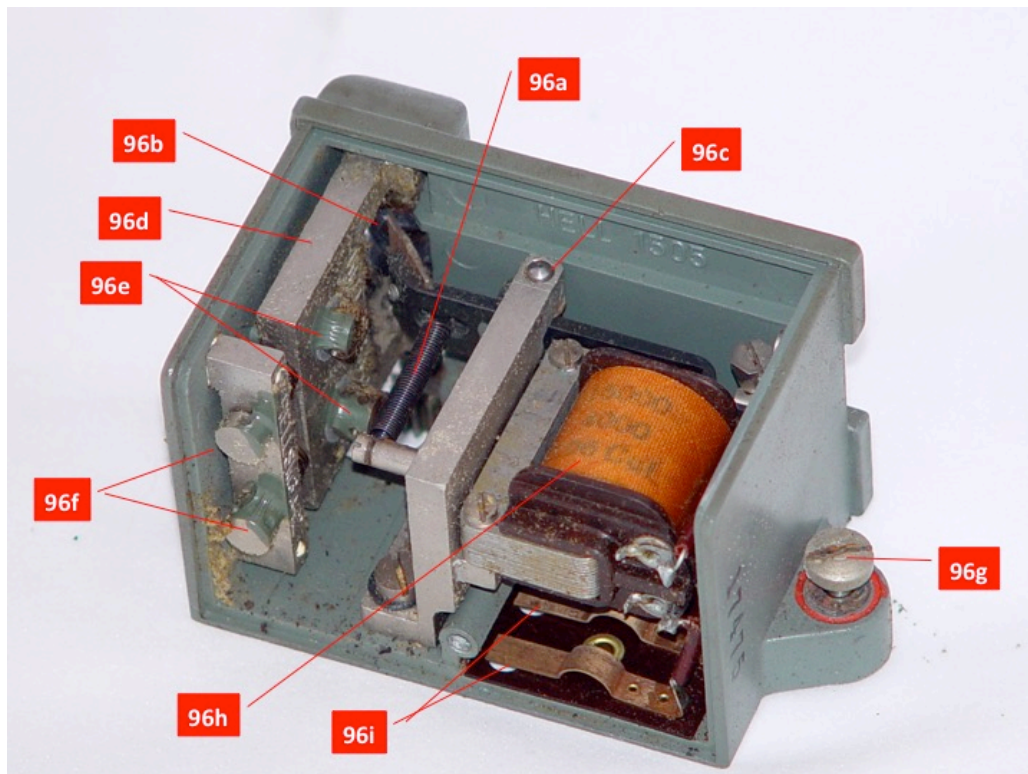
94h Morse key (green dot)
94i Pause key

Figure 95: Feldfernschreiber printing unit



- | | | |
|--|-------------------------|-----------------------------|
| 95a Locking fork handle | 95f Ink role | 95l Locking fork connection |
| 95b Ink role suspension arm | 95g Locking fork | 95m Paper feed slot |
| 95c Paper tensioning spring | 95h Worm wheel | 95n Print unit housing |
| 95d Suspension arm handle | 95i Paper feed | |
| 95e Ink role suspension arm connection | 95j Paper idle wheel | |
| | 95k Paper driving wheel | |

Figure 96: Feldfernschreiber printing unit internal view



- | | | |
|--------------------------|--------------------------------|------------------------|
| 96a Contact strip spring | 96e Worm wheel side adjustment | 96h Electromagnet coil |
| 96b Contact strip | 96f Worm wheel height adjust. | 96i Electric contacts |
| 96c Contact strip pivot | 96g Fastening screw | |
| 96d Worm wheel mounting | | |

Operation

To set up a *Feldfernshreiber* link, two *Feldfernschreiber*, two 12 V batteries or power supplies and a telephone link are required. As with the *FF 33*, a two wire connection or a single wire connection with Earth return can be used.



Figure 97: Feldfernschreiber ready for use

The *Feldfernschreiber* can also be operated over a radio link. In this case a keying unit, or a transmitter prepared to work with the *Feldfernschreiber* must be employed such as the *15 W.S.E.b* or the *AS 59*. In this chapter however, only operation over a telephone line will be described in this section.

- Set up the *Feldfernschreiber* by opening the case and set up the keyboard unit by pulling the keyboard sliding lock lever to the left and pulling out the keyboard.
- Connect the 12 V supply to the “+ 12 Volt –“ socket on the amplifier unit.
- Connect the telephone wires to the “La” or “Lb/E” terminals as with a normal *FF 33* field telephone. The unit can also be connected to an existing field telephone net by connecting the *FF 33* and *Feldfernschreiber* with a telephone interconnection cable.
- Apply some water to the ink roll or if necessary apply new ink.
- Check the paper supply and lead the paper strip through to the printing unit, underneath the worm wheel and between the driving wheels.
- Ensure that the ink role locking fork is placed in the up position.
- Plug a headset into the “Mithören” jack.
- Place the “Tonsieb 900” switch in the “Ohne” position.
- Place the main switch on “Bereit” or Standby, you are now ready to operate the *Feldfernschreiber* link.

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The *Feldfernschreiber* does not have a calling facility so the two stations will have to agree operating practices beforehand, for example that station A always calls station B first and fixed operating times should be agreed. If the equipment is used on an existing field telephone connection, contact can be made with the *FF 33* field telephones first after which a switch is made to *Feldfernschreiber* operation.



Figure 98: Feldfernschreiber plugged into an existing field telephone line

If station A wants to establish connection, it switches on the *Feldfernschreiber* by moving the main switch to the “*Ein*” (On) position. The motor will now start turning. Press the Pause key (with a red “E” symbol). This key will stay locked down and the machine will automatically keep sending the pause symbol.

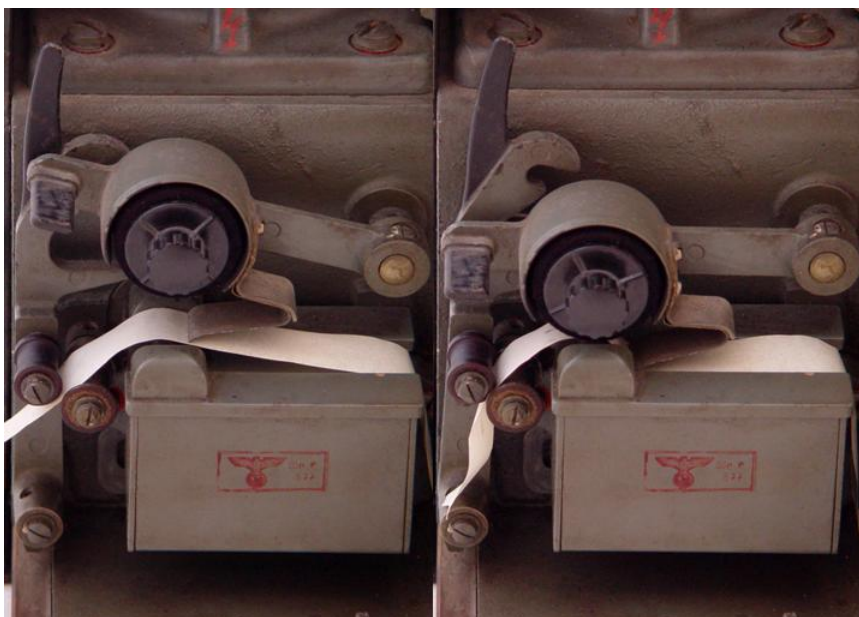


Figure 99: Ink roll in standby (l) and printing (r) position

Station B will also switch on the machine at the allotted time and will be listening for the Pause key signal with the headset. When the signal is received, station B will start printing by moving the ink role locking fork in the down position.

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The paper strip will start moving through the printing unit and the pause symbol should appear. The Operator of station B will now adjust the speed control (by turning the top adjustment ring of the motor) so that the symbols are printed horizontally on the paper. He will now adjust the “Verstärkung” control on the amplifier so that the clearest contrast of the printed symbols is established.

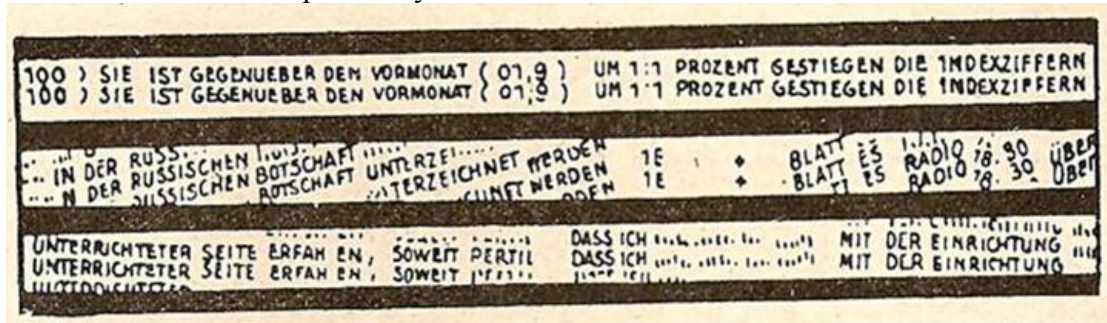


Figure 100: Properly synchronized (top), fast (middle) and slow (bottom) reception

After a few minutes of sending the Pause symbol, station A will open the communication by for example sending “Station B Station B from Station A KKKKK” (K is the telegraph code for “over”). During sending the stations can choose not to print the outgoing message by lifting the print role fork in the up position.

Station B will replay “Station A Station A reception good, KKKKK”. This will allow station A to adjust the “Verstärkung” control to maximise the contrast of the printing (speed should not have to be adjusted since station B has already synchronised the two stations). Now the messages can be switchboard between the two stations. The communication can be ended by sending “SKSKSK”. The machines can now be returned to the standby position “Bereit” with the ink role locking fork in the up position.

If required, the paper strips with the message can now be glued to a message form and handed to the recipient of the message.

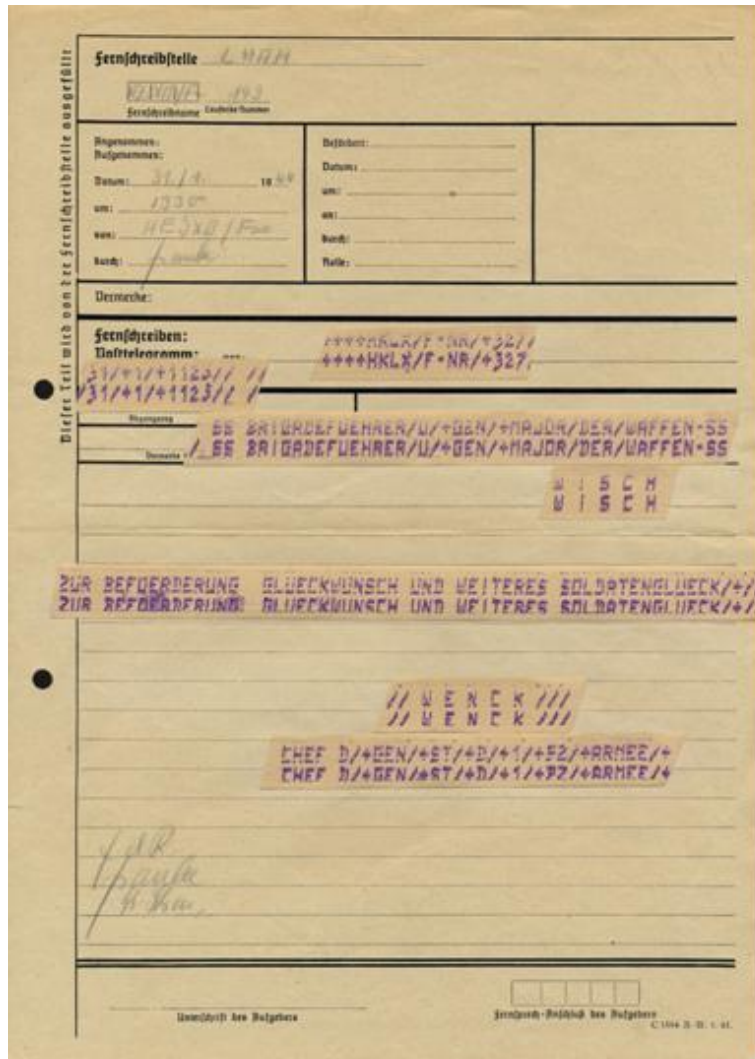


Figure 101: Feldfernschreiber message

Field Telephone switchboards

Introduction

Field telephones were not just used for point to point communication; extensive networks were built allowing commanders to reach the frontline positions of all units under their control.

A key element to link telephones into networks is the telephone switchboard, a unit that allows a particular line to be connected with all other lines in the network. The German Armed Forces developed equipment that could link from two to hundreds of lines and could link field telephone networks into existing public telephone networks.

Telephone switchboard unit *Vermittlungskästchen*

Development and description



Figure 102: Complete Vermittlungskästchen

By itself a *Vermittlungskästchen* is not very useful, but when two to ten units are connected side by side a telephone switchboard of flexible size can be created. It operates on a “single interconnection cord” principle, where each telephone line has its own interconnection cord.

The exact date of its development is unknown, but since the manufacturing dates of inspected switchboard units mostly fall in the late 1930's, it is not unreasonable to assume that it was developed in the early 1930's together with the new generation of field telephone equipment.

The *Vermittlungskästchen* is a basic single unit containing all components required to service a single field telephone connection. The *Vermittlungskästchen* consists of two parts: a wooden box containing a “Kellogg¹” switch, all connection terminals and an interconnection cord and secondly a indicator relay housed in a black metal case. The indicator relay plugs into the top of the wooden box.



Figure 103: Small exchange using Vermittlungskästchen

¹ Milo G. Kellogg held several senior positions in U.S. telephone operating and manufacturing companies in the late 19th century. In 1897 he set up his own manufacturing firm, Kellogg Switchboard & Supply Company. He held more than 150 patents, and he had invented and patented the Divided Multiple telephone switchboard. His name is often misspelled as “Kellog” in the German Armed Forces literature,

A single *Vermittlungskästchen* could be carried in a leather pouch on the belt.



Figure 104: Vermittlungskästchen in carrying pouch

They were also supplied in a box of five units. Mounted on top of the box, the units form a neat five-line telephone switchboard.

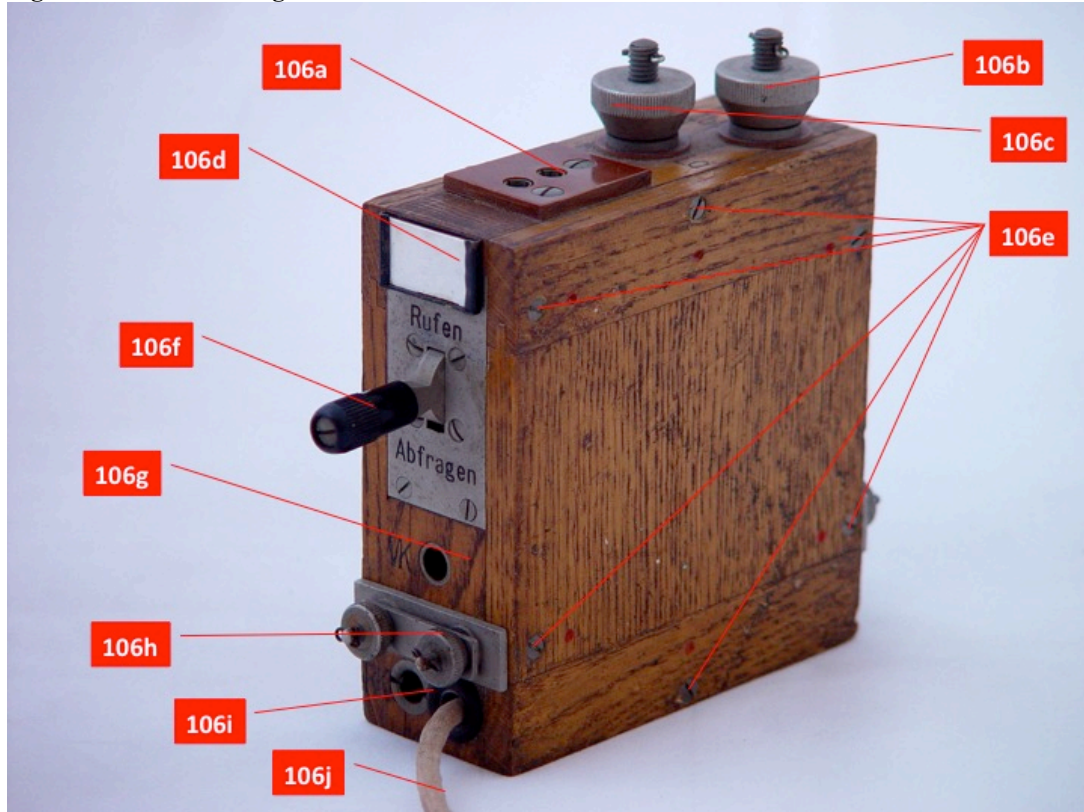


Figure 105: Five Vermittlungskästchen in box forming a five line exchange

Photographs of the *Vermittlungskästchen* in action are relatively rare. It is assumed that the small 10-line field switchboard was issued and used in preference for most field use.

Construction

Figure 106: Vermittlungskästchen outside view



106a Indicator relay socket

106b Lb/E connection terminal

106c La connection terminal

106d Writing tab

106e Screws to open housing

106f Kellogg switch

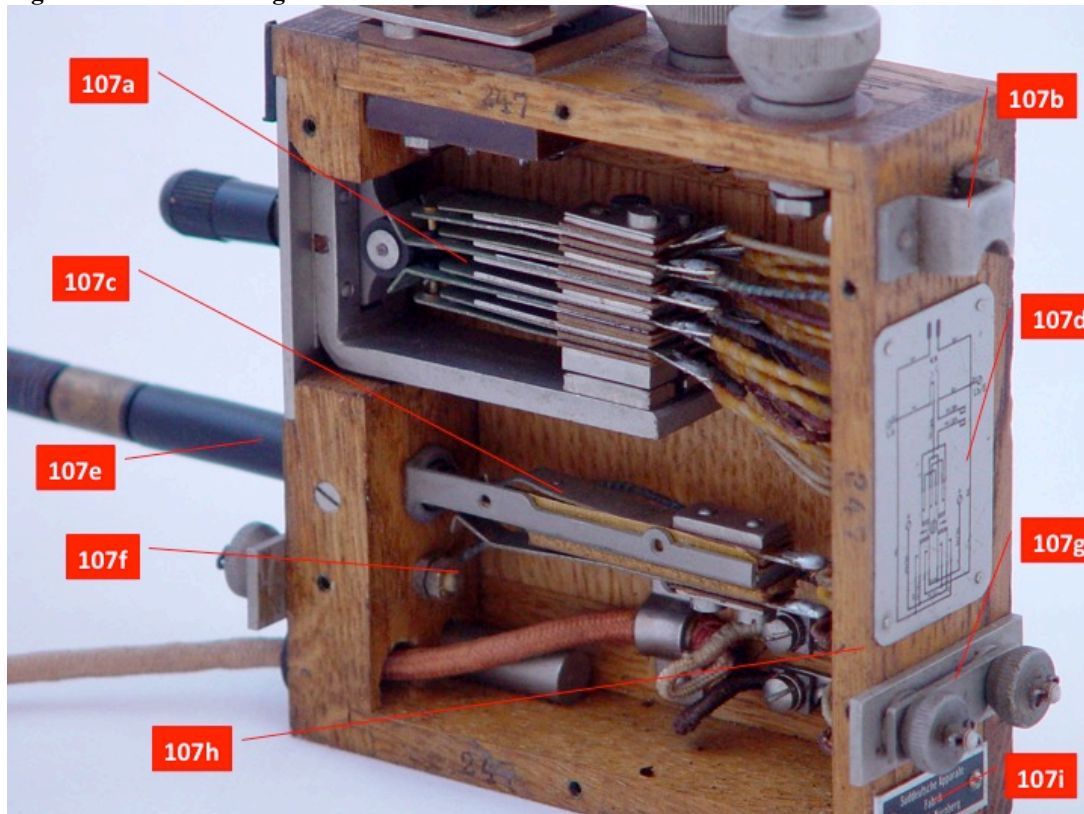
106g Interconnection cable socket

106h Front interconnection strip

106i Interconnection plug storage

106j Interconnection cable

Figure 107: Vermittlungskästchen internal view



107a Kellogg switch contacts

107b Suspension lug

107c Interconnection socket contacts

107d Schematic

107e Interconnection plug

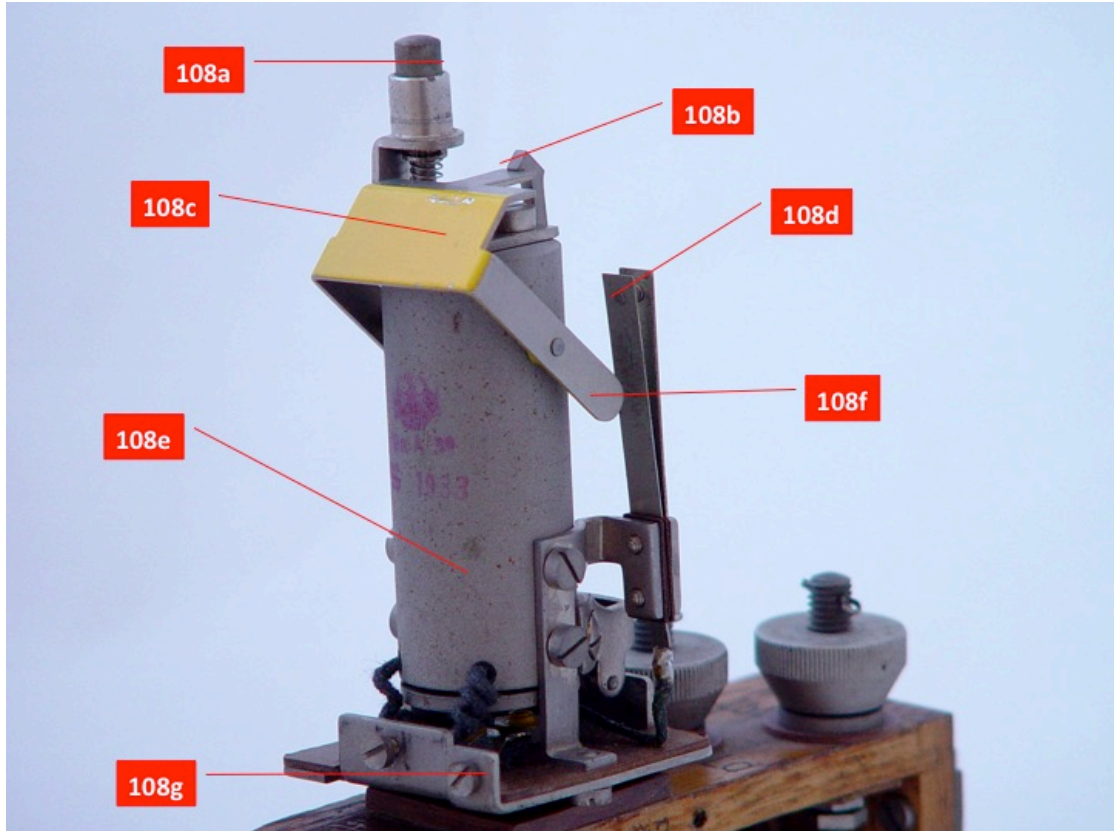
107f Front interconnection strip contact

107g Rear interconnection strip

107h Interconnection cable connection

107i Maker label

Figure 108: Vermittlungskästchen indicator relay internal view



108a Reset button

108b Indicator relay yoke hook

108c Indicator flap

108d External bell contact

108e Indicator relay coil housing

108f Lever to operate external bell contact

108g Front external bell connection

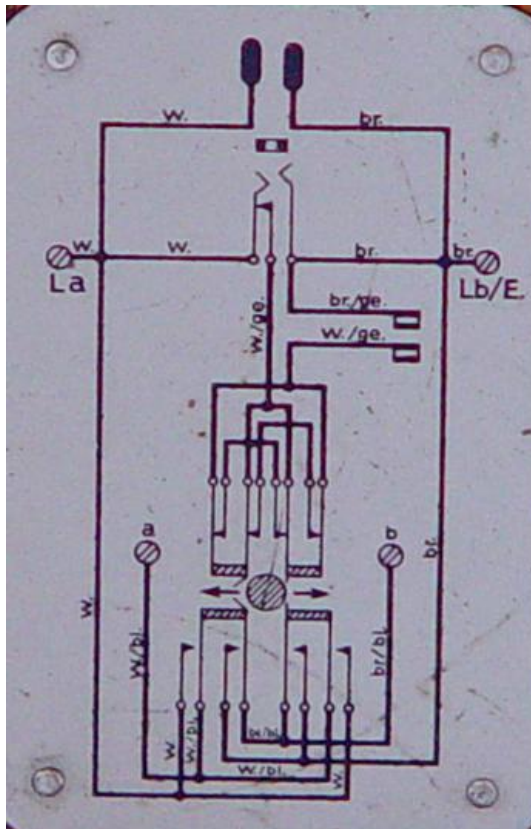


Figure 109: Vermittlungskästchen schematic

Operation

To build an switchboard using the *Vermittlungskästchen*, two to ten units are required plus a *FF 33* field telephone.

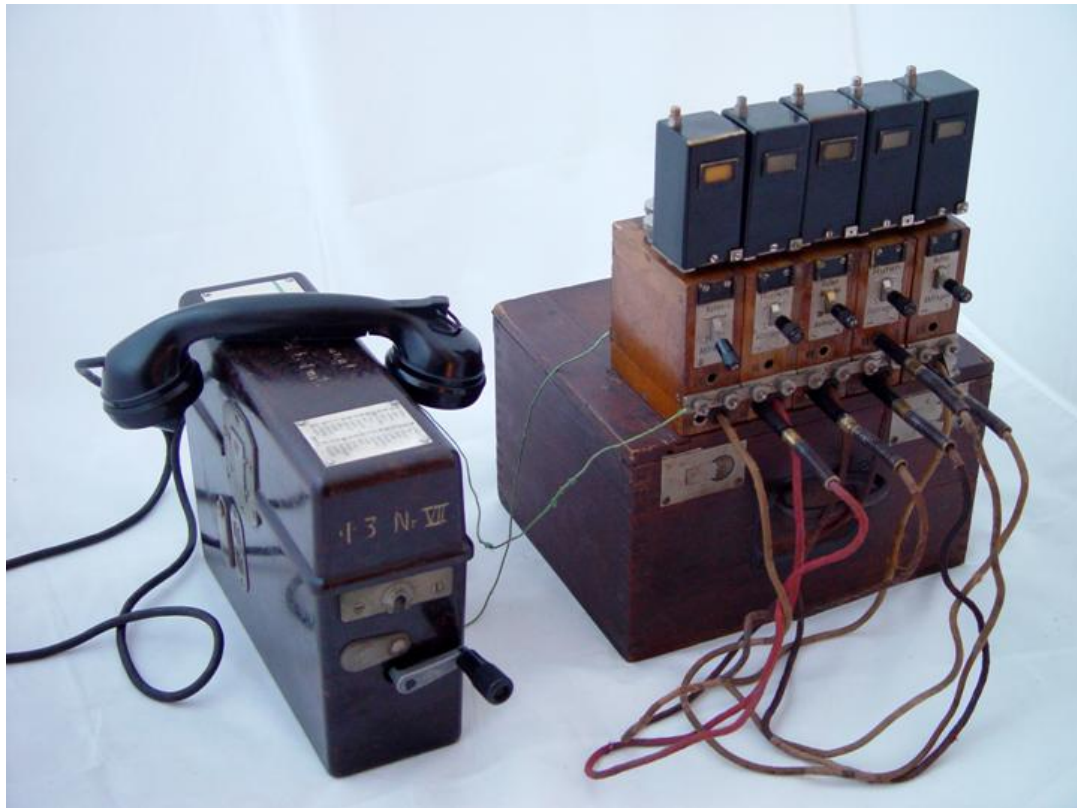


Figure 110: Small exchange ready for use

- Place the *Vermittlungskästchen* next to each other and interconnect them using the front and rear interconnection strips.
- Place the Indicator relays on top of each *Vermittlungskästchen*. (If required an external bell or light can be used by connecting the front and back switch contact of the indicator relays to a battery and bell circuit).
- Reset all the indicator relays.
- Connect the telephone lines to the “La” and “Lb/E” contacts as with a normal field telephone.
- Place the interconnection cable plugs into their storage sockets.
- The names or codes for the individual telephone lines can be written on the writing tabs.
- Set up the *FF 33* field telephone next to the switchboard and connect the phone’s “La” and “Lb/E” terminals to the front and rear interconnection strips of the nearest *Vermittlungskästchen*.

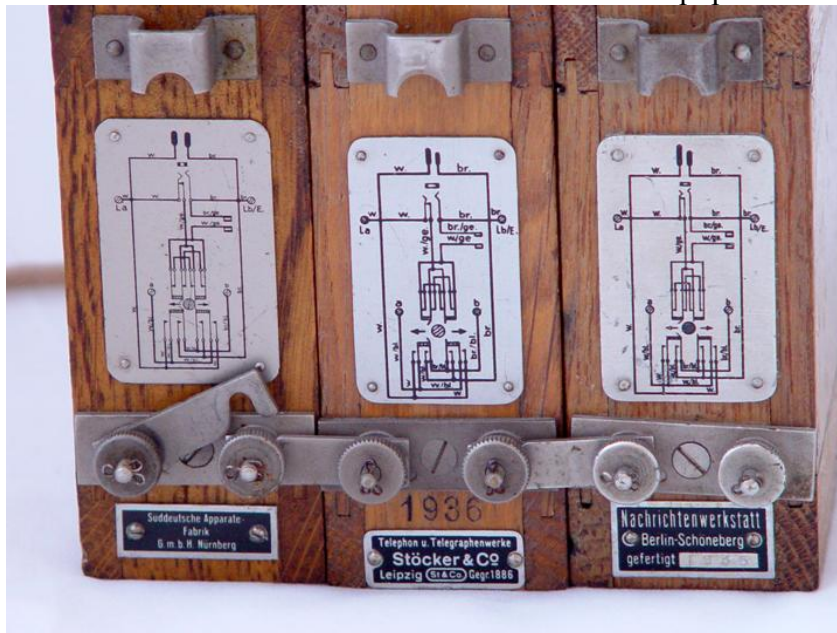


Figure 111: Strips interconnecting the Vermittlungskästchen



Figure 112: Kellogg switch to the "Abfragen" position

If an incoming call is received, the indicator relay will drop, a yellow flag will appear behind the window of the indicator relay. Move the Kellogg switch to the "Abfragen" position, the operator can now speak to the caller



Figure 113: Yellow flag to indicate incoming call

(while depressing the microphone switch in the field telephone handset as usual). When the caller has indicated to which other line he wishes to be connected, depress the Kellogg switch of the requested unit to the "Rufen" position and turn the generator handle of the FF 33. This will ring the bells of both the telephone on the far end and at the switchboard. Connect the interconnection cable of the incoming unit to the "Vk" socket of the outgoing unit to establish the connection. Reset the indicator relay and return the incoming Kellogg switch to the middle position.

At the end of the call, one of the two users has to turn the generator handle of their telephone, this will drop the indicator relay flag of the incoming *Vermittlungskästchen*. The operator now removes the interconnection cable plug from the "Vk" socket of the outgoing unit and replaces it in its storage socket. Reset the indicator relay to prepare the switchboard for the next call.



Figure 114: Interconnection cable plugged into the "Vk" socket

10 line switchboard OB 17

During the First World War a number of different field switchboards were used by the German army. The “*Klappenschrank OB 05*” (OB = *OrtsBatterie* = local battery) was available in 3, 5, 10 and 20 line versions which were meant to be replaced in 1918 by the “*Feldklappenschrank OB 17 zu 10 Leitungen*”. The end of hostilities prevented the OB 17 to be used operationally during the First World War but the type remained in production during the interwar years until it was replaced by the new type 10-line switchboard in 1933. The type remained in production until at least 1937.



Figure 115: OB 17 exchange in transport configuration

The name “*Klappenschrank*” or indicator flap cabinet refers to the way the incoming calls are shown. When the ringing signal comes in, a relay is powered that releases a small indicator flap. When the flap is down, the line number becomes visible allowing the operator to take action.

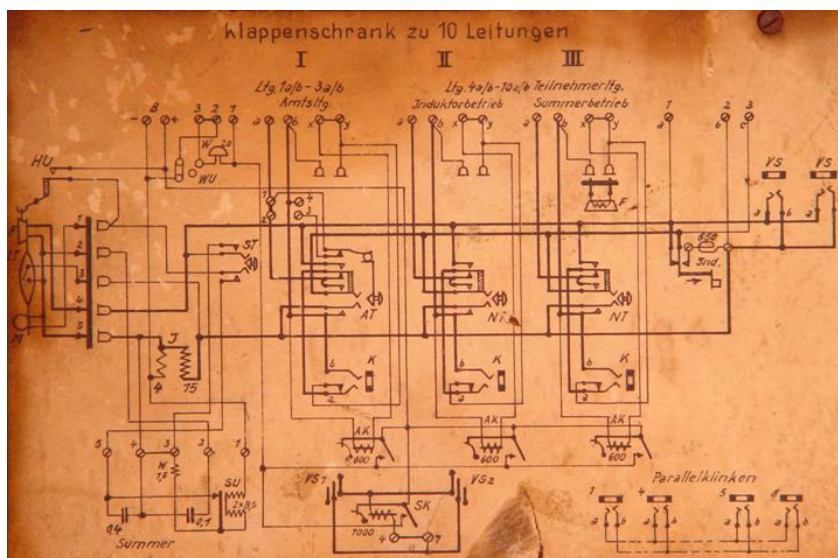


Figure 116: OB 17 Schematic

The OB 17 used a two-cord interconnection system. In this system the incoming and outgoing lines are connected using a pair of interconnection cables. A total of 8 interconnection cables was available on the OB 17, meaning it could make 4

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connections at the same time. Each cable pair is connected to a separate indicator flag, allowing the end of the call to be signalled to the switchboard. So the *OB 17* has 10 indicator flaps for the incoming lines plus an additional four (red marked) flaps for the end-of-call signalling.



Figure 117: OB 17 with the top connection panel exposed

The *OB 17* has an internal ring tone generator as well as a buzzer. The buzzer could be used in situations where the ring tone might cause problems, for example where the telephone was in hearing distance of enemy positions. In this case, the telephone could be called by using the buzzer, which would cause a loud noise in the handset of the telephone. The *OB 17* is also equipped with a DC alarm bell. When one of the indicator flap relays drops, an auxiliary contact will be closed which will cause the bell to ring. A headset can be connected directly to the *OB 17* and it has its own microphone transformer. An external battery (*Ortsbatterie*) is required to operate the microphone, buzzer and DC alarm bell. Normally a 4.8 Volt battery could be used.

The first three incoming lines could be adapted for connection to a “ZB” (*Zentralbatterie Betrieb* or central battery operation) or “SB” (*Schlusszeichen Betrieb*) network. A number of levers would have to be reset and jumpers would have to be replaced with capacitors or inductions to avoid shorting out the “ZB” battery.

All four lines could be connected to a common “conference” connection so that more than two phones could be connected to a single call.

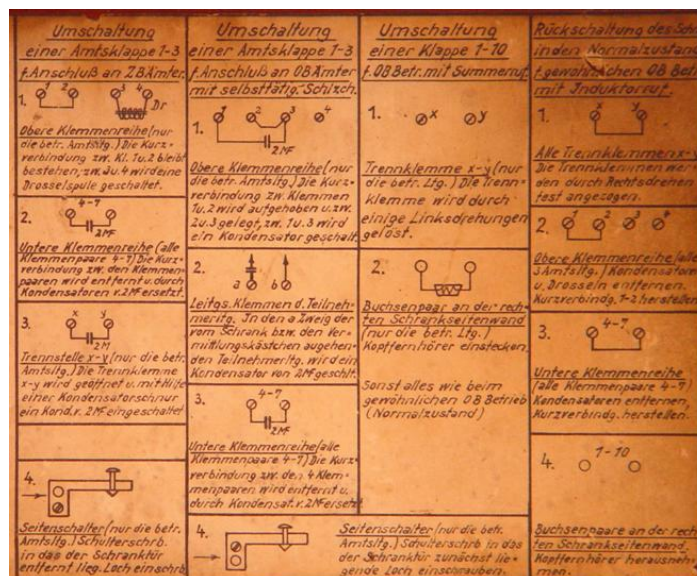
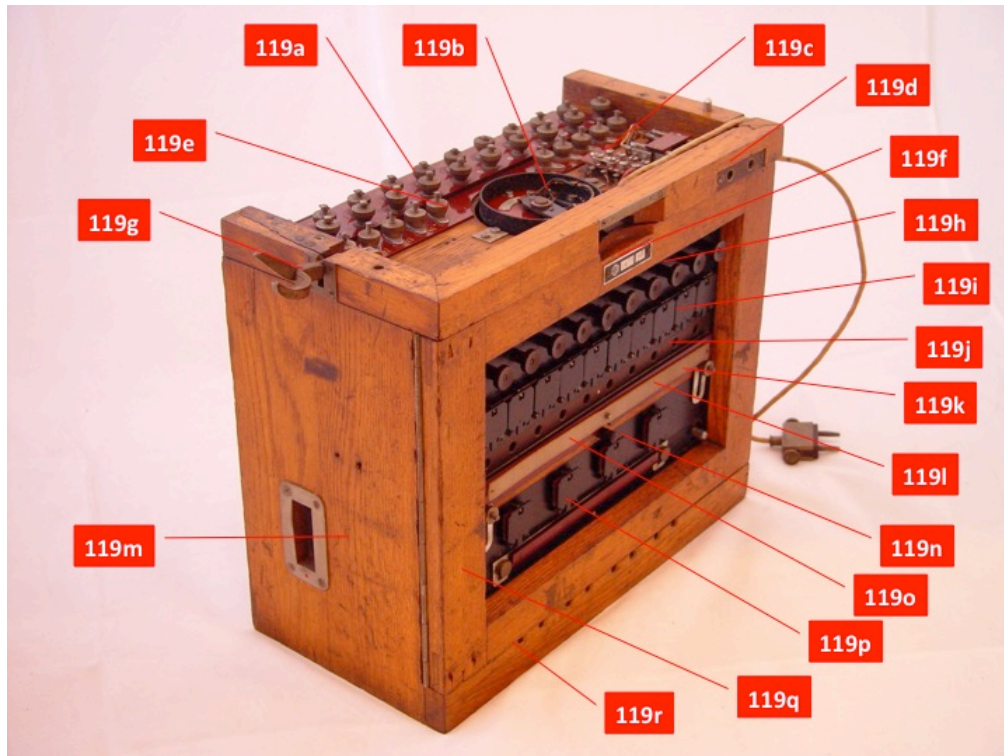


Figure 118: OB 17 jumper configuration for connection to different public networks

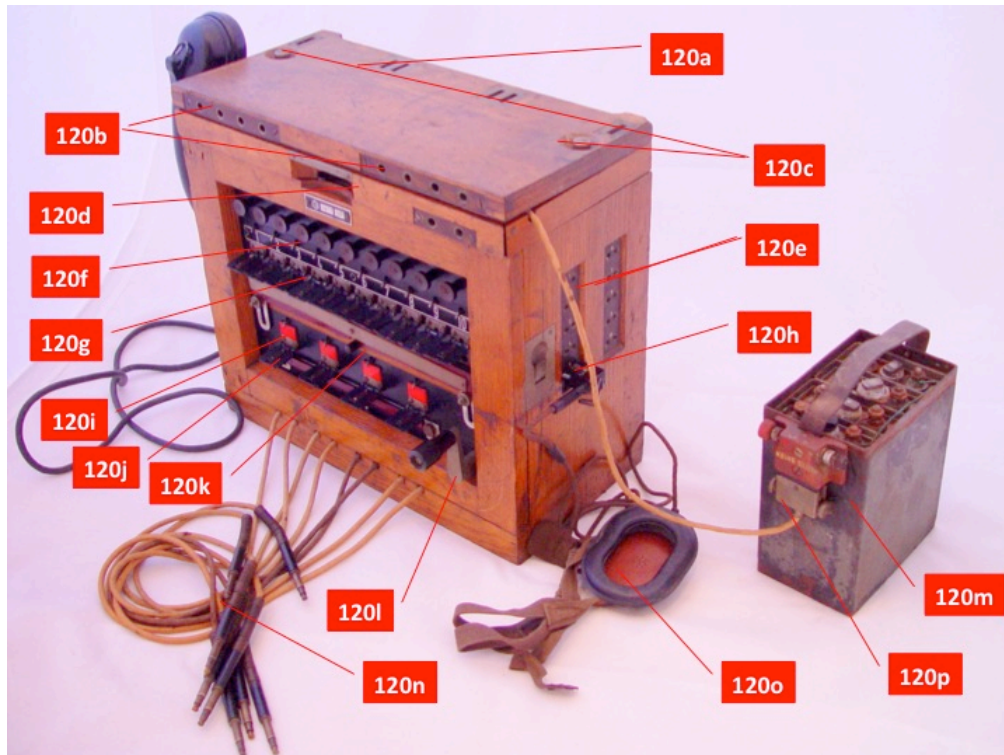
Construction

Figure 119: OB 17 overview



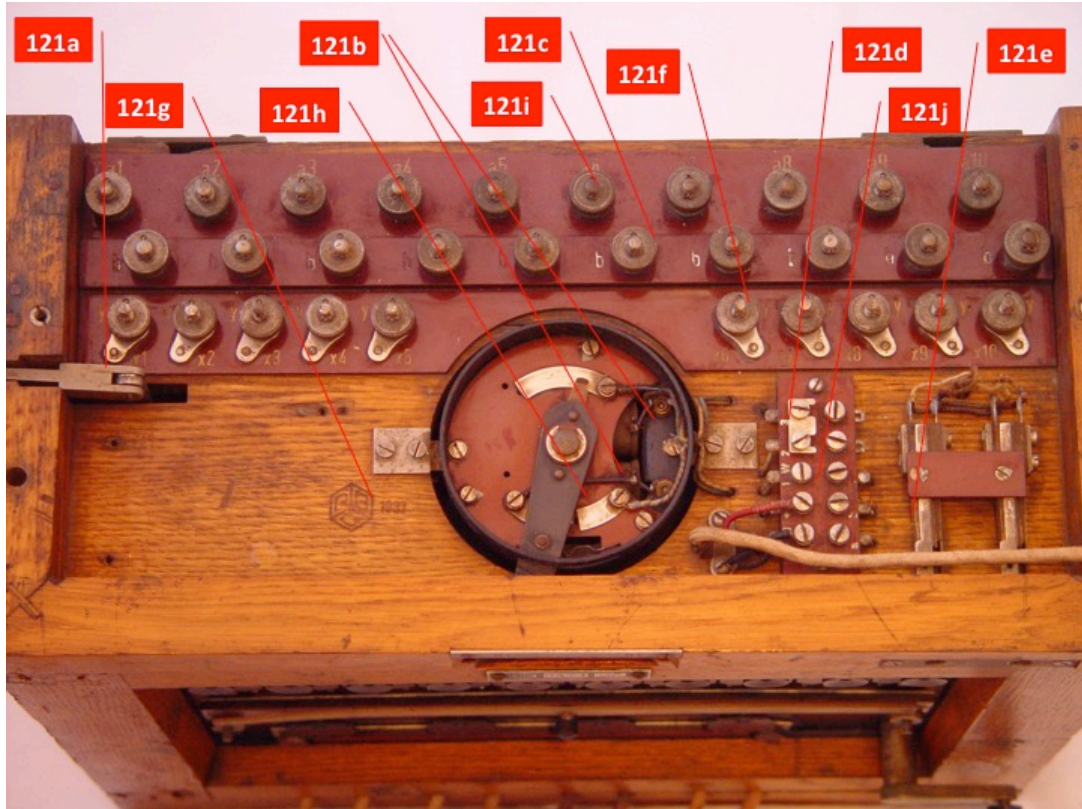
- | | | |
|----------------------------------|------------------------------|----------------------------------|
| 119a Line connection terminals | 119g Handset hook | 119m Handset socket |
| 119b Bell coil selector | 119h Connection button | 119n End of call signal flap |
| 119c Battery connection panel | 119i Signal flap | 119o Buzzer button |
| 119d Interconnection cable jacks | 119j Interconnection socket | 119p Signal flap locking bar |
| 119e Buzzer selection jumpers | 119k Locking bar fastener | 119q Locking bar fastener |
| 119f Maker tag | 119l Signal flap locking bar | 119r Interconnection cable holes |

Figure 120: OB 17 overview



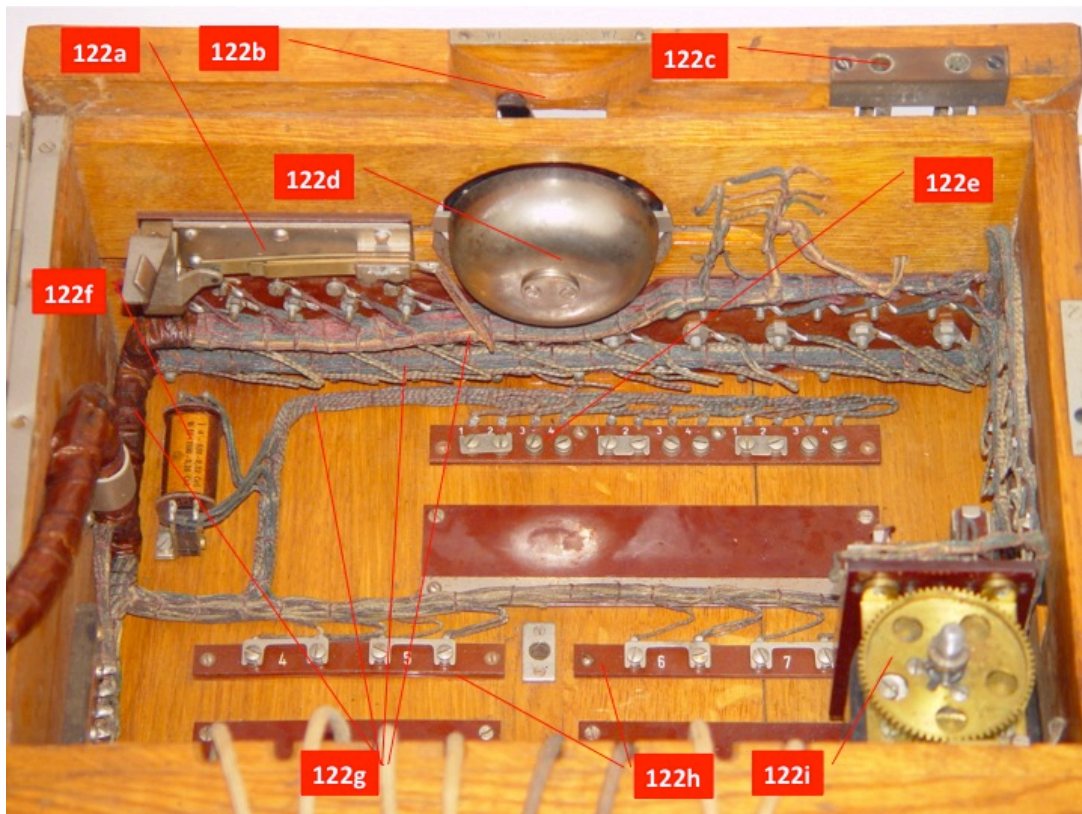
- | | | |
|---|--------------------------|-----------------------------|
| 120a Slots to mount dialler unit | 120f Line number strip | 120l Generator crank |
| 120b Conference call sockets | 120g Fallen signal flaps | 120m External battery |
| 120c Top panel locking screws | 120h Headset plug | 120n Interconnection cables |
| 120d Bell coil selector | 120i Red cable pair flag | 120o Headset |
| 120e Headset sockets for buzzer operation | 120j Fallen signal flap | 120p Battery connector |
| | 120k Buzzer button | |

Figure 121: OB 17 top view



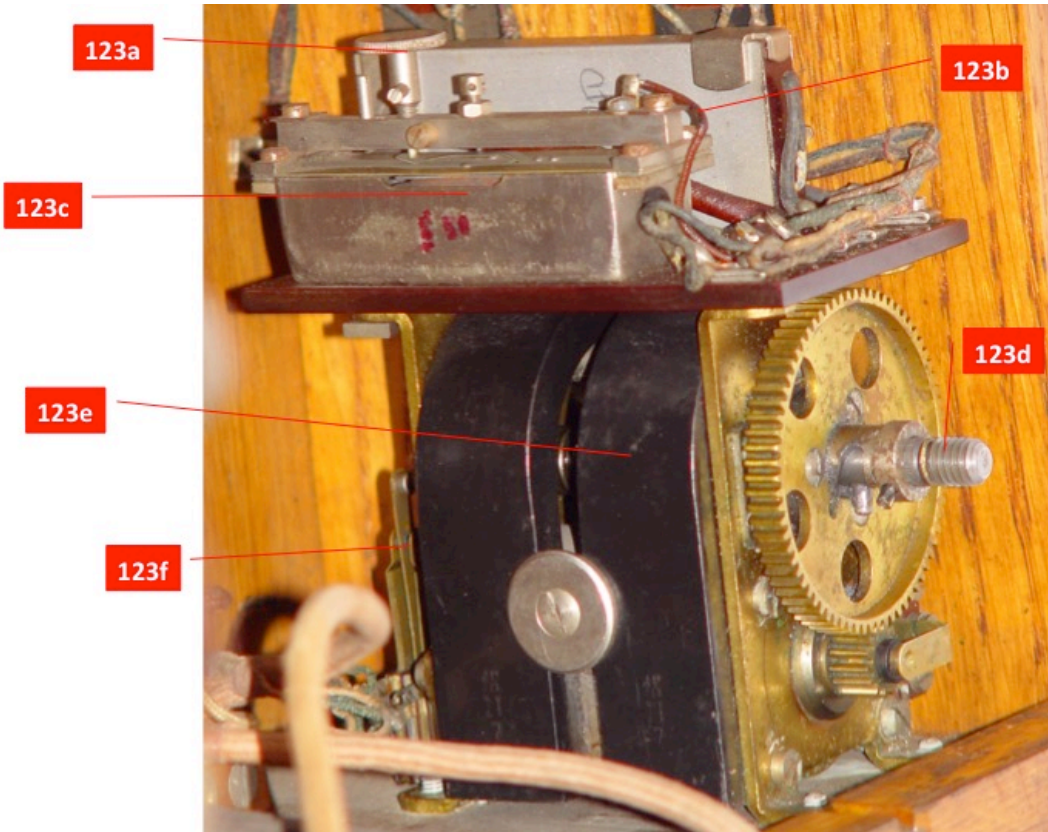
- | | | |
|--------------------------|---------------------------------|-------------------------------|
| 121a Handset suspension | 121e Interconnection cable jack | 121i "a" line connection |
| 121b Bell coils | 121f buzzer operation jumper | 121j Battery connection panel |
| 121c "b" line connection | 121g Maker mark | |
| 121d Bell battery jumper | 121h Bell coil switch | |

Figure 122: OB 17 internal view



- | | | |
|-----------------------------------|------------------------------------|-------------------------------|
| 122a Handset suspension mechanism | 122c Interconnection cable sockets | 122f Microphone transformer |
| 122b Bell coil selector | 122d Bell | 122g Wiring looms |
| | 122e Jumper connection board | 122h Jumper connection boards |
| | | 122i Generator buzzer unit |

Figure 123: OB 17 Generator buzzer unit

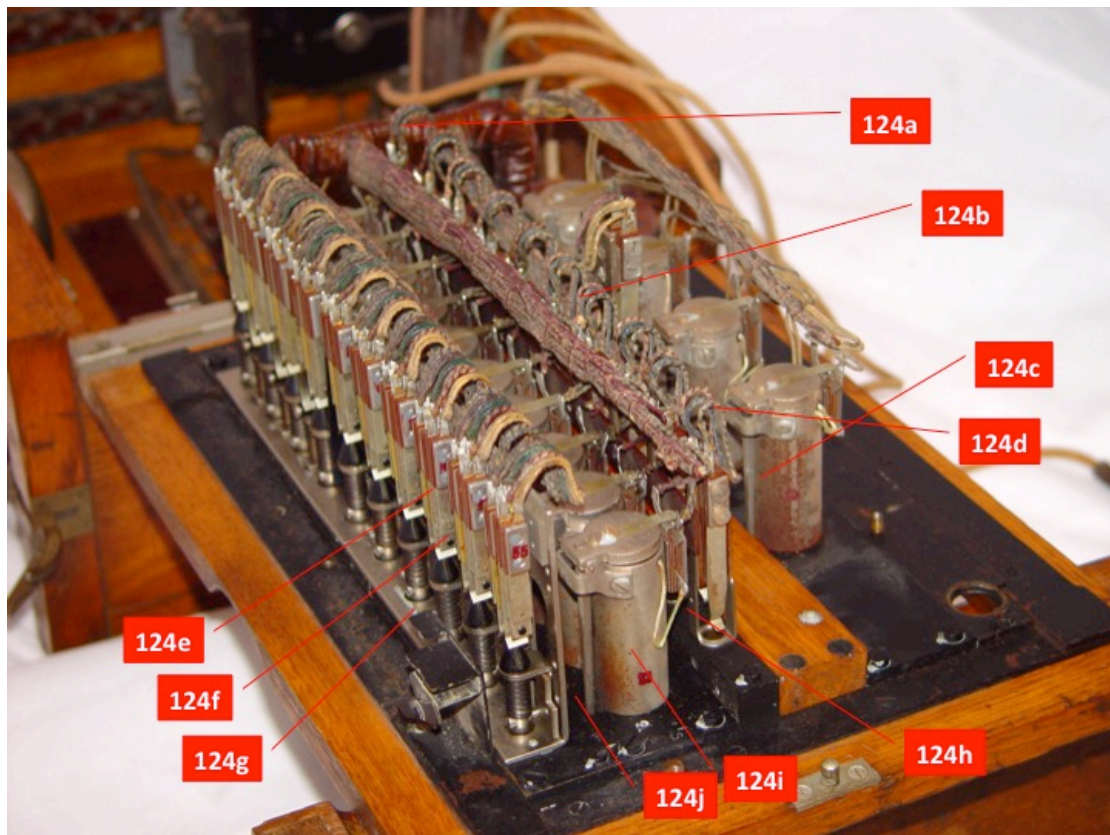


123a Buzzer adjustment screw
123b Buzzer capacitor

123c Buzzer
123d Generator crank spindle

123e Generator
123f Generator switch contacts

Figure 124: OB 17 inside front panel view



124a Wiring loom
124b Buzzer button contacts
124c End of call indicator relay
124d Indicator relay yoke
124e Interconnection button

124f Interconnection button contacts
124g Interconnection button interlock bar

124h Interconnection cable socket contacts
124i Line indicator relay
124j Indicator relay yoke

Operation

The “*Feldklappenschrank OB 17 zu 10 Leitungen*” is a self contained unit only requiring a headset and an external battery to operate, so no additional field telephone is required. In this section it is assumed that the switchboard will be used for 10 local battery field telephone connections and that all jumpers and settings are set accordingly.



Figure 125: OB 17 front panel opened up to reveal the interior

- Place the switchboard on a sturdy surface and open the front panel.
- Take the interconnection cables out of their storage sockets and lead the cables through the recesses under the front panel.
- Remove the generator crank from the storage position.
- Close the front panel and connect the generator crank to the generator.
- Remove the top lid, take out the battery lead and connect it to the battery.
- Connect the telephone lines (up to 10) between the “a1” .. “a2” and “b1” .. “b10” terminals.
- Fold out the handset hook,
- Plug in the handset in the socket on the left side and hang the handset on the hook.
- Check that all the “x” and “y” screws are tight.
- Replace the top lid.
- Unscrew the indicator flap locking bars and slide them downwards. Some indicator flaps may fall during unlocking; push them back up until held in the closed position. You are now ready to operate the switchboard.



Figure 126: OB 17 exchange ready to go

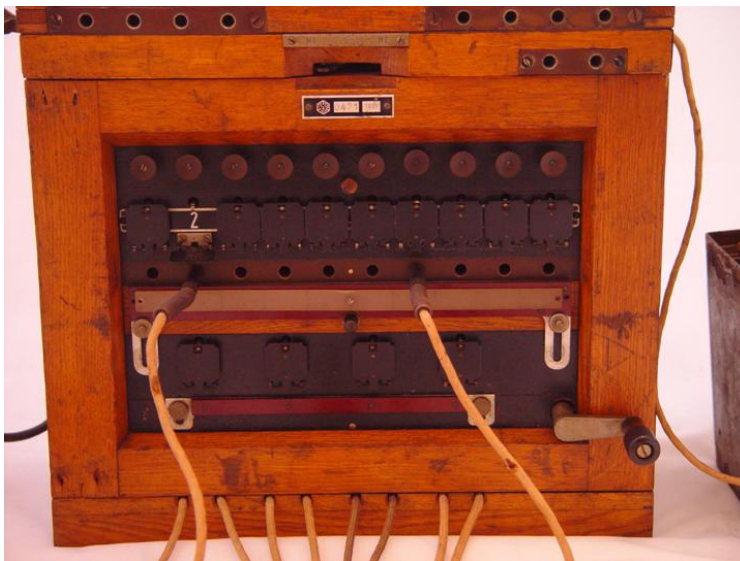


Figure 127: Incoming call on line 2

When an incoming call is received (say on line 1), the indicator flap of line 1 will drop, at the same time the alarm bell will ring. Take the handset off the hook, depress the line connection button for line 1, you can now speak with line 1 (while depressing the microphone switch on the handset as usual). Let us assume that line 1 wishes to speak to line 4. Press the interconnection button for line 4 (automatically

putting line 1 on hold by releasing line connection button 1) and turn the generator crank, ringing the bell on line 4. When line 4 answers, notify the recipient that you have a call from line 1 for him, and plug the first two interconnection cables in the interconnection sockets for line 1 and line 4. Replace the handset on the hook (automatically releasing line connection button 4). Line 1 and line 4 are now interconnected and the switchboard is ready to receive the next call.

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When the call is ended, one of the participants will crank the generator. This will cause the first interconnection cable signal flap to drop and reveal a red field. At the same time the alarm bell will ring. Disconnect the two interconnection cables from lines 1 and 4 and reset the flap. The first set of interconnection cables is now available again for a new connection.

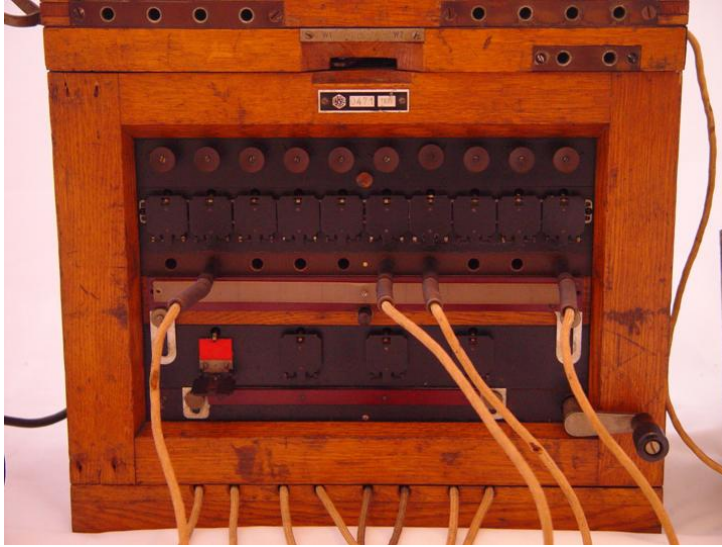


Figure 128: End of call signal for the first cable pair connection lines 2 and 6

The switchboard operator can listen in on a connection by unhooking the handset and pressing the interconnection button for one of the lines connected (for example if he suspects that they have forgotten to give the end signal).

If more than two lines need to be connected in a conference call, the process is similar to above, but now the second cable of each

interconnection cable pair is plugged into the conference sockets in the top lid. So if for example lines 1, 4 and 10 need to be in a conference, the first interconnection pair is plugged between line 1 and the first conference socket, The second pair between line 4 and the second conference socket and the third pair between line 10 and another conference socket. In this way, a maximum of four lines can be connected to one conference (five if the switchboard operator also participates). At the end of the conference, one



Figure 129: Lines 1, 4 and 7 connected to a conference call

party turns the generator crank, this will cause all the connected interconnection cable signal flaps to fall simultaneously and the switchboard can be reset.

***Kleiner Klappenschrank zu 10 Leitungen* 10 line switchboard**

Development and Description

As can be learned from the previous section, the construction and operation of the “*Feldklappenschrank OB 17 zu 10 Leitungen*” was relatively complex. The redesign of equipment in 1933 had the aim to simplify and the new 10 line field switchboard would be as simple as possible, omitting buzzers, alarm bells, built-in telephone and provisions to connect to public networks. These functions would have to be taken up by external accessories where necessary. At the same time the unit was redesigned for “single interconnection cord” operation, negating the need for separate interconnection cable indicator flaps. Instead of eight cables, the unit now has 10 interconnection cables, one for each line. The basic design with a falling indicator flap, interconnection button and interconnection cable socket for each of the ten lines remained unchanged.

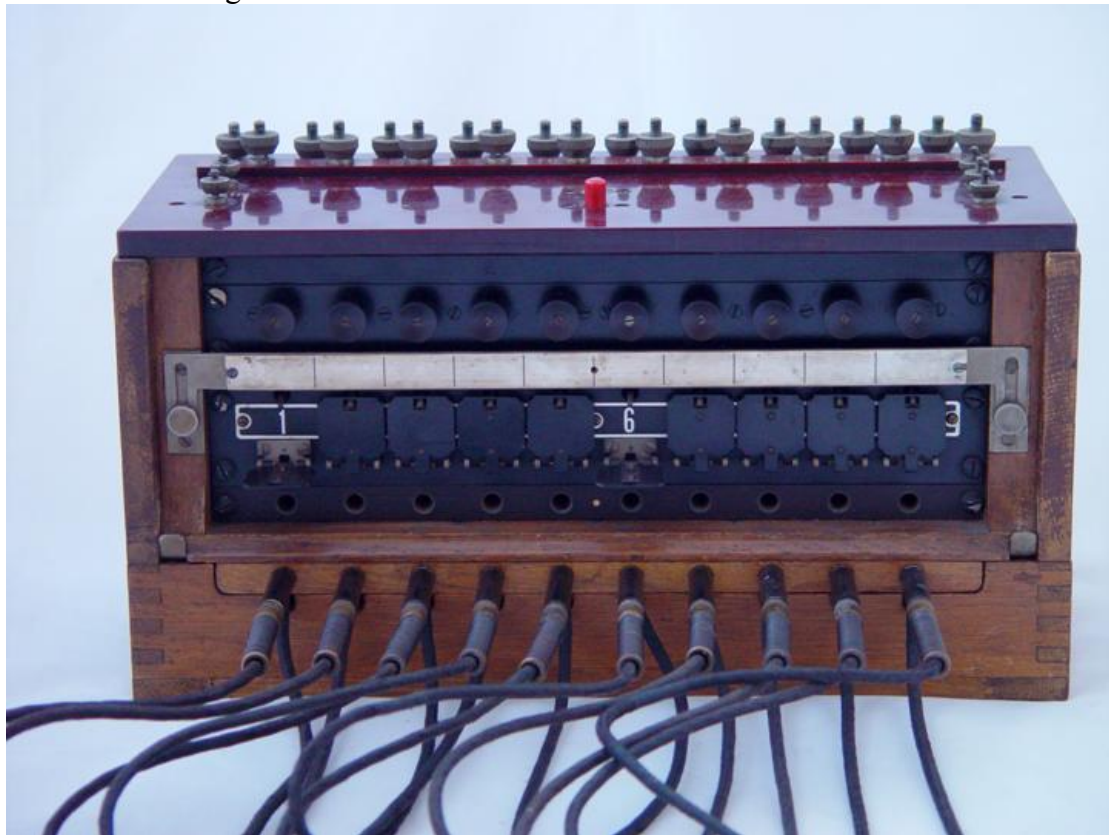


Figure 130: 10 line exchange overview

To operate the new “*Kleiner Klappenschrank zu 10 Leitungen*”, an external *FF 33* field telephone would have to be connected. If connections to public networks were required, an “*Amtszusatz*” or public network connection unit would be required.

The redesign resulted in a unit roughly half the size and weight of the old *OB 17* model. The unit did not require any presetting of jumpers or interconnections, making it far simpler to operate. A metal lid protecting the top and the use of the standard *FF 33* carrying strap allowed the switchboard to be carried in the field and protects it from the weather.



Figure 131: 10 line exchange in transport configuration

Two locks on the side allow the unit to be opened, giving access to the interconnection cable storage compartment. Also in this compartment is a 30 pole plug socket, which can connect the switchboard to a remote line terminal unit, negating the need to connect the lines directly to the switchboard.

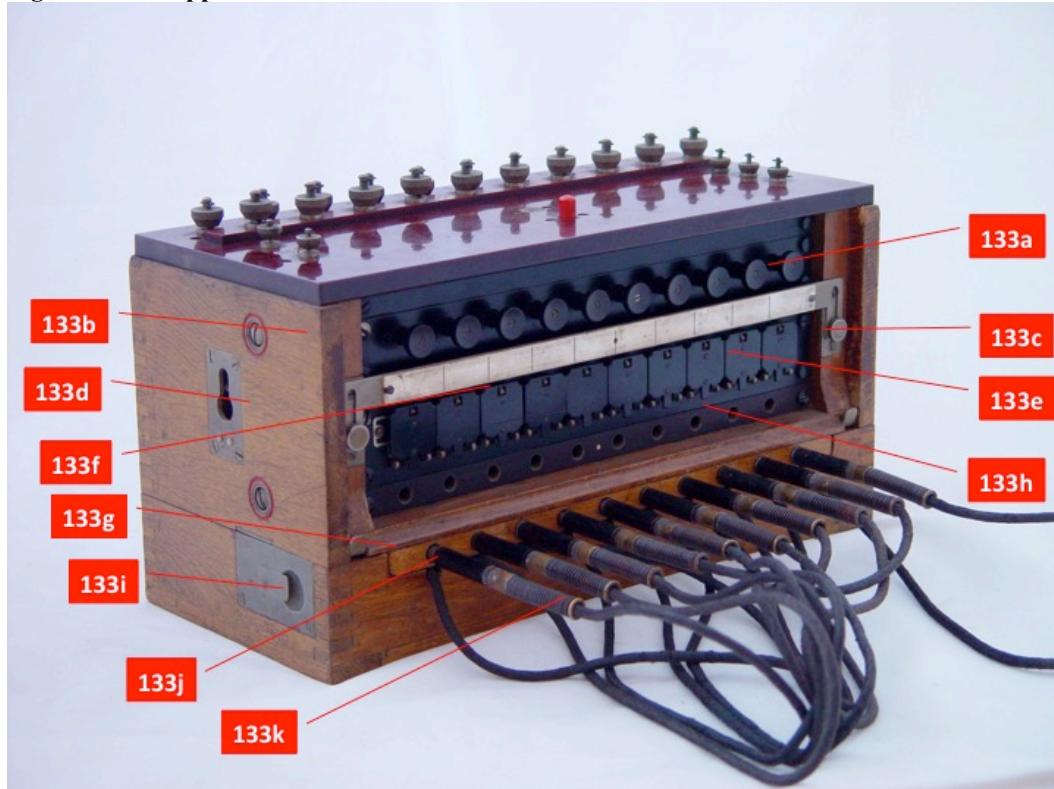


Figure 132: Remote line connection panel

Normally the incoming telephone lines are connected to the terminals on the top panel. Apart from line connections, the top panel has two terminals to connect a *FF* 33 field telephone and three terminals to connect an external alarm battery and alarm bell. These are all the connections that the operator will have to deal with.

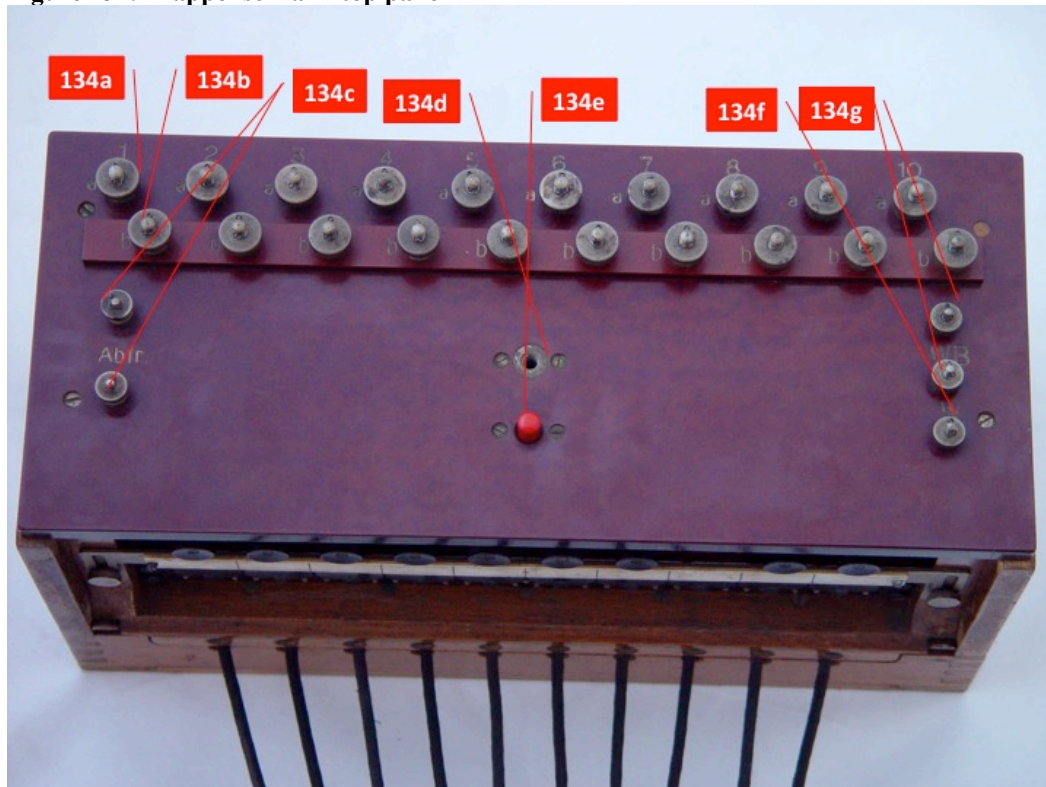
Construction

Figure 133: Klappenschrank external view



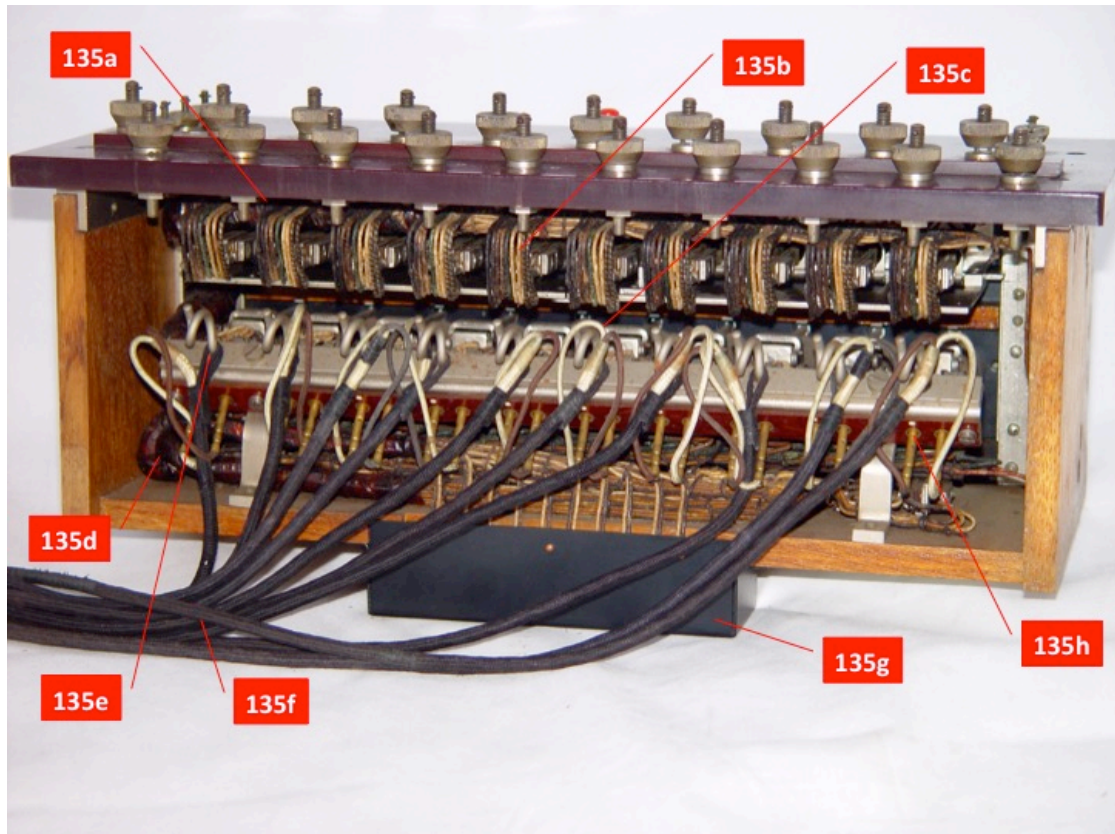
- | | | |
|------------------------------------|---|------------------------------------|
| 133a Connection button | 133f Signal flap locking bar with writing tab | 133j Interconnection cable storage |
| 133b Interior fastening screw | 133g Lug for metal cover | 133k Interconnection cable jack |
| 133c Signal flap locking bar screw | 133h Interconnection cable socket | |
| 133d Carrying strap slot | 133i Storage compartment lock | |
| 133e Signal flap | | |

Figure 134: Klappenschrank top panel



- | | | |
|--------------------------------------|---|-------------------------------------|
| 134a "a" line terminal | 134d Screw hole for metal cover | 134g External alarm bell connection |
| 134b "b" line terminal | 134e Connection button reset | |
| 134c Connections for field telephone | 134f External alarm bell battery connection | |

Figure 135: Klappenschrank interior view



- 187a Line terminal connection
- 130a Interconnection button contacts
- 130b Signal relay

- 130c Wiring loom
- 130d Interconnection cable hook
- 130e Interconnection cables

- 130f Socket for remote cable connector
- 130g Connection strip for interconnection cables

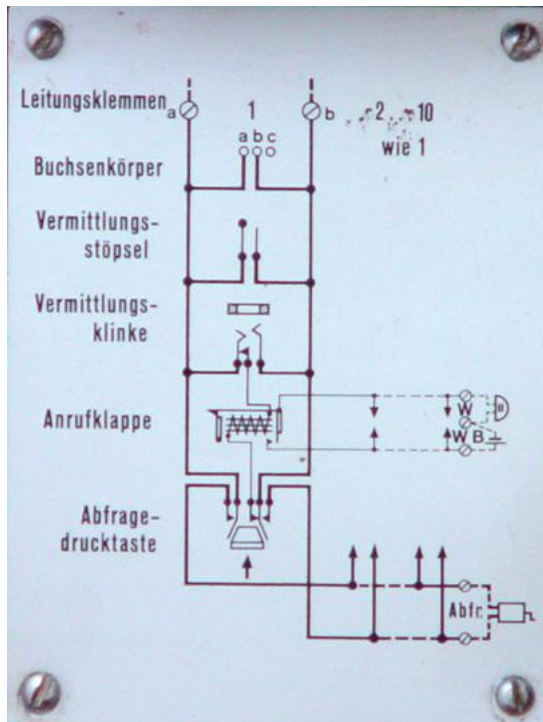


Figure 136: Klappenschrank schematic of a single field

Operation

To set up an switchboard using a “*Kleiner Klappenschrank zu 10 Leitungen*” requires the switchboard unit and a *FF 33* field telephone. If connection to a public telephone network is required, the “*Amtszusatz fuer den kleinen Klappenschrank zu 10 Leitungen (33)*” is required.



Figure 137: Klappenschrank cable storage compartment

- To set up the switchboard, place the “*Kleiner Klappenschrank zu 10 Leitungen*” on a suitable surface.
- Remove the metal lid.
- Place a *FF 33* field telephone next to the unit and connect the two “*Abfr.*” Terminals to the “*La*” and “*Lb/E*” terminals of the *FF 33*.
- Connect the incoming lines to the “*a*” and “*b*” terminals.

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- The codes or names for the incoming lines can be written on the writing tab on the signal flap locking bar.



Figure 138: Klappenschrank ready for operation

- Unlock the locking bar by sliding it upwards and locking it in place with the two locking screws.
- Close any signal flaps that may have fallen during this operation. The switchboard is now ready for operation.

When an incoming call is received the signal flap of the relevant line will drop, revealing the number of the line behind the flap. Press the connection button for the relevant line and speak to the caller via the handset of the *FF 33* field telephone (remembering to depress the microphone switch in the handset while talking). When the caller has indicated which line he wants to speak to, press the connection button for that line and turn the generator handle of the field telephone. When the call is answered, place the interconnection cord of the caller into the interconnection plug socket of the outgoing line. Return the signal flap of the caller in the up position and press the red connection release button on top. The call is now connected.



Figure 139: Klappenschrank incoming call on line 4, connected to line 8

At the end of the call, one of the callers will turn the generator rank, resulting in the signal flap of the incoming line to drop. The operator can now remove the interconnection cord of that line and replace it in its storage socket. Close the signal flap to reset the switchboard for the next call.

Conference calls can be made by repeating the connection process: the interconnection cable of caller 1 is plugged into the interconnection plug socket of caller 2; the interconnection cable of caller 2 is plugged into the socket of caller 3 etc. In theory, all ten lines can be connected to a single conference.

Amtszusatz für den Kleinen Klappenschrank zu 10 Leitungen

Development and Description

As discussed in the previous section, the “*Kleiner Klappenschrank zu 10 Leitungen*”



Figure 140: Amtszusatz front view

was a simplified design, without any provisions for connection to public telephone networks. To enable this function, the “*Amtszusatz fuer den Kleinen Klappenschrank zu 10 Leitungen*” was developed. The “*Amtszusatz*” allowed connection to “ZB” (“*Zentralbatterie Betrieb*” or central battery), “SB” (“*Schlusszeichen Betrieb*” or end-pulse battery) and “*Wahlbetrieb*” or automatic dialling networks.

The unit was designed to be placed on the left hand side of the “*Kleiner Klappenschrank zu 10 Leitungen*” and has identical height. Two strips connect the *Amtszusatz* to the “Abfr.” Terminals of the 10 line switchboard. If required, a second *Amtszusatz* can be connected to the left of the first, this will just allow the rightmost interconnection cord of the switchboard to reach.

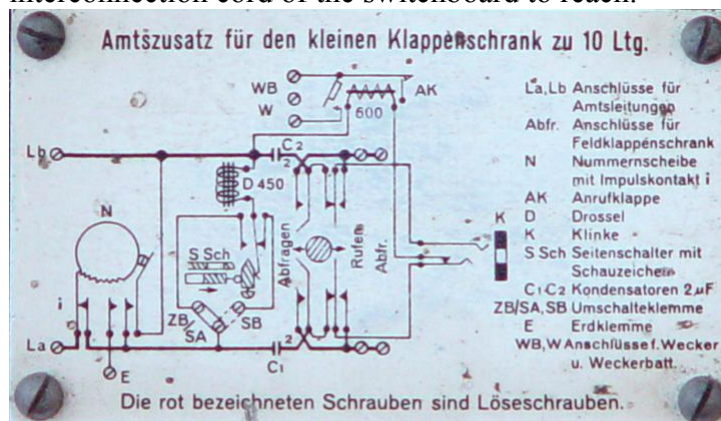


Figure 141: Amtszusatz schematic

The front panel has a dialling disk, a single signal flap to indicate incoming calls, a socket for the interconnection cable, a Kellogg switch and a “*Trennen-*” or end-pulse-button.

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The top panel contains all the connection terminals:

La	“ <i>Leitung a</i> ” or line a connection to the public network
Lb	“ <i>Leitung b</i> ” or line b connection to the public network
E	“ <i>Erde</i> ” or earth Terminal
W	“ <i>Wecker</i> ” or external alarm bell connection
WB	“ <i>Wecker Batterie</i> ” or external alarm bell battery connection
SB	“ <i>Schlusszeichen Betrieb</i> ” or End-pulse operation jumper terminal. The jumper can be set either to the “SB” or to the “ZB/SA” jumper terminal.
ZB/SA	“ <i>Zentralbatterie Betrieb / Selbstanschlussbetrieb</i> ” or Central battery / Automatic dialling network jumper terminal.
Abfr.	“ <i>Abfragen</i> ” or enquiry terminals



Figure 142: Amtszusatz connection panel

A metal cover can be placed over the unit protecting it from rain and a handle is provided on the back of the unit for carrying.



Figure 143: Amtszusatz with cover

Construction

Figure 144: Amtszusatz front view

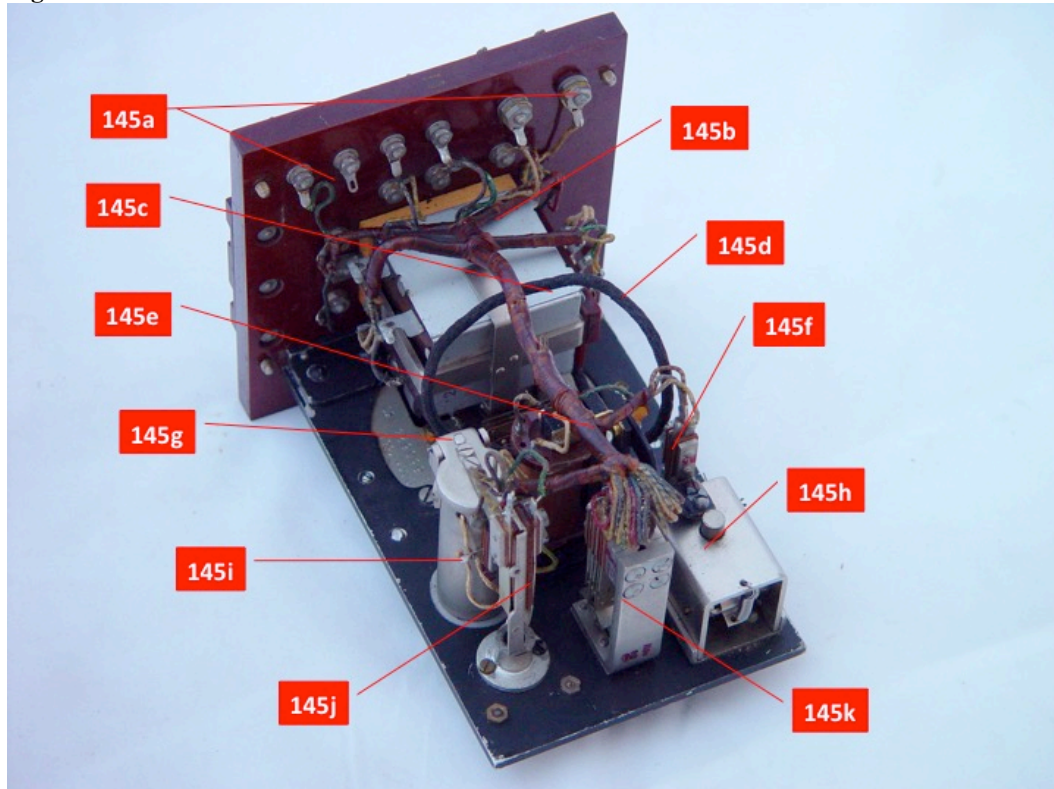


144a Connection panel
144b Dialling disk
144c Signal flap

144d End pulse indicator window
144e Interconnection cable socket

144f Kellogg switch
144g Writing tab
144h End pulse button
144i Lugs for metal cover

Figure 145: Amtszusatz internal view



145a Top panel connections
145b Capacitor blocks
145c Wiring loom
145d Dialling disk connection cable

145e End pulse self inductance coil
145f End pulse switch contacts
145g Dialling disk mechanism
145h End pulse interlock mechanism

145i Indicator relay
145j Interconnection cable socket contacts
145k Kellogg switch contacts

Operation

If your public phone network supports “pulse dialling”, you should be able to use the *Amtszusatz* on the network. Most modern networks use “tone dialling” so a pulse to tone converter might be required.

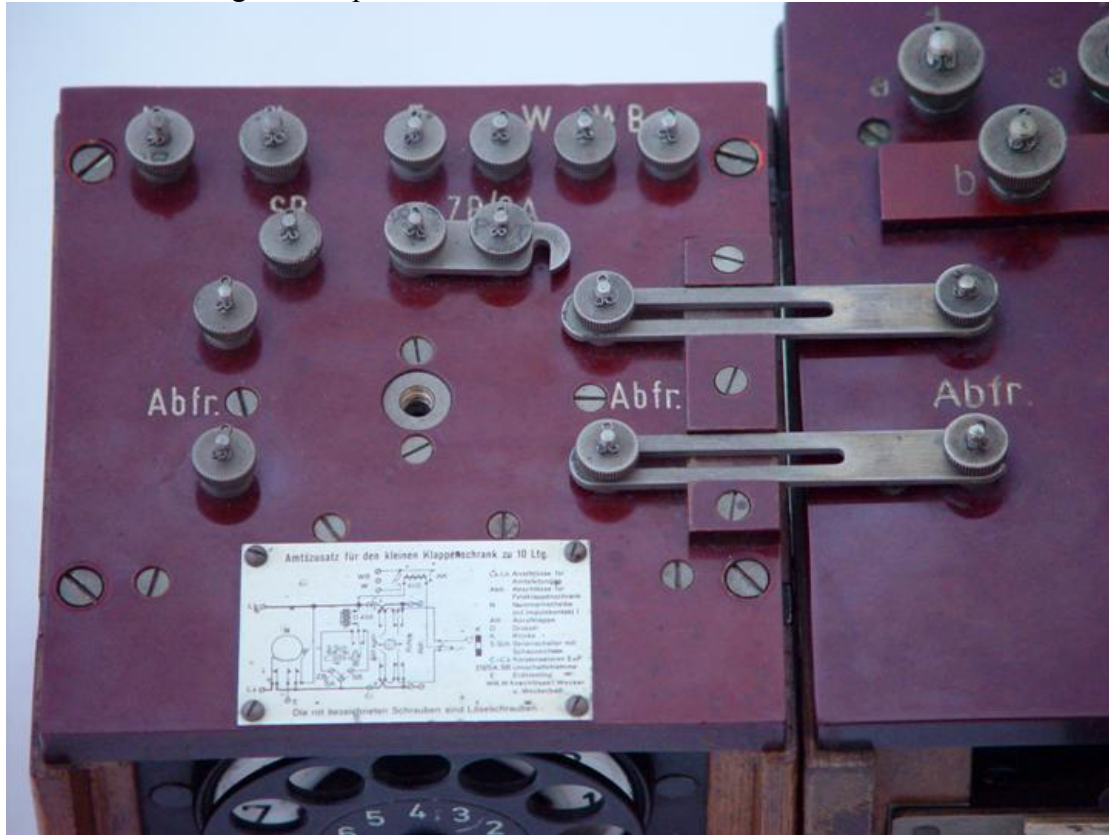


Figure 146: Amtszusatz jumper connections to the Klappenschrank

- Set up the “*Kleiner Klappenschrank zu 10 Leitungen*” as described in the previous section but do not connect the *FF 33* field telephone to the “*Abfr.*” terminals.
- Remove the lid and set up the “*Amtszusatz fuer den kleinen Klappenschrank zu 10 Leitungen*” on the left side of the switchboard.
- Connect the two “*Abfr.*” interconnection strips between the switchboard and the *Amtszusatz*.
- Connect the “*La*” and “*Lb/E*” terminals of the *FF 33* field telephone to the “*Abfr.*” terminals on the left side of the *Amtszusatz*.
- Connect the public network connection wires to the “*La*” and “*Lb*” terminals of the *Amtszusatz*.
- Ensure that the “*SB*” – “*ZB/SA*” jumper is placed in the “*ZB/SA*” position.
- Depress the end-pulse button and reset the Kellogg switch to the middle position.
- Ensure that the signal flap is closed. You are now ready to operate the *Amtszusatz*.

When an incoming call from the public network is received, the indicator flap will fall, revealing a red field. Depress the Kellogg switch to the “*Abfragen*” position, this will allow the operator to talk to the caller (as usual depressing the microphone switch in the handset of the field telephone). At the same time, the end-pulse button will reset activating the end-pulse circuit. Enquire which line the caller wants to be connected to. Reset the Kellogg switch to the central position and call the outgoing line as

German Field Line Communication Equipment of WW2© described in the previous section. Connect the interconnection cord of the outgoing line to the interconnection cord socket of the *Ambstzusatz*. Press the red disconnection button on top of the switchboard, the two lines are now connected.

When an outgoing call is requested by a field net participant, enquire as to the number to be called and put the caller on hold. Place the Kellogg switch of the *Amtszusatz* in the “*Abfragen*” position (the dialling tone should now be heard in the field telephone) and dial the requested number using the dialling disk. When the phone is answered, notify the recipient that he has a call from the field and place the interconnection cord of the caller into the interconnection cable socket of the *Amtszusatz*. Place the Kellogg switch in the middle position; the two lines are now connected.



Figure 147: Line 4 of the Klappenschrank connected to an external line

When the call is finished, the field net participant has to crank the field telephone generator to indicate the end of the call. This will result in the relevant indicator flap on the switchboard to drop and reveal the line number. Disconnect the interconnection cable and replace it into its storage socket. Depress the “*Trennen*” button on the *Amtszusatz* to generate the end-pulse to disconnect from the public network. The unit is now ready to receive the next call. Failure to press the “*Trennen*” button will be equivalent to leaving the phone off the hook; any public caller to the switchboard will get an engaged signal.

Gleichstromwecker

Development and Description

In some cases it was desirable to have an audible signal to indicate an incoming call. For this purpose a direct current ringer or *Gleichstromwecker* could be attached to the 10 line switchboard. The 10 line exchange had three terminals marked “W” and “WB” for this purpose.



Figure 148: Terminals for an external ringer on the 10 line exchange

The *Gleichstromwecker* is a direct current operated bell mounted on a wooden plate with a metal cover.

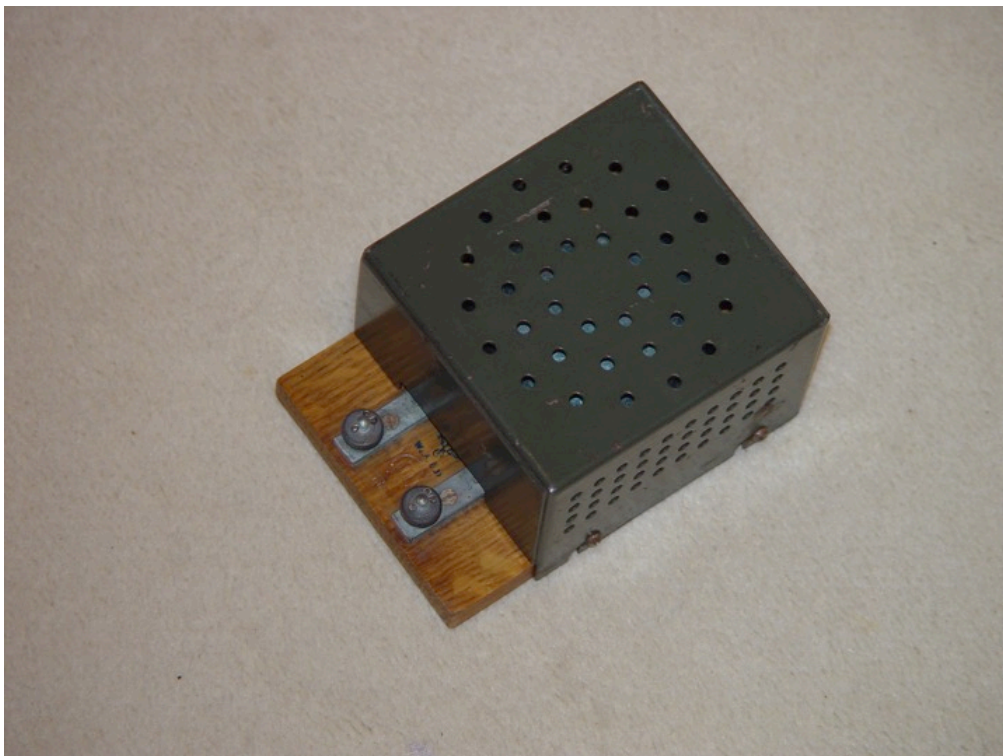


Figure 149: Gleichstromwecker for the 10 line exchange

Construction

The Gleichstromwecker contains a relay with a breaking contact. When a DC voltage is applied, the relay will contract switching off the current, resulting it to drop off again. This motion will repeat itself as long as the DC voltage is applied. A striker is connected to the moving part of the relay, causing the bell the ring.

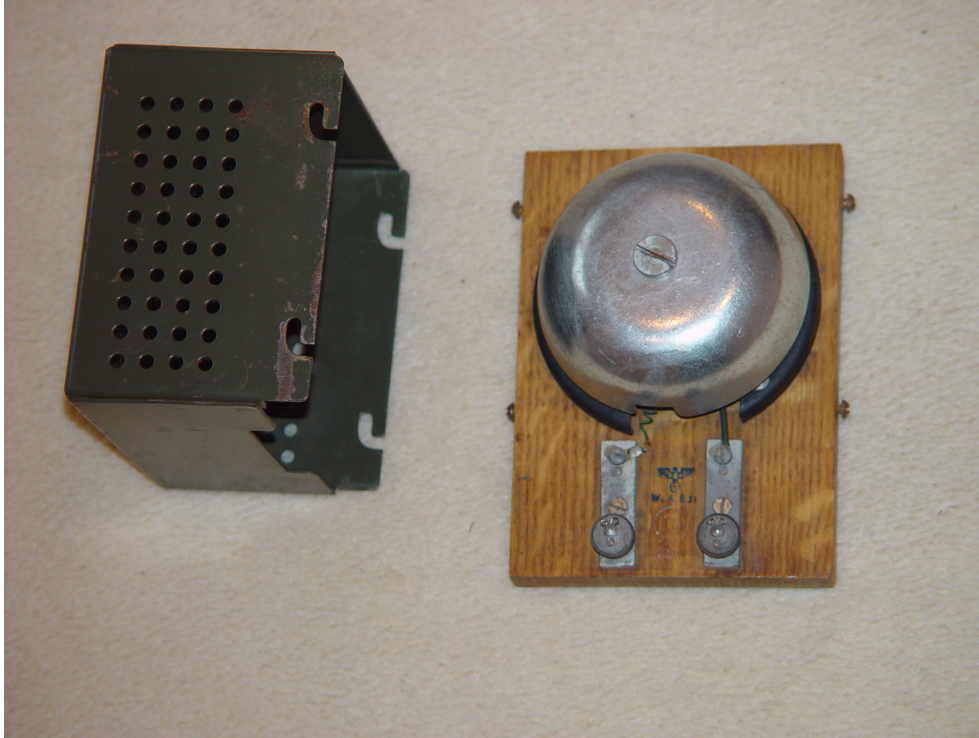


Figure 150: Gleichstromwecker with lid removed

The *Gleichstromwecker* has two terminals. The bell can be adjusted by loosening the screw and turning the bell left or right. The back of the *Gleichstromwecker* has a number of brackets so that the ringer can be hooked on a wall.

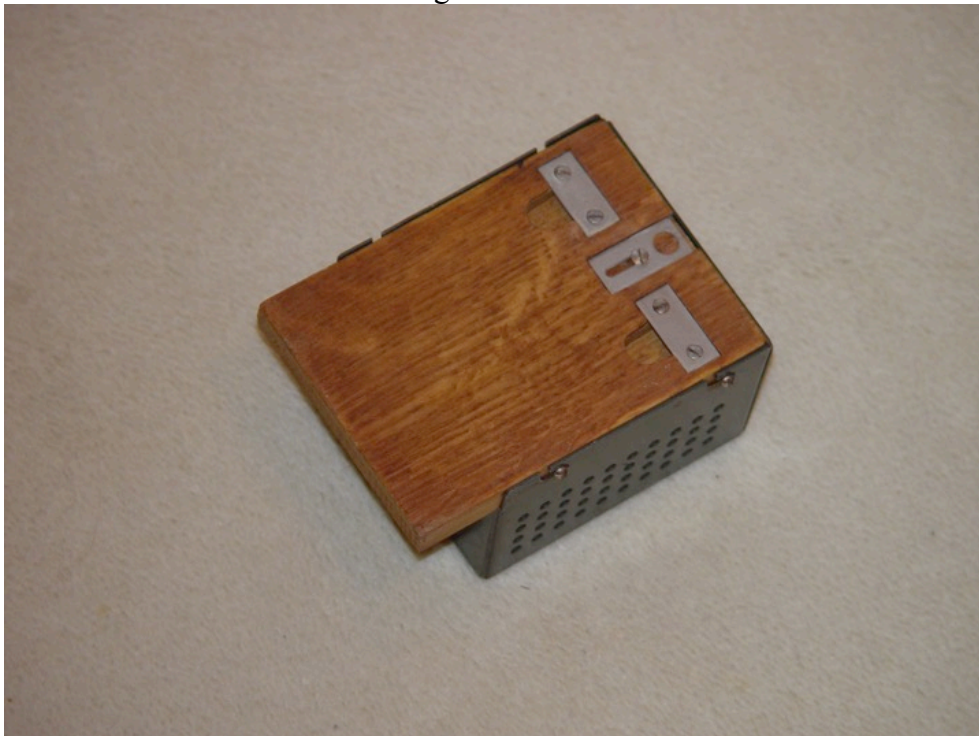


Figure 151: Back of the *Gleichstromwecker* with mounting brackets

The *Gleichstromwecker* needs an external power source to operate, typically two battery cells (about 3 Volt) were used to power the bell.

Operation

To operate the *Gleichstromwecker* the ringer unit and two 1.5 Volt batteries are required.

- Place the *Gleichstromwecker* and the batteries at a convenient place near the *Feldklappenschrank zu 10 Leitungen*
- Connect the two 1.5 cells in series and connect them to the two terminals marked “WB” (*Wecker Batterie*)
- Connect the *Gleichstromwecker* to the two terminals marked “W” (*Wecker*)
- If the *Amtszusatz* is used, interconnect the outer “W” and “WB” contacts between the *Amtszusatz* and *Feldklappenschrank*; this ensures that the *Gleichstromwecker* will also ring when a call comes in via the public line.

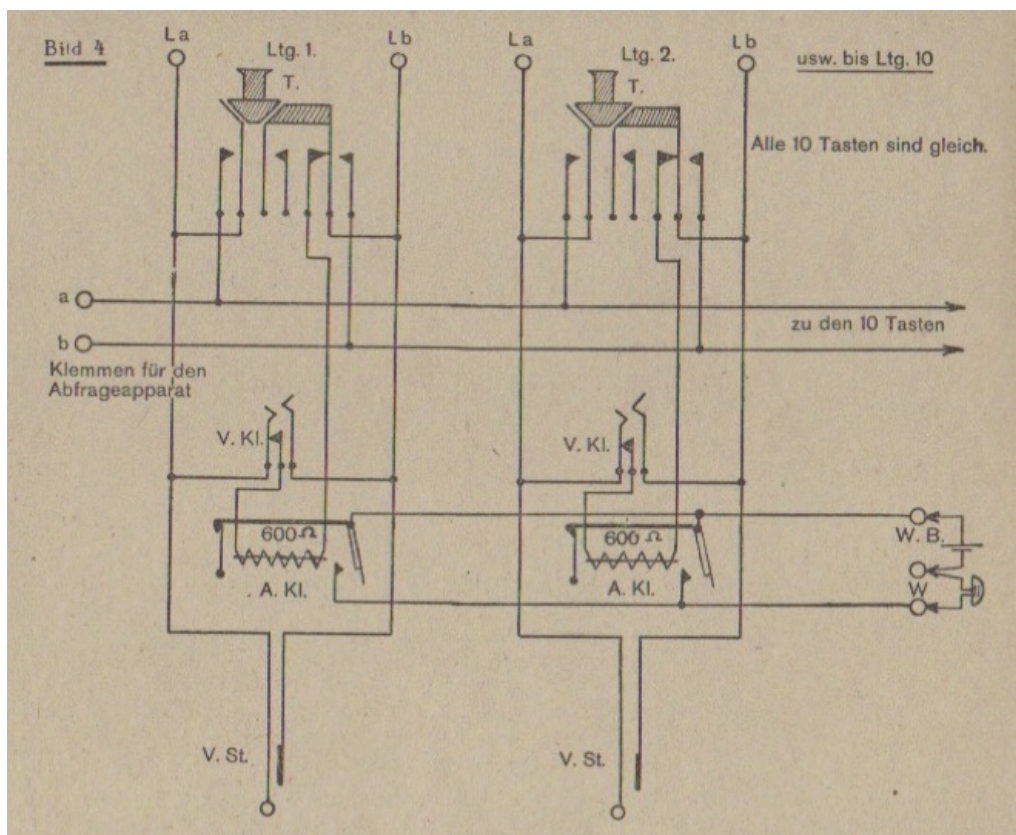


Figure 152: Schematic showing the connection of the *Gleichstromwecker*

As the schematic shows, each of the signal flaps on the 10 line exchange has a contact that closes when the signal flap relay operates. When one of the signal flaps is released, the electrical circuit containing the *Gleichstromwecker* is closed and the bell starts ringing. The ringing continues for as long as the person on the end of the line turns the ringer generator on his FF 33.

Anschlußleiste

Development and Description

It was not always convenient to connect all incoming telephone lines to the exchange directly. For example if the exchange was placed inside a building or fortification, the telephone lines were terminated outside and connected to a remote connection panel.

Two models existed, a pre-war model constructed on a wooden board and a later model made out of a bakelite pressing with a metal rain cover.

The remote connection panel was connected to the exchange via a single 30 core cable to the exchange



Figure 153: Later model *Anschlußleiste* Remote control panel

The remote control panel was designed to connect up to 10 lines, a pair of screw connectors was available for each line. White plastic strips inside the lid allowed the line identifications to be written in pencil. The *Anschlußleiste* had two hooks on the back so that it could be suspended from a connection rack or wall.

The 30-core cable could be plugged into the 30-pin socket inside the 10 line exchange or could be connected via a special connector fitted to the top terminals of the exchange. Again this adapter exists in a pre-war wooden version and a wartime bakelite version. The connector could be used with both the old type and the new type 10 line exchange.



Figure 154: Laer model remote cable adaptor fitted to the 10 line exchange

Construction

The complete set of the *Anschlußleiste* consists of the remote connection board, the adaptor and a 30 core cable. These were supplied in a single canvas bag.



Figure 155: Later type connector, remote connection board and 30 core cable

Note that a bakelite cover is provided with the connector to protect the terminals when not in use. Both the connector and the remote connection panel have a metal latching mechanism to keep the 30 pin plugs in place. The cover of the remote connection panel can be closed to keep out rain and dirt.

Operation

When the *Feldklappenschränk* is placed inside a building or fortification, the incoming phone lines are best terminated outside. Outside a *Abspannbock* is build using *Baustangen* or improvised wooden branches. All incoming cables are firmly tied to the top cross member of the *Abspannbock* to provide pull relief. The cable ends are then lowered down and connected to the *Anschlußleiste* remote connection panel. The *Anschlußleiste* is tied to the lower cross member. For larger exchanges, several *Anschlußleisten* can be fitted next to each other on the lower cross member. If necessary, stabilise the *Abspannbock* with guy wires.

The use of the *Abspannbock* not only assured a proper pull relief for the incoming cables, but it kept all the connections off the ground and within easy reach for inspection and maintenance.

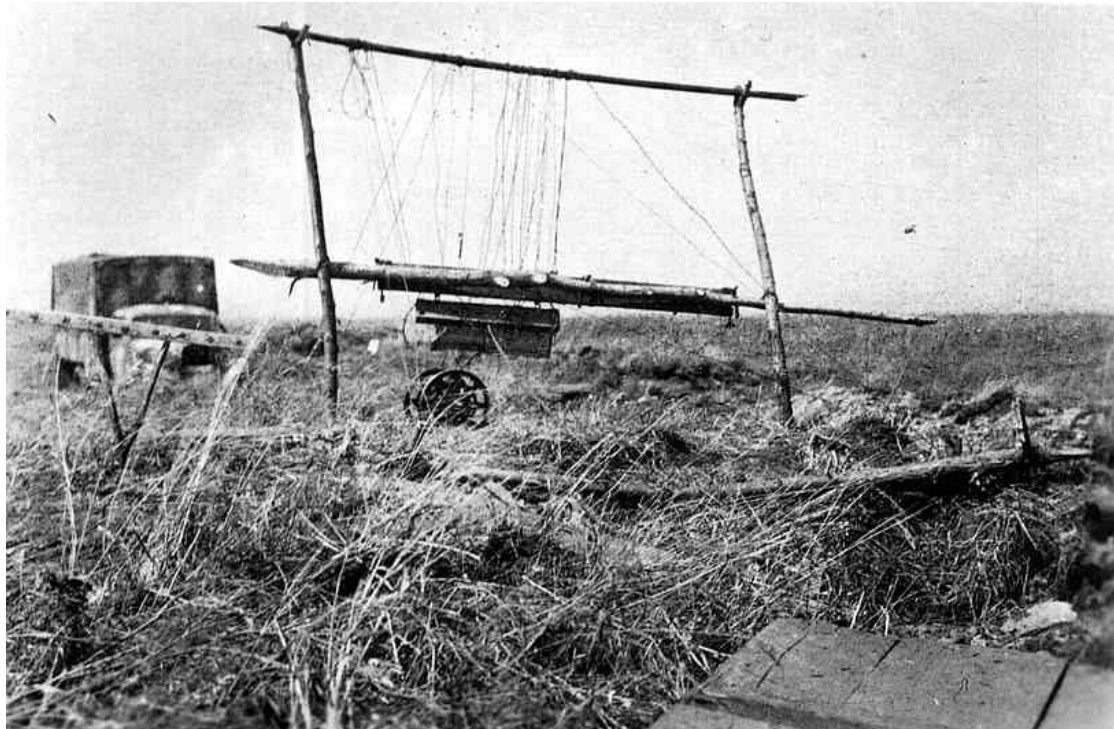


Figure 156: *Abspannbock* used for terminating incoming phone lines

- Connect the 30-core cable to the *Anschlußleiste* and lead the cable towards the *Feldklappenschränk* inside the building or fortification.
- Connect the other end of the 30-core cable to the 30 pin socket inside the *Feldklappenschränk* or to the connector unit
- Connect the connector unit to the top of the *Feldklappenschränk*: first unto all 20 terminal screws on top of the *Feldklappenschränk* and slide the connector in place; re-tighten all 20 terminal screws to ensure proper connection



Figure 157: *Feldklappenschrank* connected to the *Anschlußleiste*

- Note down the line identifications on the *Anschlußleiste* and copy these to the white line identification strip on the *Feldklappenschrank*.

The *Feldklappenschrank* can now be operated as per normal.

Development and Description

To bridge the gap between the smaller 10-line and larger 60+ line switchboards, in 1940 the “*Klappenschrank zu 20 Leitungen*” or 20-line switchboard was introduced. Weighing in at about 40 Kg, the switchboard is a heavy sturdily built unit. The unit is fully encased, offering excellent protection during transport with even the interconnection cables being protected within the casing. Like the small 10-line switchboard, the unit could be set up and connected quickly. The unit also contains its own alarm bell, alarm bell generator, buzzer and handset connection, so no external *FF 33* field telephone is required for operation.



Figure 158: Klappenschrank zu 20 Leitungen

An enlargement unit could be placed on top of the “*Klappenschrank zu 20 Leitungen*”, containing additional line connections and two public network connection fields, complete with dialling disks.

The “*Klappenschrank zu 20 Leitungen*”, like the *OB 17*, uses a two-cord interconnection system. Ten interconnection cord pairs are provided. When not in use, the interconnection cords automatically roll into the interconnection cable enclosure which forms the bottom section of the unit, preventing snagging and damage. Ten Kellogg switches are connected to the interconnection cords, this means that the operator can only speak to a incoming line once one of the interconnection cords is plugged into the relevant field (in the previously discussed switchboards, each incoming field had its own dedicated Kellogg switch or interconnection button).

On the left and side of the front panel are three 5-pin connection sockets for handsets, or headsets with breast microphones when hands-free operation is required. On the top left of the panel is a provision to hang the handset

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On the right of the front panel is an enclosed battery compartment, which houses the local battery (“*OrtsBatterie*”) and the alarm bell battery (“*WeckerBatterie*”). A switch on the front panel allows the alarm bell to be switched off for silent operation.

The front panel contains four centre sections. The top section houses the conference parallel sockets, which allows several lines to be connected to the same call. The two middle sections contain the 20 incoming line fields, each with a signal flap and an interconnection cable socket. The bottom section contains the ten interconnection cable flaps, one for each cable pair.

If the internal buzzer could not be operated, a alarm bell generator was provided, the crank handle can be found on the right bottom side of the interconnection cable enclosure.



Figure 159: Enlargement unit placed on top of the exchange

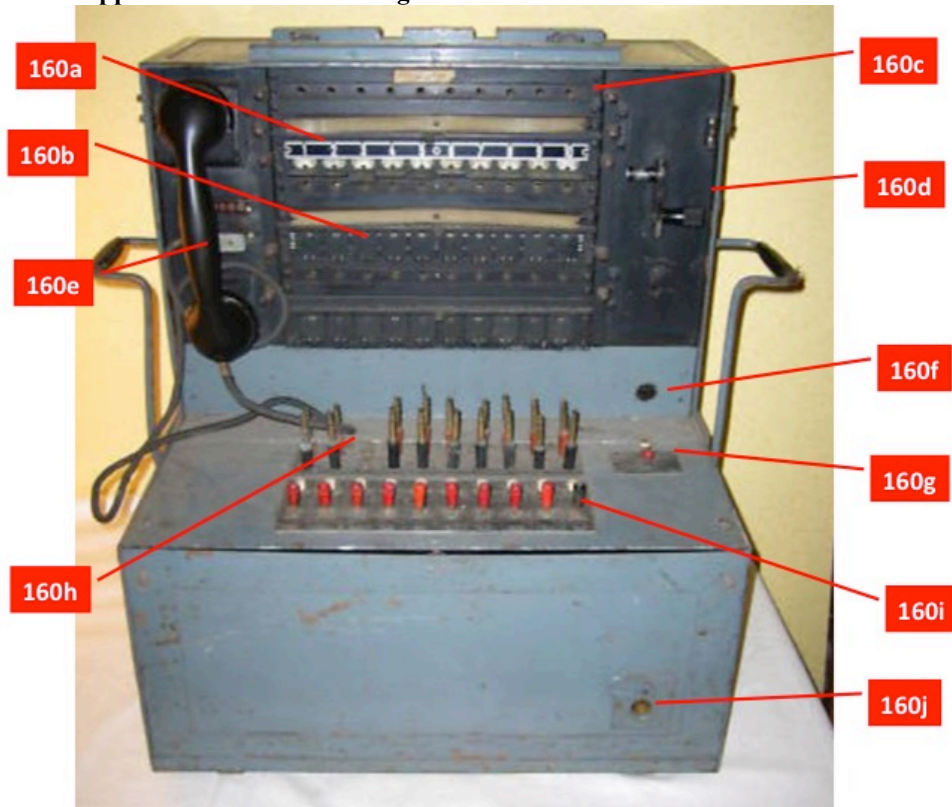
The enlargement unit sits on top of the switchboard. On the left and right side it contains two fields for interconnection to public networks. Each field has a writing tab, dialling disk, signal flap with Kellogg switch and interconnection cable socket, similar to the “*Amtszusatz fuer den Kleinen Klappenschrank zu 10 Leitungen*”. The centre section contains the incoming line fields, either an additional 30 lines, or 10 additional fields and a 9 by 10 “Scribner²” parallel connection field, which allows four complete 20-line units plus enlargement units to be coupled as a single, 120 line switchboard.

Due to the weight and size, it is likely that it was designed to be a vehicle mounted mobile switchboard.

² C.E. Scribner was a Western Electric Manufacturing Company engineer credited with many patents and inventions, amongst others the telephone “jack”. Building large telephone switchboards posed specific challenges, at some point the length of the interconnection cables limits the number of lines it can reach. This problem was solved by connecting each subscriber to multiple sockets along the switchboard. The original solution was patented by Firman and later refined by Scribner. In this solution, each “workstation” of the switchboard has a parallel socket matrix, allowing an operator of a particular workstation to place outgoing calls to the lines of all other workstations.

Construction

Figure 160: Klappenschrank zu 20 Leitungen

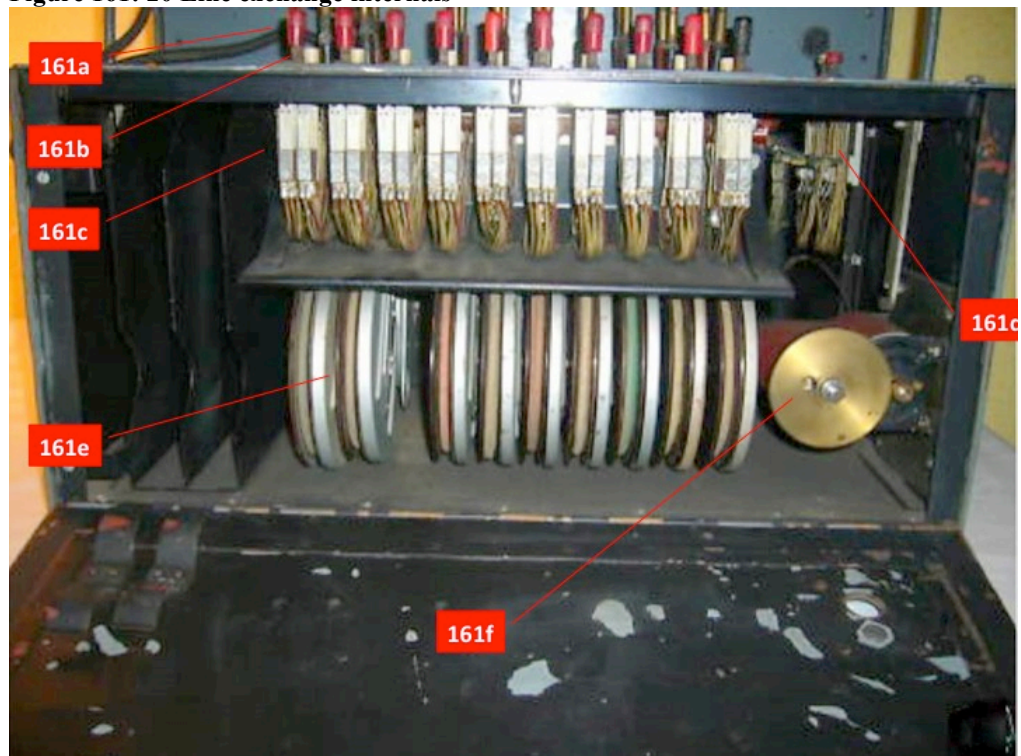


160a Upper 10 lines with signal flaps and interconnection plug sockets
 160b Lower 10 lines with signal flaps and interconnection plug sockets
 160c Conference call sockets

160d Alarm bell battery compartment
 160e Handset
 160f Signal indicator
 160g Switches for ring tone generation and parallel operation

160h Interconnection cable jacks
 160i Kellogg switches and call-back buttons
 160j Generator crank

Figure 161: 20 Line exchange internals



161a Kellogg switch
 161b Call back button
 161c Call back button contacts

161d Parallel operation and ring tone switch contacts
 161e Spring loaded cable reels

161f Generator

Figure 162: 20 Line exchange back connection panel



162a 30 pole sockets for remote connection of lines

162b 30 pole sockets for parallel operation

162c Direct line connection terminals

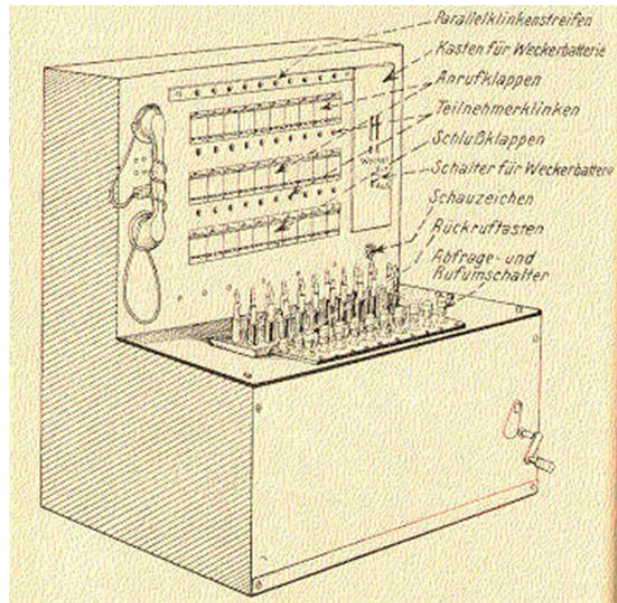


Figure 163: Handbook illustration

Operation

- Place the “*Klappenschrank zu 20 Leitungen*” on a suitable surface.
- Remove the front panel. Remove the back cover and connect the incoming field telephone lines.
- Unlock the signal flap locking bar and lock in the up position. Close any signal flaps that have dropped during this operation.
- Open the battery panel and connect the battery.
- If the enlargement panel is used, place this on top of the switchboard and connect the incoming lines to the connection terminals on the back.
- Set the alarm bell switch to the desired operation (“*Aus*” for silent operation). You are now ready to operate the switchboard.

When an incoming call is received, the signal flap of the incoming line will drop. At the same time, the alarm bell will ring (if switched on) or the alarm indicator with flash. Place the first red interconnection cable into the socket of the incoming line and place the Kellogg switch in the “*Abfr.*” position. Take the handset from the hook; you can now speak to the incoming caller (while depressing the microphone switch on the handset as usual). When the caller has given the outgoing line he wishes to speak to, place the first black interconnection cable into the socket of the outgoing line. Hold the Kellogg switch in the “*Rufen*” position and crank the generator handle. When the outgoing line answers, place the Kellogg switch in the neutral position and close the signal flap of the incoming line. The connection is now established and the switchboard is ready to take the next call. Up to 10 calls can be connected like this at the same time.



Figure 164: Klappenschrank zu 20 Leitungen in action

To end the call, one of the participants has to crank the generator handle, this will cause the signal flap of the relevant cable pair (bottom row of signal flaps) to fall. At the same time the alarm bell will ring or the alarm indicator will flash. Disconnect the interconnection cables from both the incoming and outgoing line and let them retract into the bottom panel. The interconnection is now ready for re-use.

The key difference with the switchboards described earlier in the chapter is that not every individual line has its own Kellogg switch or interconnection button. Before the operator can speak to an incoming line, one of the interconnection cables has to be plugged into the required socket. If all ten interconnection cable pairs are in use, it will not be possible to respond to an incoming call.

When the enlargement unit is placed on top, calls can be made to more lines and to external lines. The operation of the external line fields is identical to that of the “*Ambstzusatz*” described before.

Grosse Feldklappenschrank (1937)

Development and Description



Figure 165: Grosse Feldklappenschrank

The development of the large field switchboard goes back to 1916, when the imperial army introduced the “*Grosse Feldklappenschrank 16*”. Conceived as a modular system, the large field switchboard was not designed for a particular number of lines, but could be configured as required. The design was slightly updated in 1937, after which it was simply known as “*Grosse Feldklappenschrank*”. Units from the 1916 and 1937 versions remained interchangeable.

The main modules of the “*Grosse Feldklappenschrank*” are:

- a) Collapsible metal table frame
- b) Base unit a (“*Untersatz a*”), containing the interconnection cable pairs and switches
- c) Base unit b (“*Untersatz b*”), forming a writing surface
- d) Line connection unit for 10 lines, containing 10 signal flaps and interconnection cable sockets
- e) Line connection unit for 50 lines, containing 50 signal flaps and interconnection cable sockets
- f) “Scribner” parallel connection unit for 40, 100 or 150 lines.
- g) Public network connection unit (“*Ambstszusatz*”), containing three public line connection field complete with dialling disks
- h) Conference call connection strips with 10 interconnection cable sockets



Figure 166: Configuration with 70 lines, three public connections and one conference call unit (in base unit a)

The units were interconnected with 30-pole plugs and cables. The outgoing telephone lines were not connected to the units directly, but a remote terminal block was used connected by a 30-pole cable interconnection cable.

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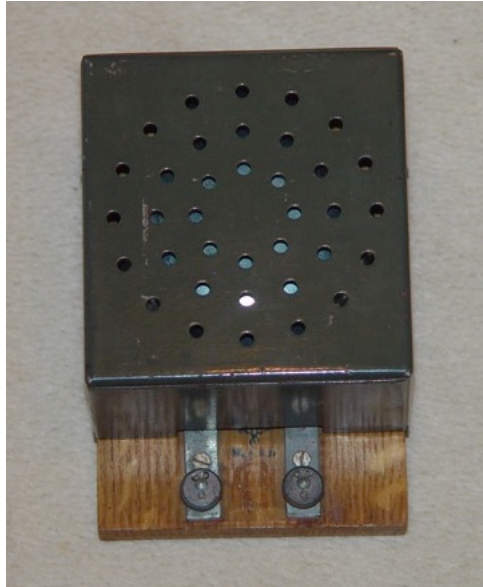


Figure 21: Gleichstromwecker

10 line connection units and the Public network connection unit would be stacked on top of base unit b. This would give the switchboard a total of 50 field telephone lines and 3 public network connections. If more field telephone lines were required, the three line connection units could be replaced with a single 50-line unit, in this way 70 field telephone lines could be serviced.

For larger switchboards, several switchboards could be placed next to each other and interconnected by using “Scribner” parallel connection units. For example, the units on the base unit b could be replaced with a 150 line parallel connection unit. In this way, a total of six complete 30 line switchboards could be linked together for a total of 180 lines. By sharing the “Scribner” connection units both left and right of each operating station and using 50 line connection units, a total of 7 complete 50 line switchboards could be linked into a single 350 line switchboard.

A number of accessories could also be used such as an *Gleichstromwecker* external alarm bell and the ring tone generator, usually containing two buzzer circuits (*Doppelpolwechselfalter*).

The modular construction of the large switchboard meant that it was easily transportable and highly flexible. A typical set up would consist of both base units placed side by side on the table frame. Three 10 line connection units and a conference call unit would be stacked on top of base unit a and two



Figure 168: Doppelpolwechselfalter

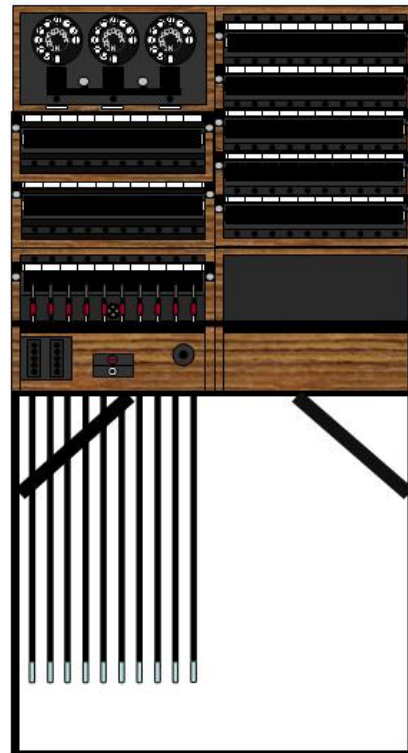


Figure 169: Configuration with 70 lines + 3 public network connections

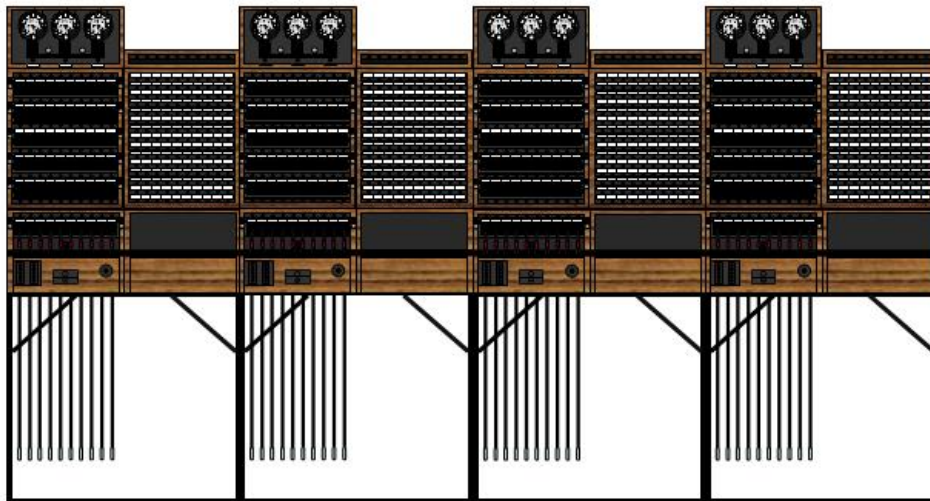


Figure 170: Large exchange (200 lines + 12 public connections) using 50-line units and 150-line Scribner units

For larger switchboards, an “*Überwachungsschrank*” or monitoring panel could be added, allowing a supervisor to monitor the operation and perform fault finding.

The metal frame has a height of 72.5 cm, the height of the base units are 11.5 cm to the line panel and 23.5 cm total height. The “working surface” is therefore a comfortable 84 cm off the ground.

The module standard width and depth are 32 x 18 cm while the standard line connection unit for 10 lines is 11 cm high. The *Ambstzusatz* unit is 17 cm high while the conference call connection unit is only 6 cm high. The height of the 50-line unit and the 100-line “Scribner” unit is 39 cm. By combining the units, stacks of the same height can be constructed. For example 3 x 10-line units plus a conference call unit or 2 x 10-line unit plus the *Amtszusatz*. The total height of the switchboard including the frame is typically 135 cm.



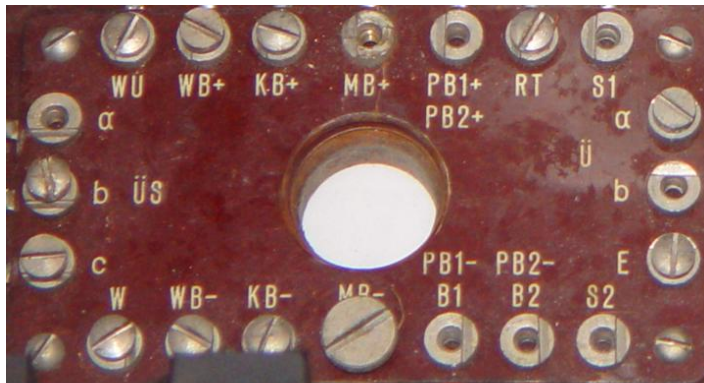
Figure 171: (r) Supervisor base unit and measuring unit on top

Most units have an alignment ridge on the bottom and a corresponding slot on the top of the unit. Each stack of units could be fixed together with a locking pin running top to bottom through all units. The conference call unit is clearly designed to be the top unit, as the top lid has to be opened to gain access to the locking pin holes.

The “*Grosse Feldklappenschrank*” uses a two-cord interconnection system. A total of ten interconnection cord pairs are provided in base unit a. When not in use, the interconnection cords are suspended under the base unit, weighed down by cable weights. Ten Kellogg switches are connected to the interconnection cords; this means

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that the operator can only speak to an incoming line once one of the interconnection cords is plugged into the relevant field. To avoid confusion, the cable pairs are alternatively coloured white, green and red.



The lid of the bottom section of the base units can be lifted, giving access to various connection strips. Accessories like external batteries, alarm bells, buzzer unit are connected to these strips in the base unit.

Figure 172: Base unit a connection panel (see table for explanation)

WU	Wecker Untersatz	Connects to the stacking pin contacts in both base units and to the external alarm bell.
W	Wecker	
WB+	Wecker Batterie +	Connects the alarm bell battery
WB-	Wecker Batterie -	
KB+	Kontroll Batterie +	Connects control battery
KB-	Kontroll Batterie -	
MB+	Mikrofon Batterie +	Connects the microphone battery
MB-	Mikrofon Batterie -	
PB1+ PB2+	Polwechselschalter Batterie 1&2 +	Connects the ringtone generator batteries
PB1- B1	Polwechsel Batterie 1 – Batterie 1	
PB2- B2	Polwechsel Batterie 2 – Batterie 2	
RT	Ruf Taste	Connects to the activation contact of the ringtone generator
S1	Signal 1	Ringtone signals for the ringtone generator
S2	Signal 2	
Ü a	Überwachung a	
Ü b	Überwachung b	Connects to the monitoring panel.
ÜS a	Überwachungs Schrank a	
ÜS b	Überwachungs Schrank b	
ÜS c	Überwachungs Schrank c	Earth connection
E	Erde	

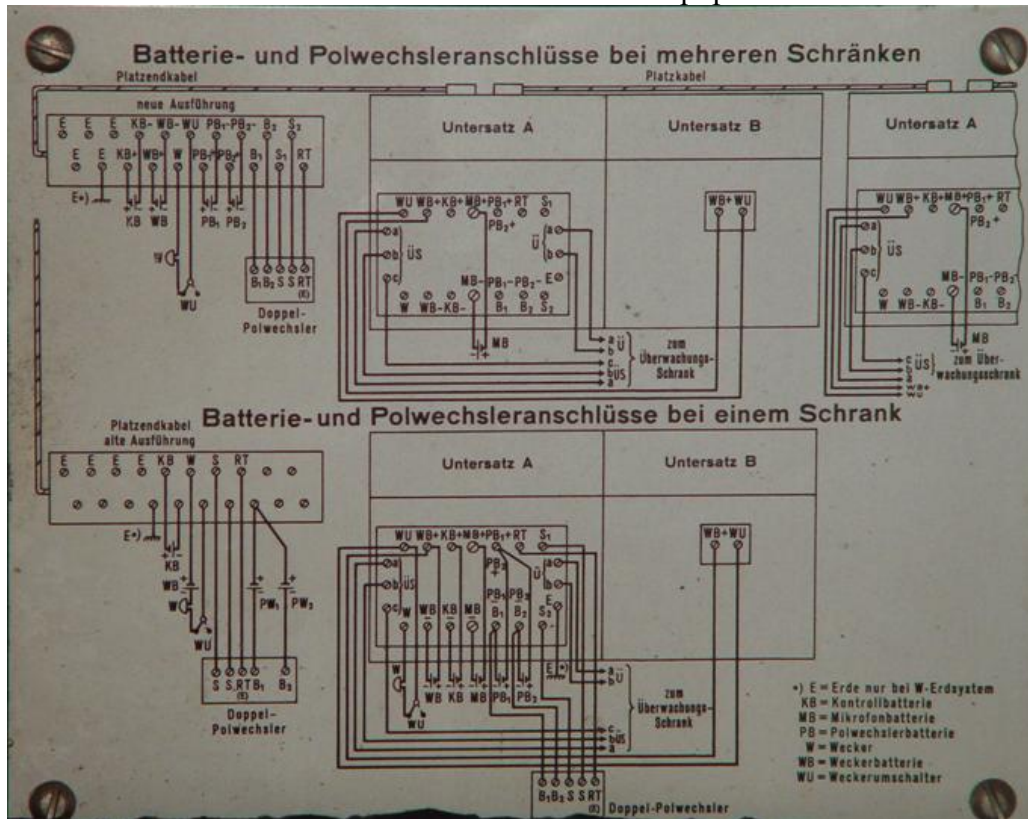


Figure 173: Connections for single or multiple switchboards.

Two five-pin plugs on the front of base unit a allow connection of handset and/or headset. Typically a busy switchboard would require the use of a headset and breast microphone, keeping the hands of the operator free. The base unit b surface could be used as a writing surface to keep logs.

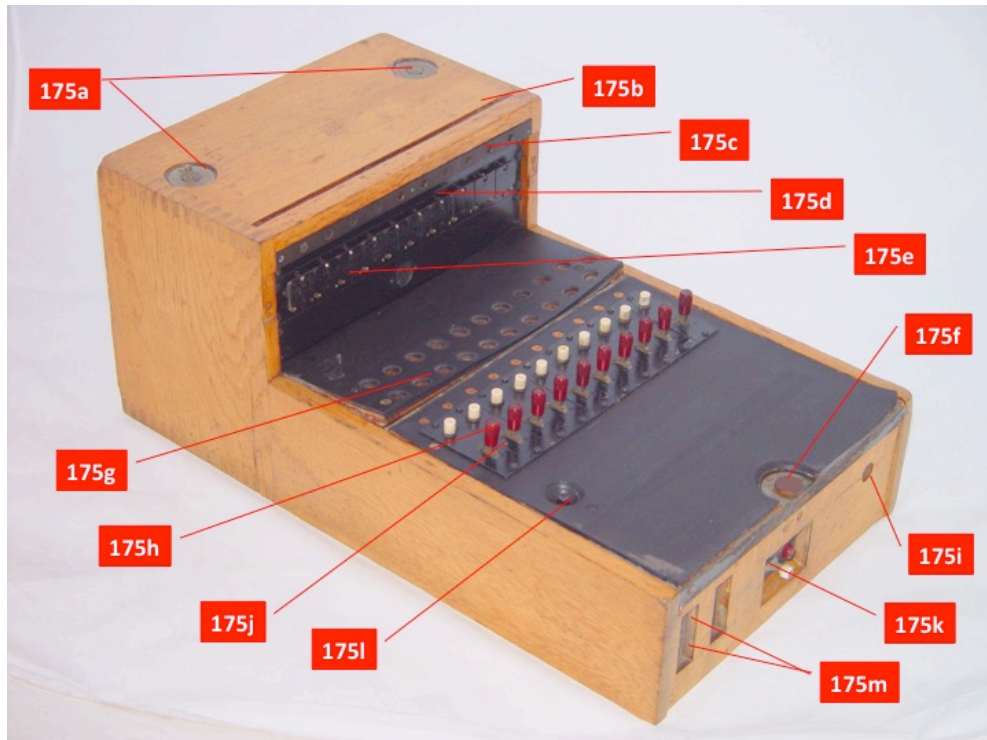
All line connection units used remote connection panels to connect to the incoming telephone lines with the 30-core cables plugging into the back of the units.



Figure 174: Remote connection panel plugged into the back of a 10-line connection unit

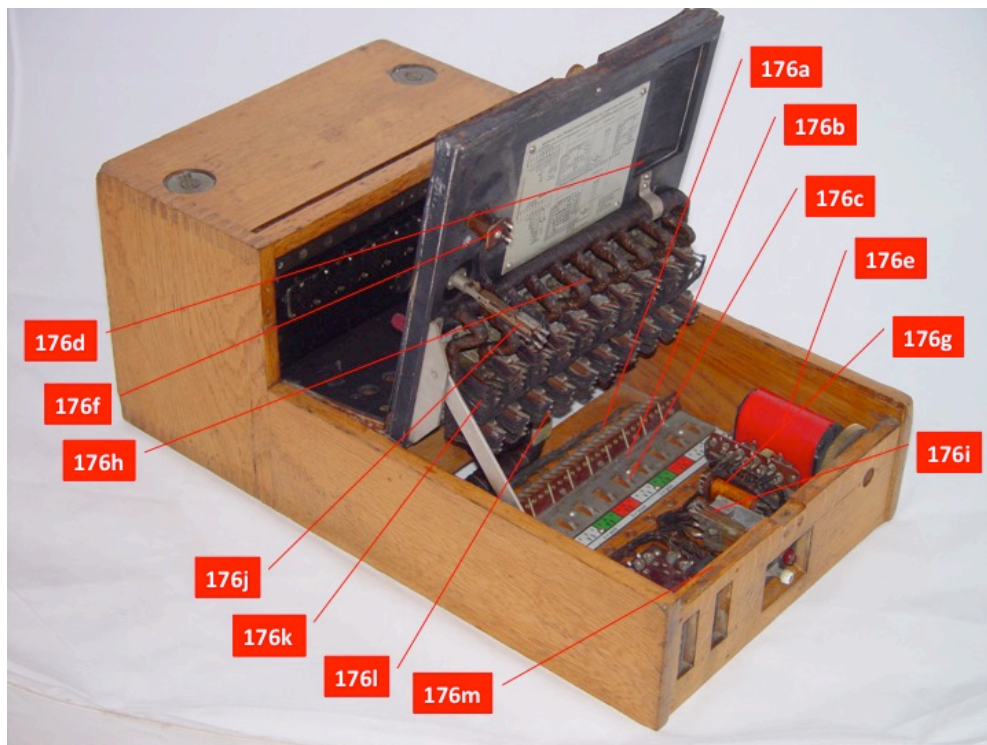
Construction

Figure 175: Base unit a overview



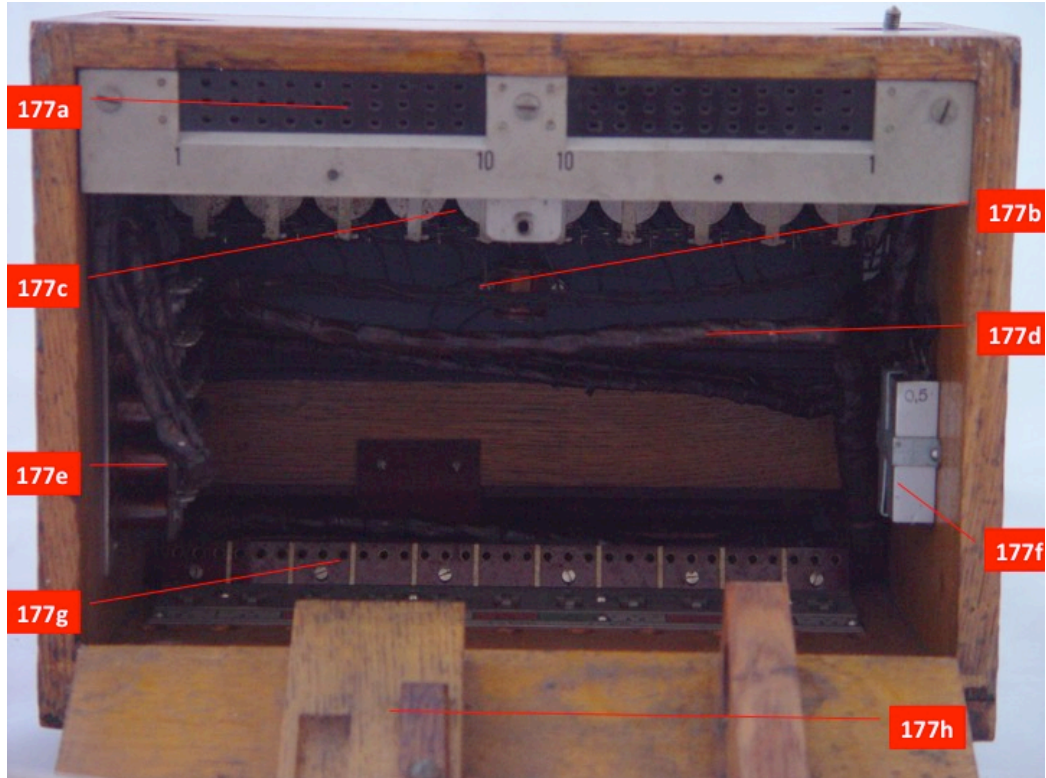
- | | | |
|-----------------------------------|--|---|
| 175a Stacking pin sockets | 175g Passages for interconnection cables | 175k External alarm bell and parallel connection switches |
| 175b Alignment groove | 175h Callback buttons | 175l End pulse button |
| 175c Monitoring plug sockets | 175i Generator crank hole | 175m Sockets for hand- or headsets |
| 175d Signal flaps for cable pairs | 175j Kellogg switches | |
| 175e Alarm indicator | | |
| 175f Locking screw | | |

Figure 176: Base unit a front compartment



- | | | |
|---|--------------------------------|-------------------------------|
| 176a Front interconnection cable connection strip | 176d Schematic | 176i Front switch contacts |
| 176b Hooks for interconnection cables | 176e Ringtone generator | 176j Wiring loom |
| 176c Connection instructions | 176f End pulse coil | 176k Kellogg switch contacts |
| | 176g Microphone coil | 176l Callback button contacts |
| | 176h End pulse switch contacts | 176m Connection panel |

Figure 177: Base unit a back compartment



177a 30-pole interconnection socket
177b Alarm indicator coil

177c Signal relays for cable pairs
177d Wiring loom
177e Coils

177f Capacitor block
177g Rear interconnection cable connection strip
177h Tool storage

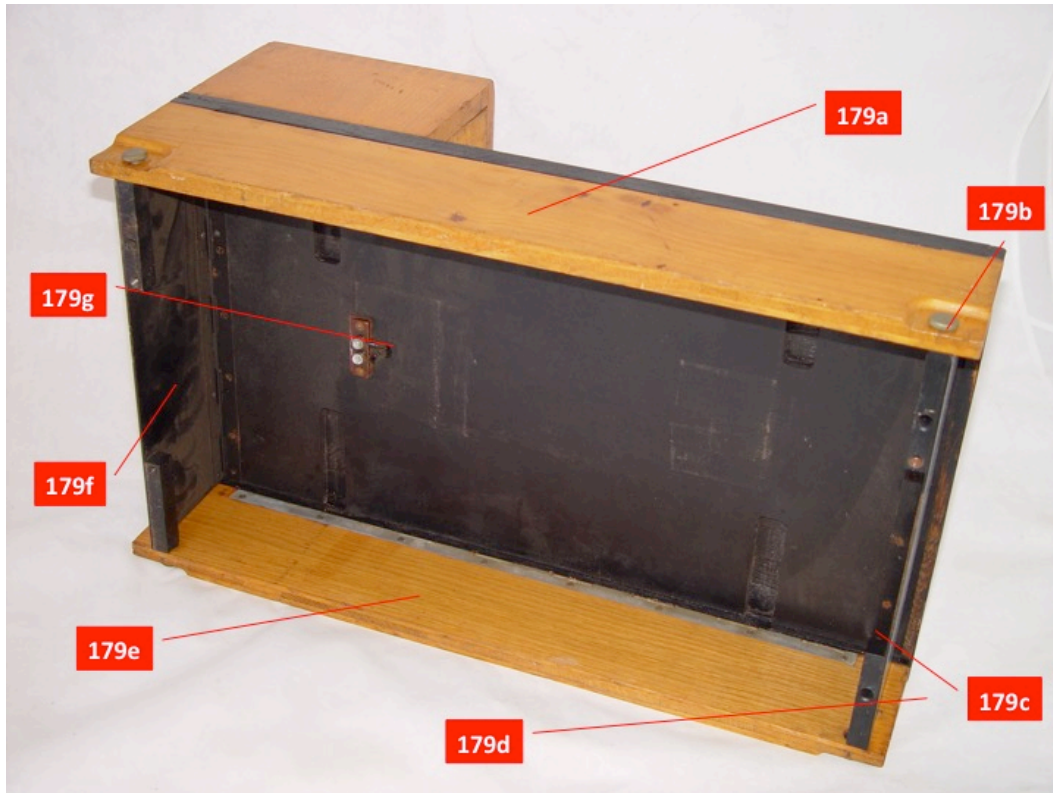
Figure 22: Base unit B overview



178a Lid closure storage compartment

178b Stacking pin socket
178c Fastening screw

Figure 23: Base unit B underside

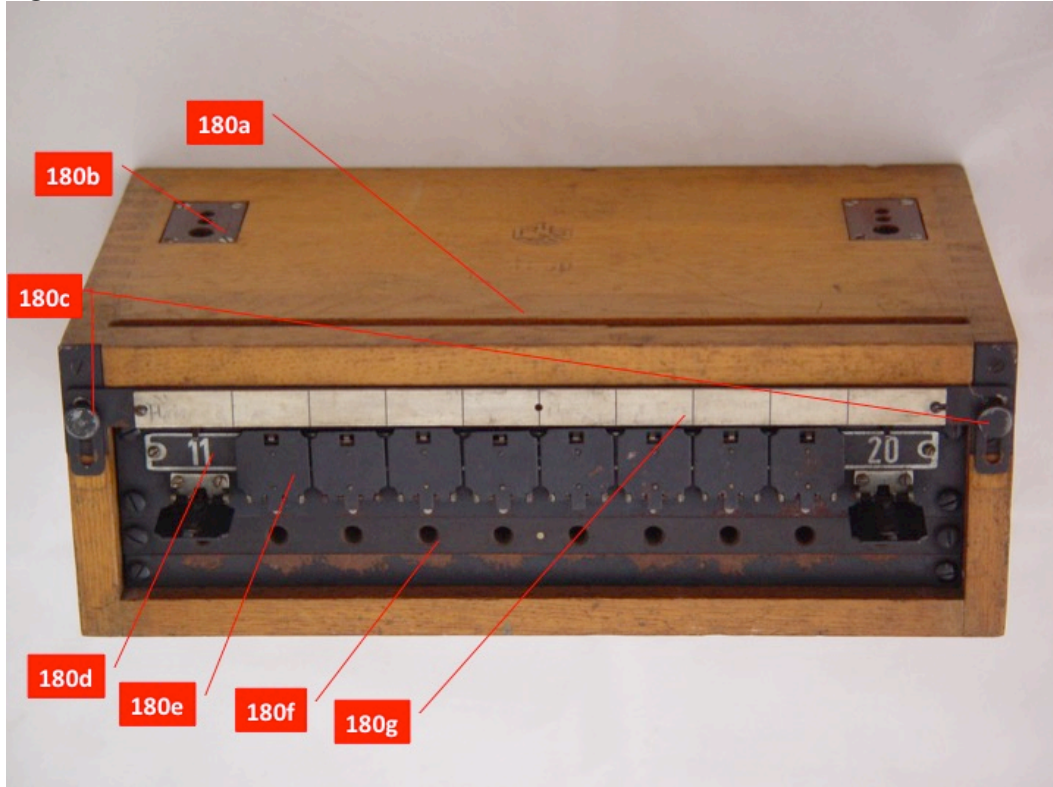


179a Sidewall folded out
179b fastening screw for
sidewalls

179c front wall folded out
179d Frame mounting hole
179e Sidewall folded out

179f Backwall folded out
179g Connections for stacking
pin contacts

Figure 180: 10 line connection unit front view

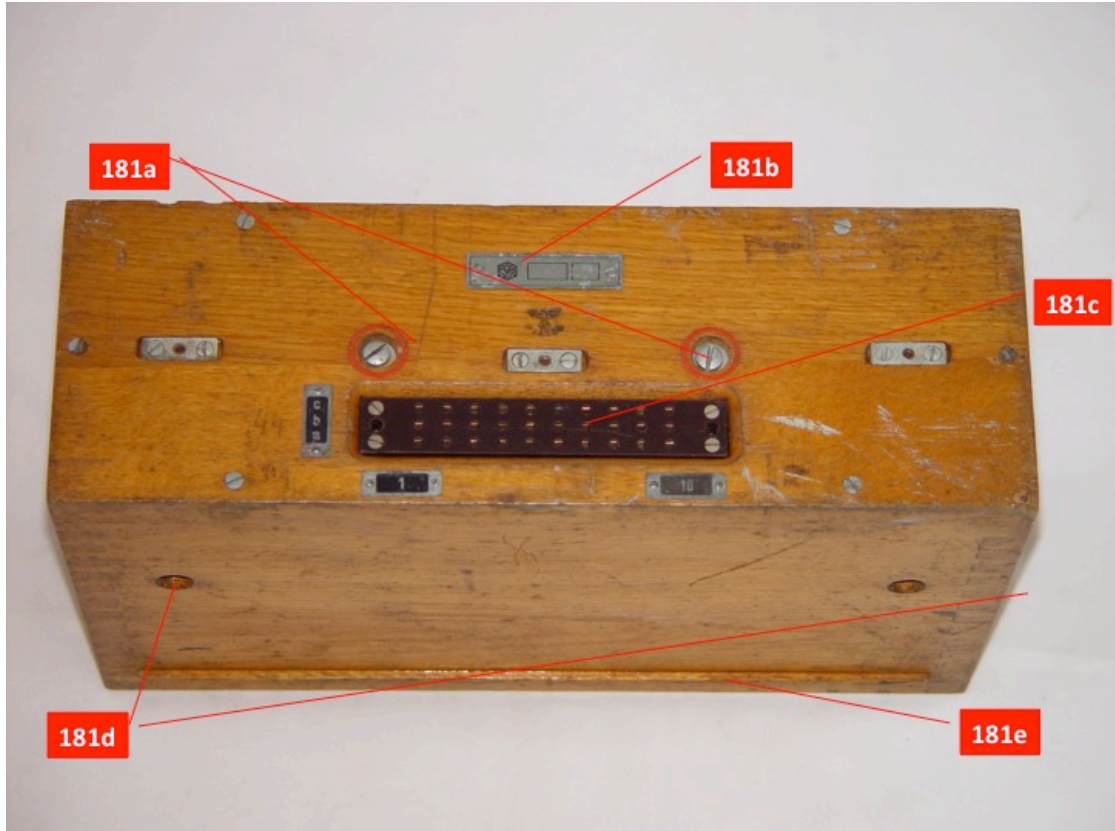


180a Alignment groove
180b Holes and contacts for
stacking pin
180c Locking bar screws

180d Line Number strip
180e Signal flap
180f Interconnection cable
socket

180g Locking bar with
writing tab

Figure 181: 10 line connection unit back view

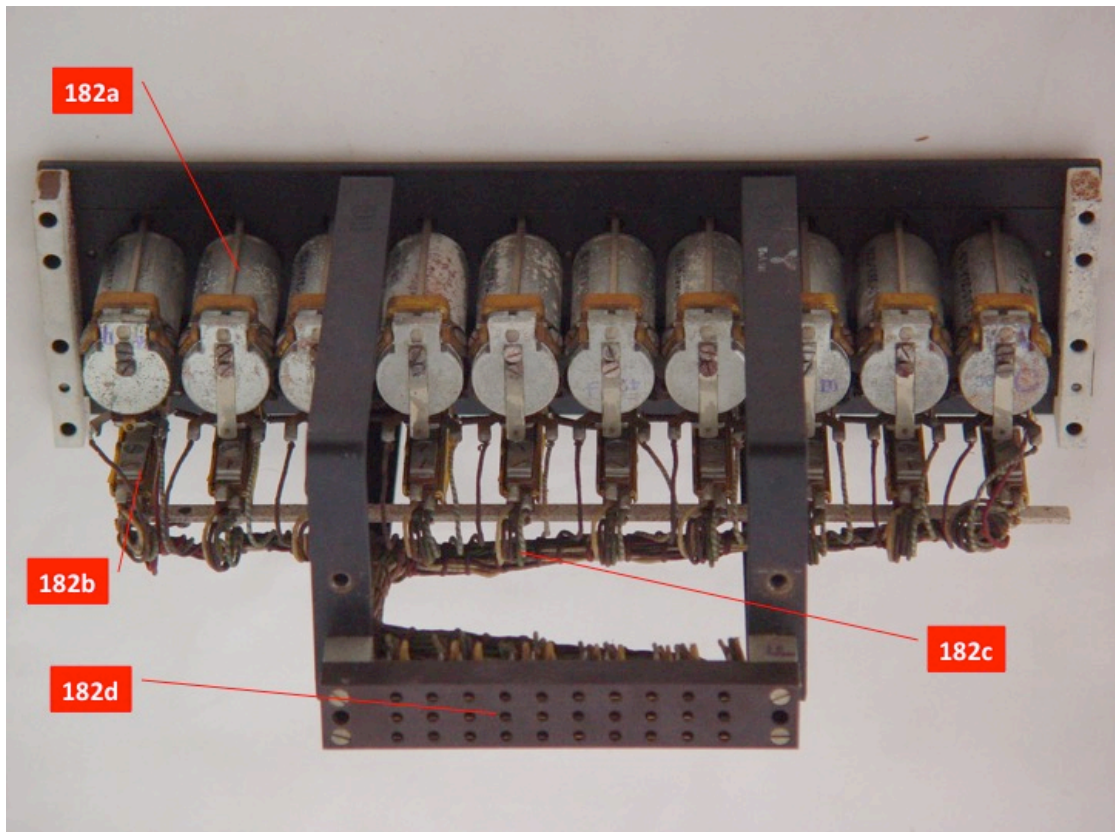


181a Housing locking screws
181b Maker/date tag

181c 30-pole interconnection
socket

181d Holes for stacking pins
181e alignment ridge

Figure 182: 10 line connection unit internal view

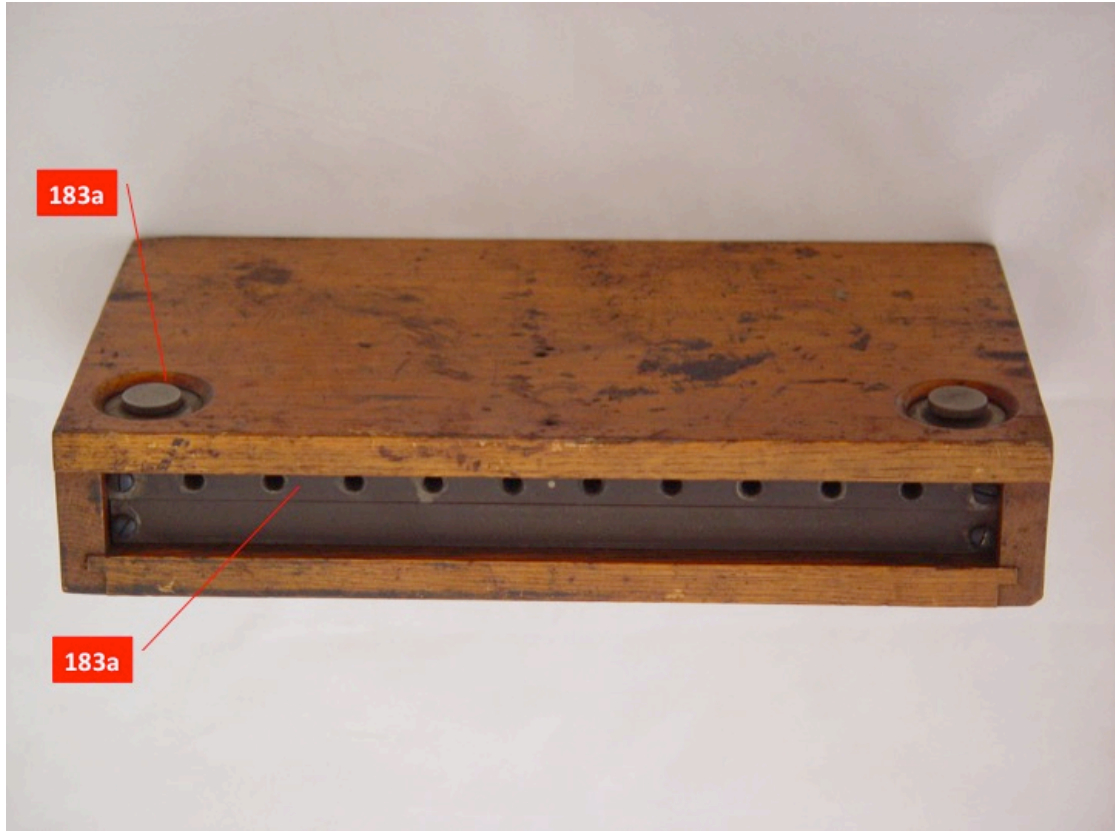


182a Signal relay

182b Interconnection cable
socket contacts

182c Wiring loom
182d 30-pole connection socket

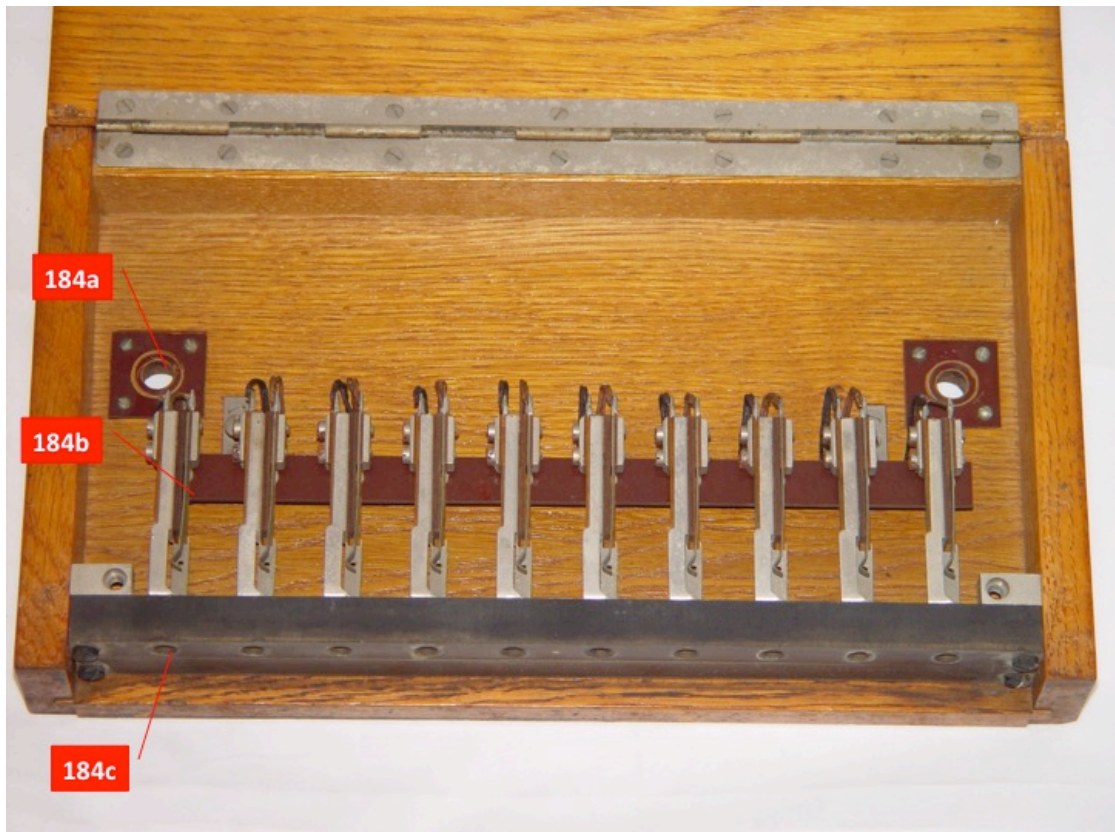
Figure 183: Conference call unit front view



189a Top lid locking screws

183b Interconnection cable sockets

Figure 184: Conference call unit internals



184a Hole for stacking pin

184b Interconnection cable socket contacts

184c Interconnection cable socket

Figure 185: Amtszusatz front view



185a Stacking pin holes
185b Alignment groove
185c Dialling disk

185d Signal flap
185e Locking bar screw
185f Locking bar

185g Connection cable socket
185h Writing tab

Figure 186: Amtszusatz rear view

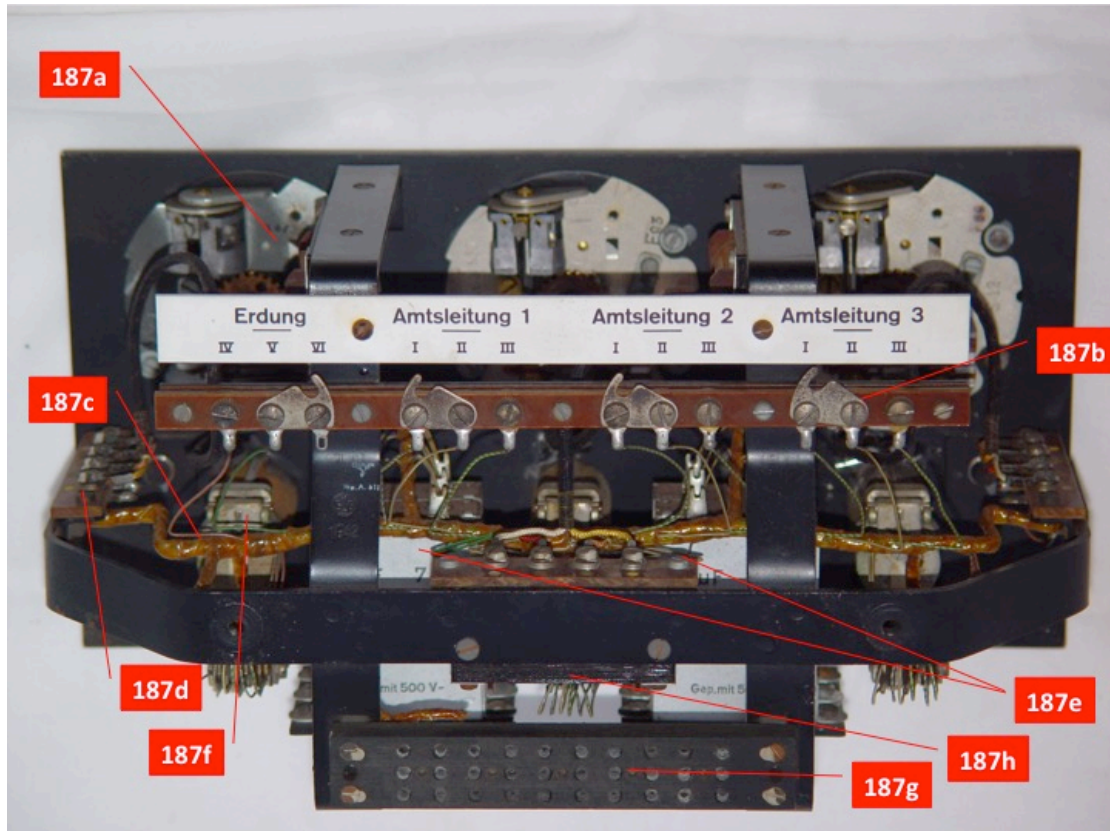


186a Earth jumper
186b Jumper numbering

186c Public network type
jumper
186d Jumper setting instructions

186e 30-pole plug socket
186f Schematic

Figure 187: Amtszusatz internal view



187b Dialling mechanism

187c Jumper strip

187d Wiring loom

187e Dialling disk connector

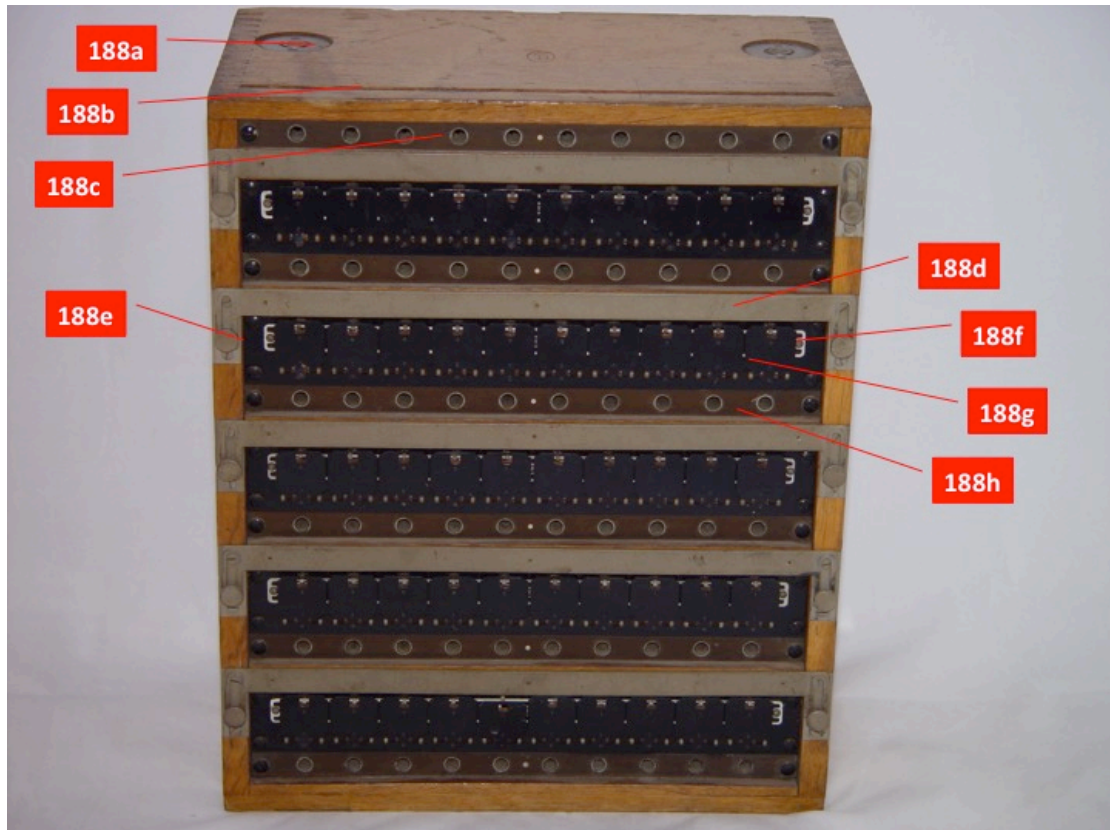
187f Capacitor blocks

187g Signal relay

187h 30-pole connection socket

187i End pulse self induction

Figure 188: 50 line interconnection unit front view



188a Stacking pin connector

188b Alignment groove

188c Conference call sockets

188d Locking bar

188e Locking bar screws

188f Numbering strip

188g Signal flap

188h Interconnection cable socket

Figure 189: 50 line interconnection unit rear view

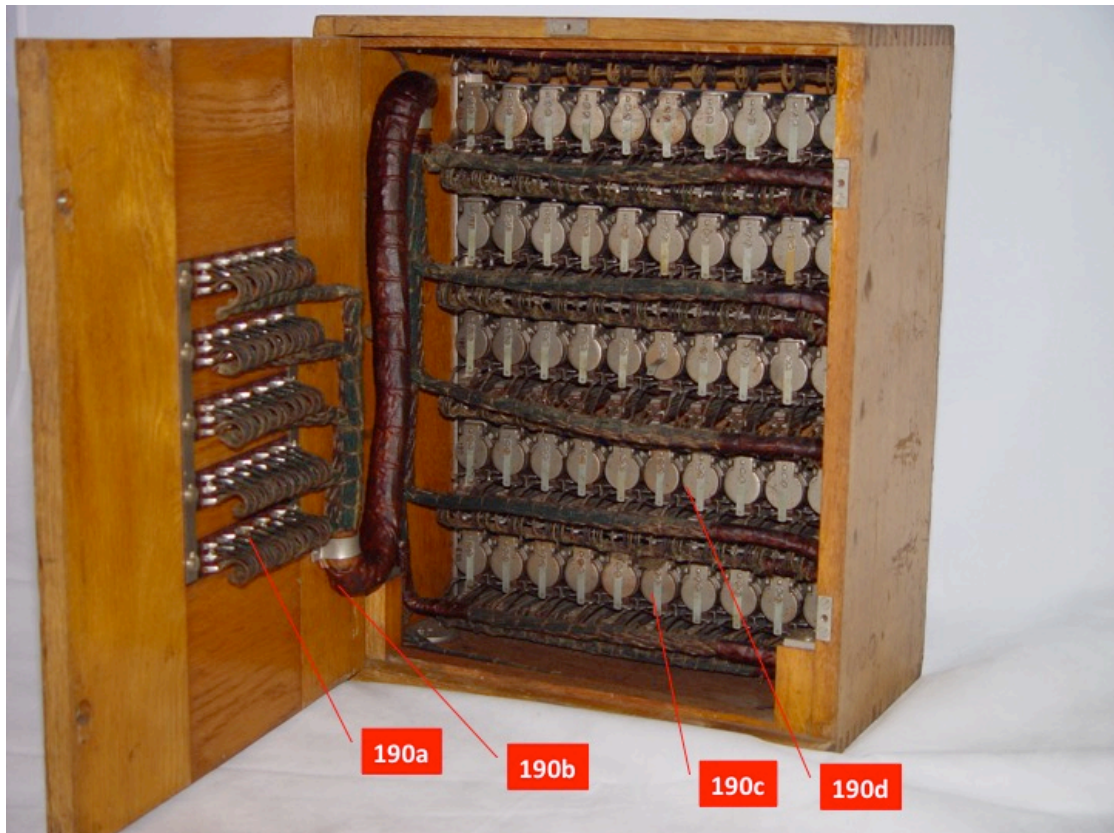


189b Rear panel locking screw

189c Maker/date tag

189d 30-pole socket

Figure 190: 50 line interconnection unit internal view



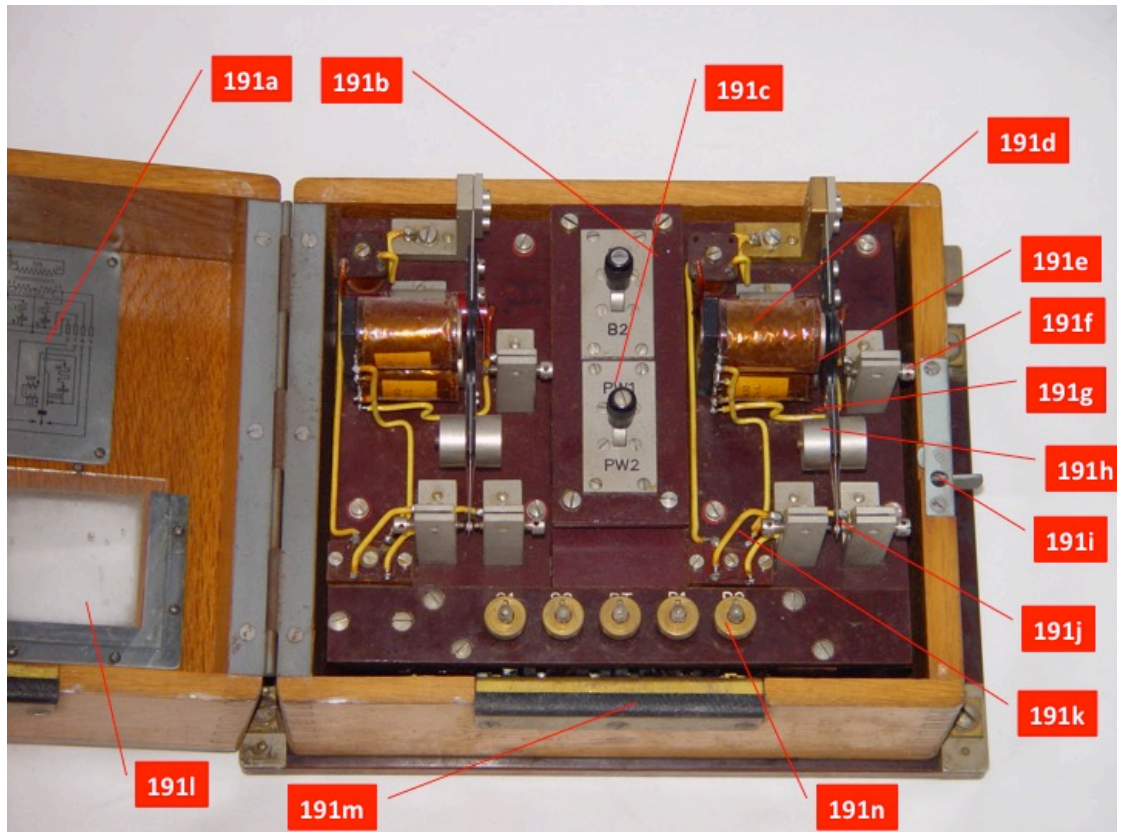
190a 30-pole connections

190b Wiring loom

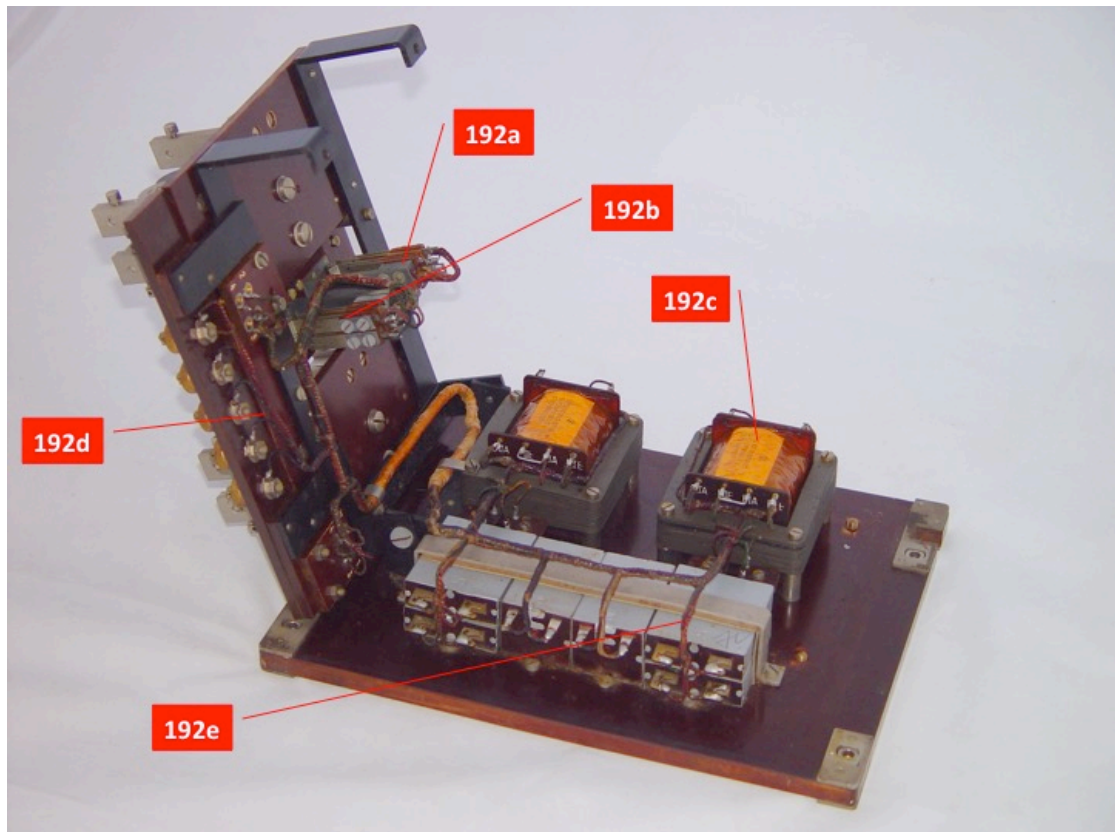
190d Signal relay

190c Interconnection socket contacts

Figure 191: Doppelpolwechschler top view



- | | | |
|---------------------------------|-----------------------------------|--------------------------------|
| 191a Schematic | 191f Generator contact adjustment | 191j Generator output contact |
| 191b Battery selection switch | 191g Swing arm | 191k Output contact adjustment |
| 191c Generator selection switch | 191h Swing arm weight | 191l Window |
| 191d Generator coil | 191i Casing lock | 191m Rubber cable transit |
| 191e Generator contact | | 191n External connections |
- Figure 192 Doppelpolwechschler internal view



- | | | |
|----------------------------------|---------------------------|-----------------------|
| 192a Battery selector contacts | 192c Output transformers | 192e Capacitor blocks |
| 192b Generator selector contacts | 192d External connections | |

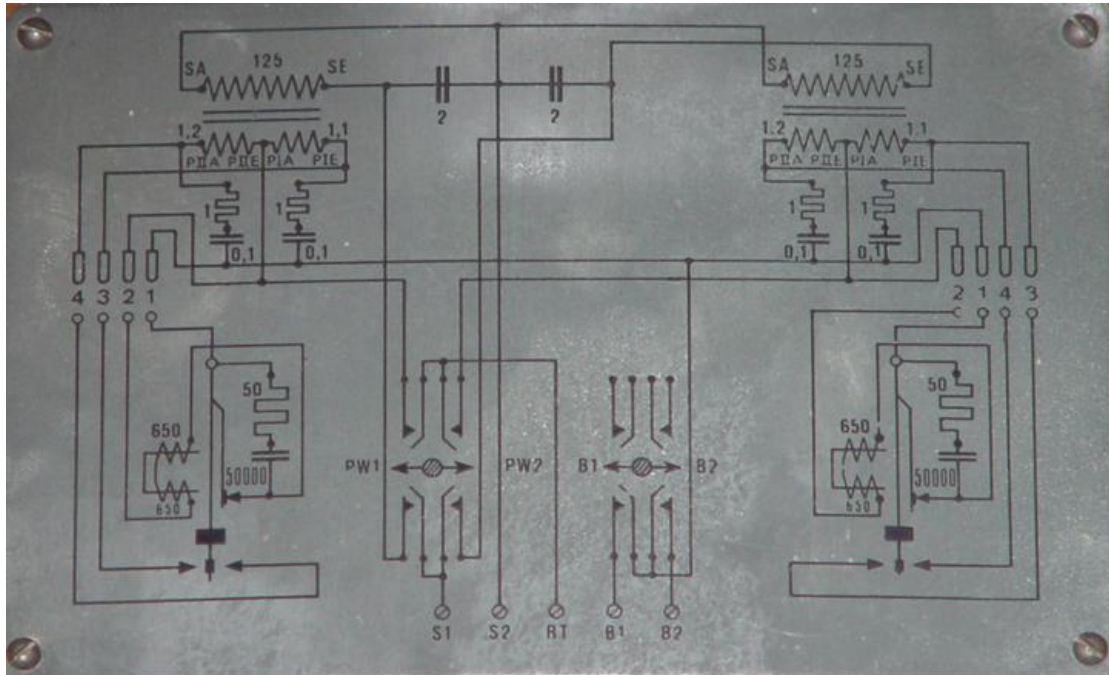


Figure 193: Doppelpolwechsellerschalter schematic

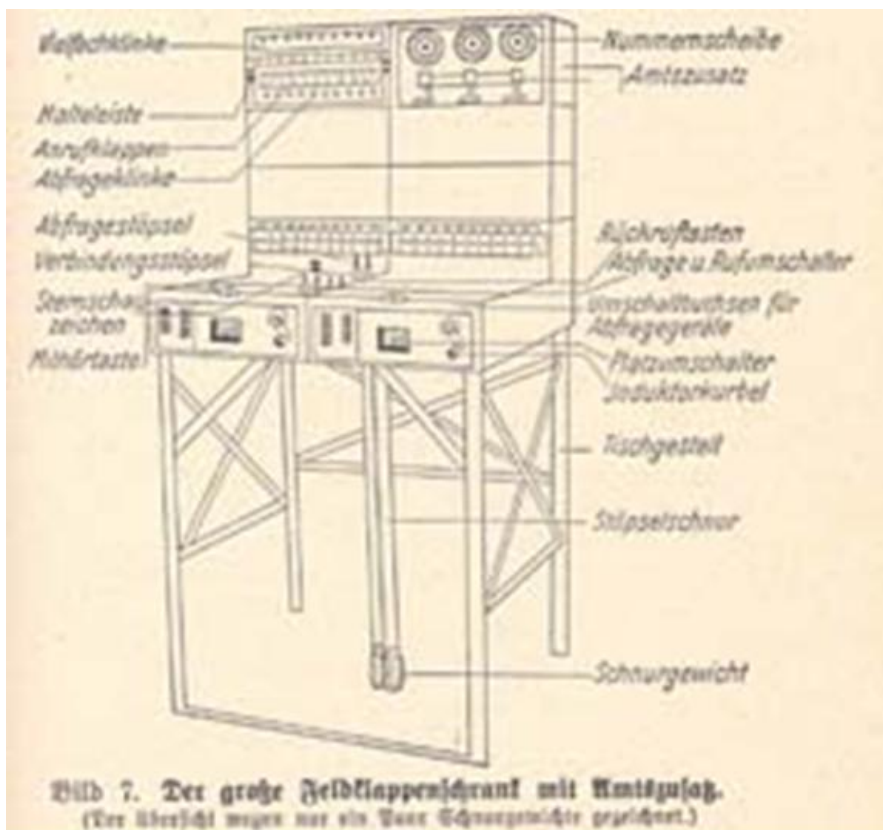


Figure 194: Grosse Feldklappenschränk description from instruction booklet

Operation

The *Grosse Feldklappenschrank* could be used in many configurations; in this section a single 50-line set-up is assumed. This setup consists of:

- a. Table frame
- b. Base unit a
- c. 10 interconnection cable pairs
- d. Cable weights
- e. Base unit b
- f. 10-line unit 1-10
- g. 10-line unit 11-20
- h. 10-line unit 21-30
- i. 10-line unit 31-40
- j. 10-line unit 41-50
- k. Conference call unit
- l. 3-line *Amtszusatz*
- m. *Doppelpolwechselfalter*
- n. External Alarm Bell
- o. Line connection units
- p. 30-pole interconnection cables
- q. Stacking pins
- r. Battery

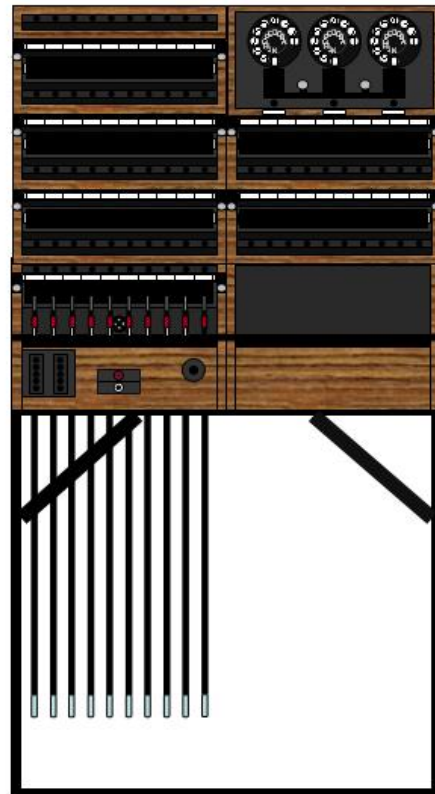


Figure 195: Feldklappenschrank 50 line configuration

To set up the *Grosse Feldklappenschrank*:

- Erect the table frame, ensure all locking screws are tight
- Place base unit a on the left of the table frame
- Place base unit b on the right on the table frame.
- Connect the interconnection cables to base unit a, each cable held taught by a cable weight. Ensure that the cables are not crossed in any way and run freely.
- Connect the Alarm bell contacts in base unit b to the connection panel in base unit a.
- Connect the microphone battery and the battery for the *Polwechselfalter* to the connection panel in base unit a.
- Connect the *Doppelpolwechselfalter* and the external alarm bell to the connection panel in base unit a.
- Set both control switches on the front panel to the central position.
- Stack the 10-line units 1-10, 11-20, 21-30 and the conference call unit on top of base unit a.
- Open the lid of the conference call unit and place the stacking pins through the units and screw them tight onto the base unit a.
- Stack the 10-line units 31-40, 41-50 and the 3-line *Amtszusatz* on top of base unit b.
- Place the stacking pins through the units and screw them tight onto base unit b.
- Place the five line connection units at the place where you want to collect the incoming field lines (usually outside the building or shelter where the switchboard is placed).

German Field Line Communication Equipment of WW2©

- Connect the line connection units to their respective line units using the 30-pole cables.
- Connect the incoming field lines to the line connection units.
- Connect up to three public telephone lines to the *Amtszusatz*.
- Plug in the operator headset and connect the generator crank handle to the generator.
- Unlock all the signal flaps by moving the locking bars and mark up line information on the writing strips and tabs. Close any flaps that fall during this operation. You are now ready to operate the *Grosse Feldklappenschrank*.

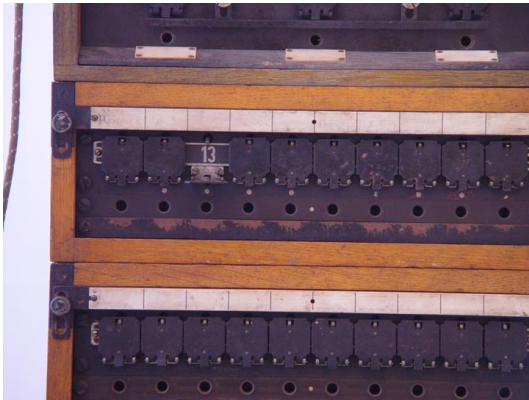


Figure 196: Signal flap indicating incoming call

Move the Kellogg switch backwards in the “*Abfragen*” position. Now the operator can speak to the incoming line. When the caller has indicated which outgoing line is required, place the first front interconnection cable into the outgoing field and move the Kellogg switch forward to the “*Rufen*” position.

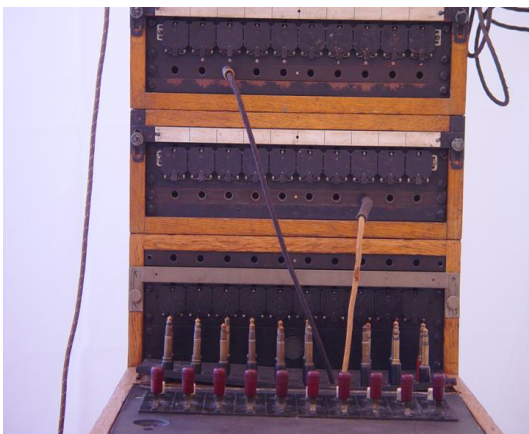


Figure 198: Incoming and outgoing lines connected

When an incoming call is received, the signal flap of the relevant line will drop. At the same time the alarm indicator on the front panel will flash and the external alarm bell will ring. Place the first rear interconnection cable into the incoming field; this will automatically reset the signal flap to the closed position.

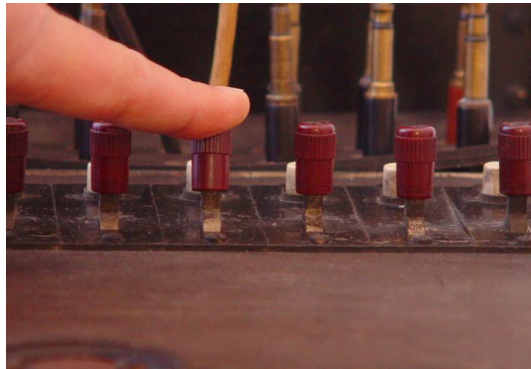


Figure 197: Operating the Kellogg switch to speak to the incoming caller and to ring the requested line

This will activate the “*Doppelpolwechselschalter*” and will cause the alarm bell to ring at the outgoing line. When the outgoing line answers, place the Kellogg switch in the middle position, the incoming and outgoing lines are now connected.

If the incoming line has to be called back, this can be done by pushing the white button behind the Kellogg switch. This will activate the *Doppelpolwechselschalter* and the alarm bell will ring of the phone of the incoming line.

German Field Line Communication Equipment of WW2©

Up to ten connections can be made simultaneously this way. If several callers have to connect to the same call, one of two conference socket strips can be used, one in the base unit a and one at the top of the left stack. In this way two separate conference calls can be made simultaneously.

If a connection to a public line has to be made, call the required number on one of the three dialling disks and place the interconnection cable into the corresponding socket of the *Amtszusatz*. The end-pulse is automatically generated when the interconnection plug is pulled from the socket.



Figure 199: Calling an outside line

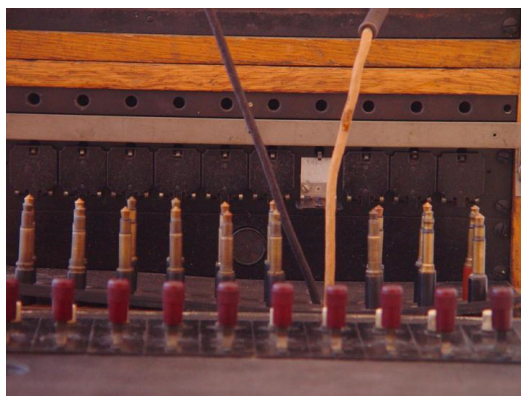


Figure 200: Connection indicator flap indicates that the call has ended and that the cable pair can be removed

At the end of the call, one of the participants has to crank the generator of his field telephone. This will cause the signal flap of the occupied interconnection cable pair to drop (the field behind the signal flap as well as the corresponding cable pair are coloured white, green or red for easy identification). At the same time the alarm indicator will flash and the external alarm bell will ring. Remove the interconnection cables and reset the signal flaps. The cable pair is now available for the next connection.

After prolonged use, the battery polarity of the “*Polwechselfschalter*” should be reversed (this will undo some of the wear on the contacts). This can be done by changing the switch in the “*Doppelpolwechselfschalter*” from “B1” to “B2” or vice versa. If the generator is starting to falter, change over to the second “*Polwechselfschalter*” in the unit by moving the switch from “PW1” to “PW2” or vice versa. Adjust the contacts of the failing generator if required. If both generator circuits fail, the generator can be used for manually generating the alarm signal. The red control switch on the front of base unit a has to be flicked to the right to operate the generator. The Kellogg switch has to be pushed forward while cranking the generator

Field Cables and laying equipment

Introduction

Command and control depends on secure and reliable communications, so as soon as possible the wire connection between headquarters and units would be established. In Germany itself extensive fixed networks were built up prior to the hostilities but when the fast moving Blitzkrieg broke out, entirely new field networks had to be built in record tempo.

In the build up to war, Germany allocated a significant amount of raw materials to the manufacture of Field cable so at the early stages of the war, the communication troops were relatively well placed to deal with the demands. During the Russian campaign however, the vast distances caused serious challenges. For example wooden poles to build long distance lines were in short supply and insufficient transport was available to ship the huge amount of materials required.

The telephone networks would originate from hubs on Germany's borders and the main trunk lines would follow the thrust lines of major battle formations such as army groups. Connections would branch off to minor formations down to the level of front line units. When higher headquarters advanced the trunk lines were extended and all the branches had to be dismantled and build-up again at the new positions.

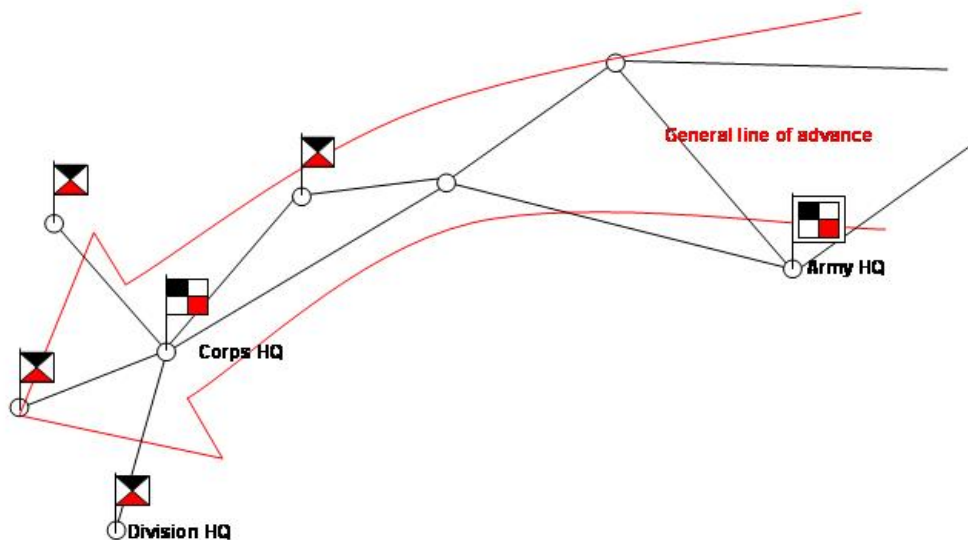


Figure 201: Higher formation networks, usually using existing civil lines or heavy long distance field cable (FFK) along the main axis of advance

Wherever possible, existing public telephone networks would be used for these trunk lines but often these were destroyed during the enemy retreat. In this case lines were provisionally built using “*Schweres Feldfern-kabel*” or Heavy Field Long Distance Cable. As quickly as possible, the Signal troops would then work to restore the public networks or build new overhead telephone lines so that the “*Schweres Feldfern-kabel*” could be reused during mobile operations.

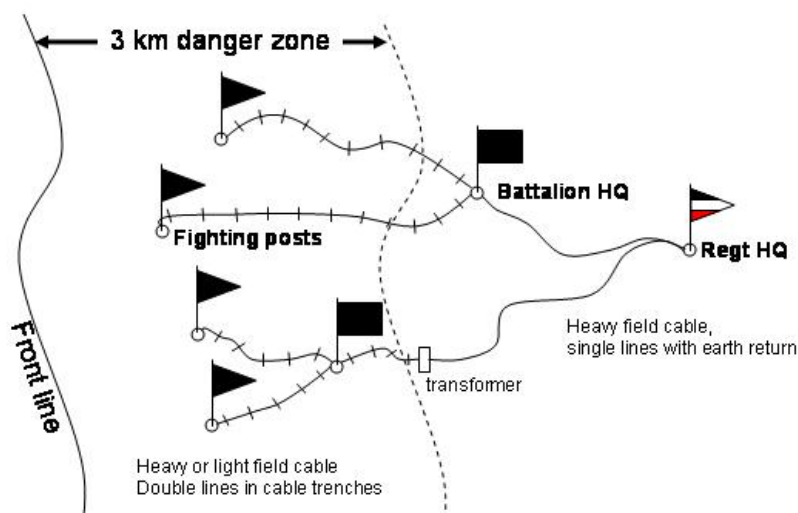


Figure 202: Forward branches using light or heavy field cable. Within 3 Km of the frontline, low-built double cable lines were the norm (hashed lines).

Typically in the Divisional area, single core heavy field cable would be used, usually with earth connections used for the return current. Along roads and where suspension points were available, the cables would be suspended at 3.3 meters above ground (“*Hochbau*”). Away from roads, near villages and on stretches under enemy observation, the lines would typically be laid low (“*Tiefbau*”).

To minimise the risk of interception, double cables were prescribed within 3 km of the front line, preferably suspended in cable trenches or on other low suspension points. It was forbidden to lay double field cables directly on the ground or suspend it in tree tops.

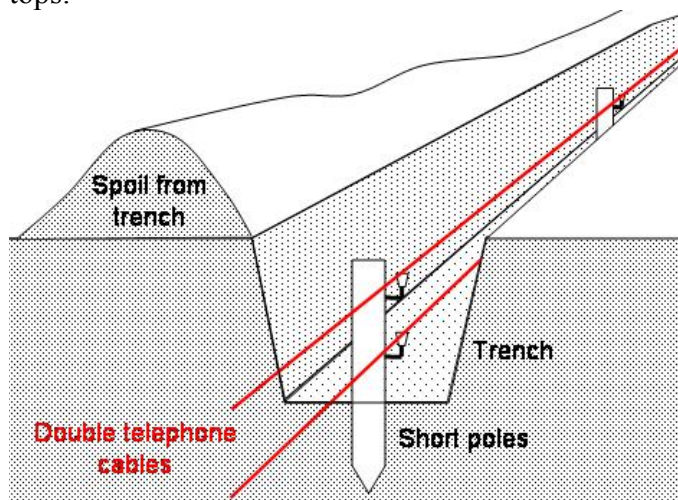


Figure 203: "Tiefbau" of double cables in a cable trench near frontline positions

When time or enemy action did not permit the building of such secure lines between fighting units, single core light or heavy field cable could be used, but the “*Feind hört mit!*” parole had to be adhered to.

The Germans also produced special cable for crossing rivers and water bodies (“*Flusskabel*”) but this would only have been used in short lengths.

German Field Line Communication Equipment of WW2©

For permanent suspended telephone lines ("*Freileitungen*"), the Germans used any suitable wire they could get hold of, typically un-insulated copper, bronze or steel wire 1.5 to 5 mm diameter.

Forward connections would primarily be built by "*Leichten Fernsprechtrupps*" Light Telephone Troops or "*Fernsprechanschlußtrupps*" Telephone Connection troops.

- A Light Telephone Troop consisted of 1 leader and 4 men and a vehicle. They were responsible for building the main lines backwards and sideways from the forward positions. They were equipped with both light and heavy field cable.
- A Telephone Connection troop consisted of 1 leader and 3 men. They were on foot and responsible for building lines to and between forward positions. They were equipped with light field cable only.



Figure 204: A light telephone troop engaged in "Geschlossene Bau" of a telephone line

The complete equipment of a "*Fernsprechanschlußtrupp*" consisted of the three signal backpacks, 2 *FF 33* field telephones, 2 signal pouches, 2 "*Vermittlungskästchen*" (switchboard units) and 2 earth pins.

Two men were usually required to build a single line. The first would be responsible for unrolling and tensioning the wire, the second would be equipped with a "*Drahtgabel*" or cable fork to hang the cable over branches etc. The Leader would usually accompany these two men to reconnoiter the route and indicate where the line was to be built. The third man in the troop would stay at the point of origin to test the line once established. For double lines, this procedure had to be performed twice. When cables were placed and suspended at the same time, the Germans called it a closed construction or "*Geschlossene Bau*".

When under time pressure, it was not always possible to properly suspend the wire while building. In this case the wire would simply be put on the ground to establish connection as quickly as possible and a second troop would follow to suspend and affix the cables. This was called split construction or "*Getrennter Bau*".

Within the Regiments, the "*Mittlere Fernsprechtrupps*" Medium Telephone Troops would be responsible for building connections between Regimental HQ and higher headquarters and to the neighboring regimental HQ. Because the majority of these lines were in rearward areas, single line connections would normally be built. It was also widely used by divisional and higher level communication troops for medium distance connections. The Medium Telephone troops would primarily use Heavy Field cable.

German Field Line Communication Equipment of WW2©

The building of a Heavy Field Cable took a minimum of 3 men. The first carried a spool of Heavy Field Cable on the “*Rückentrage*” carrying frame. The second was responsible for tensioning the line while the third used the cable fork to hang the wire over branches etc. The Troop leader would reconnoiter the route and indicate where the line was to be built.

At 17 Kg per spool only one spool could be carried per person; special cable carts were developed to carry multiple spools over longer distances.

In many cases the Heavy field cable was laid alongside roads, in which case the cable was unspooled from vehicle mounted frames. For longer lines racks filled with multiple spools could be mounted on the back of trucks.

Typical building times for Field Cable (either light or heavy) are given as:

- Closed construction: 20 - 40 min / km
- Split construction: 12 - 20 min / km
- From horseback: 5 - 25 min / km
- From vehicle: 5 - 25 min / km
- Double line: 30 -60 min / km

For dismantling the following typical times were used:

- Dismantling: 15 -30 min / km
- Dismantling using horse or vehicle: 5 -20 min / km

In the corps and higher headquarter areas the building of the lines was the responsibility of the communication troops attached from the *Nachrichten* regiments to these higher headquarters. The *Feldfernkabel* would typically be built by “*Schwere Fernspechtruppen*” or heavy telephone troops. These vehicle mounted troops would typically build About 2 km of FFK cable connection per hour, mainly along roads following the main axis of advance.

Light Field Cable

Light Field Cable or “*Leichtes Feldkabel*” consists of a 0.8 mm solid copper conductor with double layered cloth insulation. Later in the war the copper was partly replaced by steel strands and towards the end of the war plastic insulation was used. It came on small collapsible drums in lengths of 500 metres weighing 2-3 Kg each.

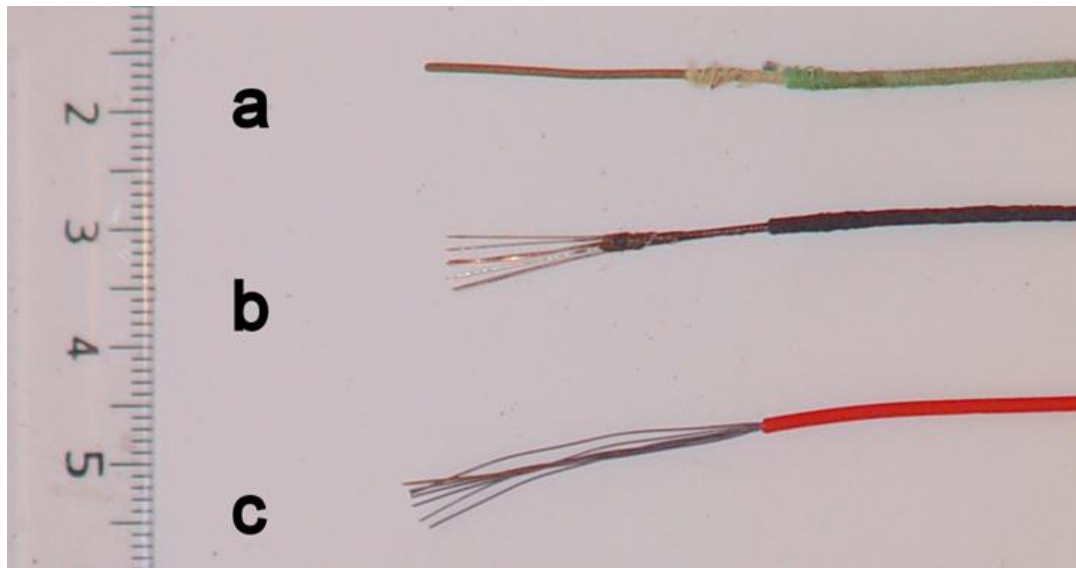


Figure 205: Leichtes Feldkabel

186a Pre-war, solid copper conductor, cloth insulation, waxed green cloth outer layer

186b Mid-war, 6 steel strands + 1 copper strand, cloth insulation, rubberized cloth outer layer

186c Late-war, 6 steel strands + 1 copper strand, red plastic insulation

Each regiment was issued with 8 Km of Light field Cable for use in forward positions. The drums of 17.5 cm diameter and 5 cm width were usually carried in the so called “signals backpack” and could be slid onto a handle (“*Abspuler*”) for easy unrolling. Since light field cable was predominantly used in forward areas it would be required to build double lines.

When simply placed on the ground, the range of the Light Field Cable would 3 to 5 km. By suspending the wires in the air by using trees, existing telephone poles and fences etc. this range could be extended to 20 km. The maximum span (for example to cross roads or rivers) would be 20-25 meters.



Figure 206: Cable reels with winder and dispenser

Heavy Field Cable

Heavy Field Cable or “*Schweres Feldkabel*” consists of a 2 mm twisted copper conductor with rubber/cloth insulation. Late in the war aluminium/steel conductors and plastic insulation were used.

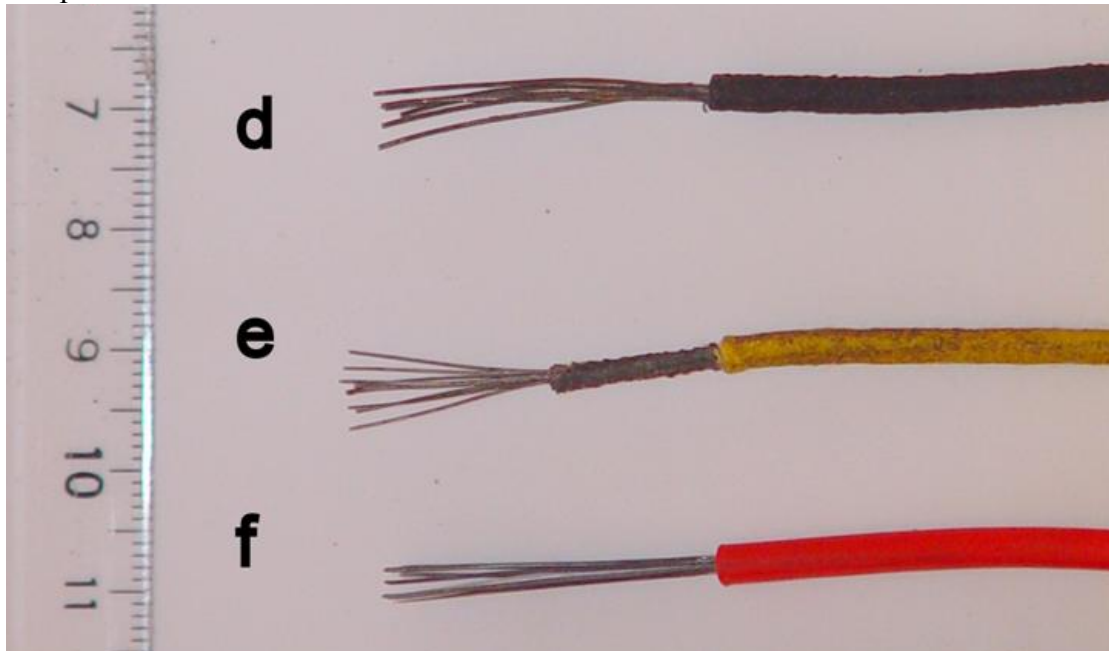


Figure 207: Schweres Feldkabel

188d Mid-war, 5 steel strands + 2 copper strands, rubber insulation, rubberized cloth outer layer

188e Mid-war, 5 steel strands + 2 copper strands, cloth insulation, waxed yellow cloth outer layer

188f Late-war, 8 steel strands +1 aluminium strand, red plastic insulation

Heavy field cable came on steel or wooden drums in lengths of 1000 metres weighing 17 Kg each.



Figure 208: Various drums of heavy field cable.

On one end of the drum, a gear wheel was mounted on the axle. This gear wheel allowed connection to the spooling mechanism of the “Rueckentrage”. On the other end of the drum, an exterior groove and connection screw were used to terminate the inner end of the cable. It was forbidden to cut heavy field cable, at the end of the line, the telephone had to be directly connected to the drum without cutting the cable.



Figure 209: End of the cable connected to the drum

Each regiment was issued with 14 Km of Heavy field Cable for use in backward areas. A number of specialized carrying frames and devices were developed so that the heavy cable could be dispensed on foot, horseback or by vehicles.

When simply placed on the ground, the range of the Heavy Field Cable would 10 to 12 km. By suspending the wires in the air by using trees, existing telephone poles and fences etc. this range could be extended to 60 km. The maximum span (for example to cross roads or rivers) would be 150 meters.



Figure 210: Wire termination

To terminate the wire, strip 3 cm off the insulation. Separate the copper (or later aluminium) strand from the steel strands and wind the copper strand tightly around the steel strands. Cut off the excess length of the steel strands.

Heavy Long Distance Field Cable



Figure 211: A Luftwaffe soldier connecting a Pupin coil to a heavy long distance field cable

Heavy Long Distance Field Cable or “*Schweres Feldfernkabel*” (FFK) consisted of two double twisted cable pairs in heavy rubber insulation. Each cable end was fitted with a large, four pin connector.

So called “Pupin³” coils could be placed between these connectors. The use of Pupin coils would significantly increase the range of the Heavy Field Long Distance Cable.

The FFK cable came on reels with 250 meters cable each weighing 65 Kg. Too heavy to be man carried, it had to be transported and laid using a special cable cart or from vehicles. For example ,a version of the Sd.Kfz 2 “*Kettenkrad*” was adapted for carrying and laying FFK cable. About 2 km of FFK cable connection could be built per hour.



Figure 212: Heavy long distance field cable

192g 19-strand copper conductors, 2-layer black/natural colour rubber insulation (reversed on second cable pair); Two cable pairs twisted around a rubber core, 2-layer rubber outer insulation.

Cable could be laid on the ground, or be suspended using special cable hooks.

Without Pupin coils, distances of 40-48 Km could be achieved, with coils 100 -120 km.



Figure 213: Cable hooks

³ Michael Pupin was a Serbian immigrant to the US w transmission lines based on the theory by Oliver Heaviside. Even though the solution proposed by Pupin was not practical, a patent battle ensued between Pupin’s submission and that of George Campbell of AT&T who is normally credited with inventing the loading coil. In German literature however, Pupin’s name has become synonymous with the transmission line loading coil.

Figure 214: Couplings and Pupin coil for Schweres Feldfernkabel



214b Schweres Feldfernkabel
214c Allingment mark on

214d Locking groove
214e Locking ring

214f Cable contacts
214g Allignment collar



Figure 215: Several reels of Schweres Feldfernkabel at a termination point

Verbindungskabel 30-adrig

The *Verbindungskabel 30-adrig* or 30-core interconnection cable was used to interconnect various telephone exchange modules. For example these cables were used to connect the line unit to the remote connection panels placed outside. The cables existed with cloth insulation for inside use and rubber insulation for outside use.

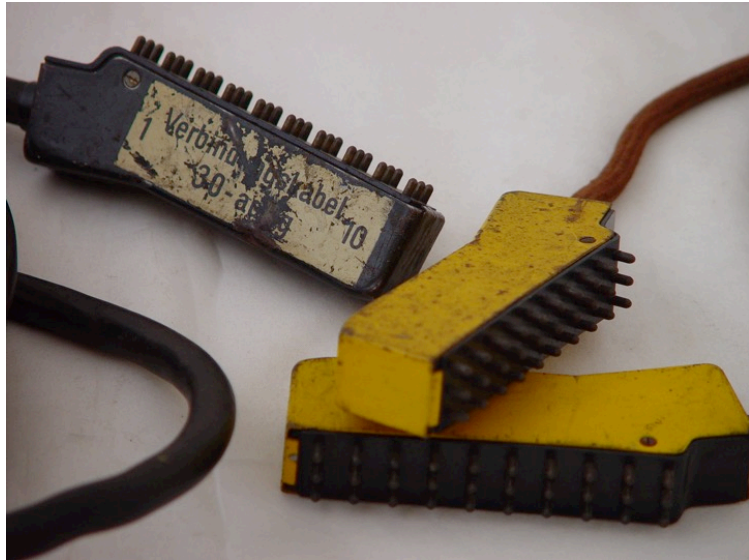


Figure 24: indoor 30 core cable (yellow connectors) and outdoor cable with connector

The connectors had 10 rows of 3 pins, the first and tenth row are typically marked on the connector as well as on the telephone exchange units to ensure that that plug is inserted in the right orientation.



Figure 217: 30 pin socket on the back of line unit

Several lengths of cables exist, the longest single outdoor cable encountered was 60 meters long. Several lengths of cable could be connected using a special weather proof connector.



Figure 218: 30-core cable connector

The cable connectors is closed using clamps and butterfly nuts and has a ring so it can be suspended above ground.



Figure 219: 30-core cable connector opened up

The use of several lengths of 30-core cable means that the *Abspannbock* on which all the incoming telephone lines are connected can be placed a fair distance away from the actual exchange.

Signal Pouch

The “*Nachrichten Tasche*” or Signal pouch was used by the telephone operators and carried tools and supplies to connect and repair wire, make simple adjustments to equipment and operate the telephone.



Figure 220: "Nachrichtentasche" and contents

The Signal pouch contained the following items:

- a) 1 small message pad
- b) 1 roll of paper labels (to mark lines)
- c) (1 each) black pencil, blue pencil, red pencil
- d) 1 folding cable knife
- e) 1 screwdriver
- f) 1 set of combination pliers
- g) 1 roll of electrical tape
- h) 1 table of contents for the Signal Pouch

Cable glove

Leather cable gloves were issued to protect the hands when handling telephone wires. Two types are known, a mitt type and a flap type which has a loop for two fingers and a strap to fasten around the wrist. By squeezing the hand close the flap will fold around the cable.



Figure 221: Cable handling gloves

Cable laying pole

The “*Drahtgabel*” or cable fork was used to guide and suspend telephone lines when building or dismantling. A set of hooks and loops at the tip of the pole allowed the operator to grab, lift, pull and guide the wire into position or to move branches of trees. By twisting the pole, the wire could be released from the loops.



Figure 222: Cable fork

Two types are known, a four meter pole, breaking down in two parts was mainly carrying on vehicles and cable carts. The other type was three meters long, breaking down into three parts which could be strapped to the side of the “*Fernsprechtornister*” by troops on foot.

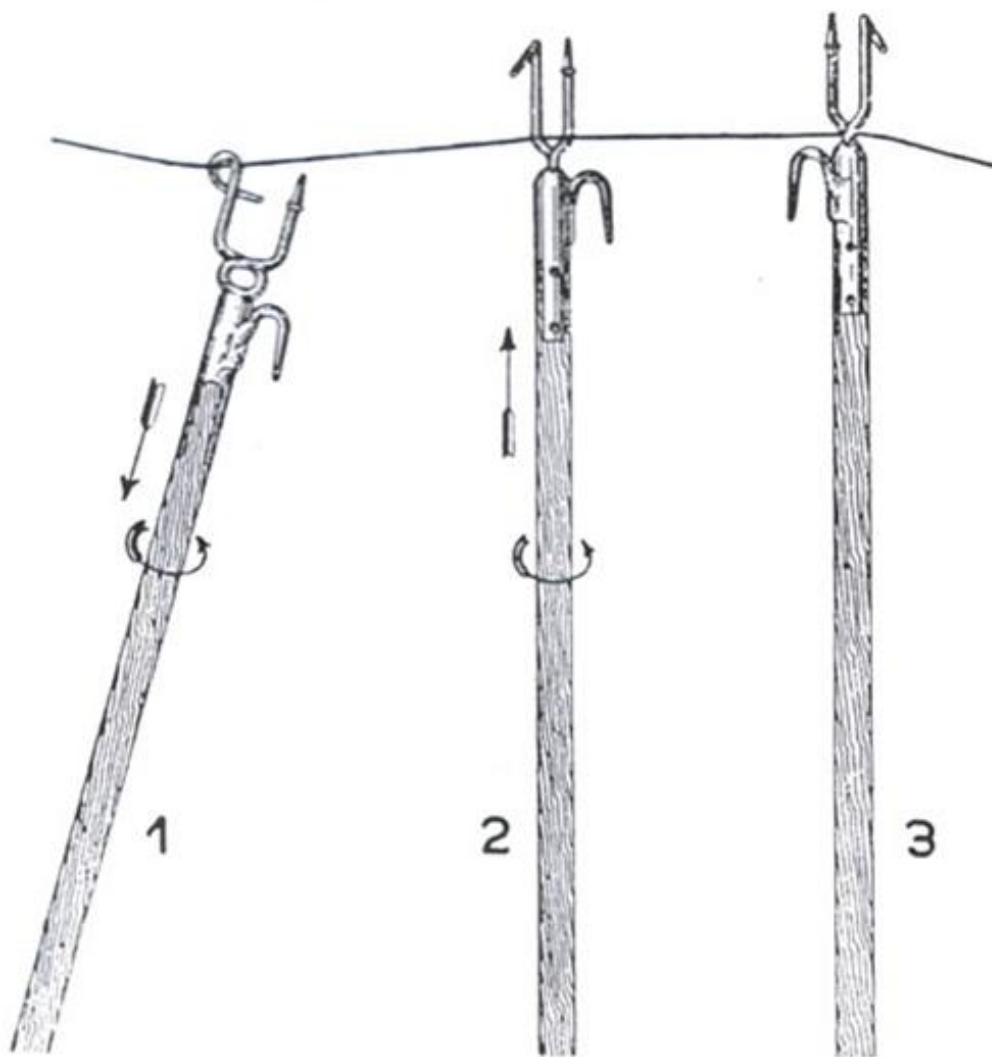


Figure 223: Instructions for use of the cable fork

Climbing belt and irons

To enable the troops to climb in to telephone poles, either to suspend field cables or to tap into existing wires, climbing irons belt were used.

The climbing irons strap to the boots and have large curved hooks that fit around the pole. Two types of climbing irons are known, one for smaller diameter poles, the other for larger diameters. The main difference is in the hook arrangement.

The Climbing belt consisted of a broad leather waist belt with a leather or rope loop that could be slung around the pole.



Figure 224: Climbing gear in use



Figure 225: Climbing irons for small poles



Figure 226: Climbing belt

Fernsprechtornister

The backpacks or *Fernsprechtornister* backpacks used by the *Fernsprechanschlußtrupp* were numbered 1, 2 and 3; each man in the troop had a differently numbered backpack. Unnumbered versions can also be found, presumably for use in vehicles.



Figure 227: Fernsprechtornisters 1, 2 and 3



Figure 228: *Fernsprechtornister* in use with a *Fernsprechanschlußtrupp*

The *Fernsprechtornister* used by the Wehrmacht were slightly updated versions of the types used in the first world war which in turn were based on the standard backpack of the era. Internal divisions to hold reels and equipment and equipment pouches fixed to the inside of the lid allowed for secure storage of its contents. Two leather straps with adjustable quick release fasteners held the lid in place. When the lid is opened, cloth sidewalls keep the lid horizontal so that nothing will fall out and a handy working surface is created to prepare equipment for use.



Figure 229: Fernsprechtornister nr 2

The contents of backpacks 1 and 3 were identical:

- a) 1 battery (spare)
- b) 3 reels with 500 m light field cable
- c) 1 crank for cable reel
- d) 1 headphone
- e) 1 spool earthing wire, 1 spool waxed wire
- f) 2 cable placement rods
- g) 1 "fork" for cable placement rod
- h) 1 insert for cable placement fork
- i) 1 cable dispenser ("*Abspuler*")
- j) 1 battery tester in pouch
- k) 1 cable glove
- l) 1 Microphone in tin
- m) 1 Zeltbahn
- n) 1 tin of wire connectors



Figure 230: Fernsprechtornister interior

The "2" backpack had a slightly different content with the following changes:

- 2 reels with 500 m light field cable
 - o) 1 empty reel, collapsed
 - p) 1 cable winder with crank ("Aufspuler")

Figure 231: Fernsprechtornister contents



231a	Headphone in pouch	231f	crank for cable winder	231j	Spools for earthing wire
231b	Carrying strap	231g	Cable winder "Aufspuler"	231k	Cable dispenser "Abspuler"
231c	Wire reels	231h	Spare reel, collapsed	231l	Spare microphone in tin
231d	Field telephone battery	231i	Cable glove		
231e	Battery tester in pouch				

Rückentrage

The *Rückentrage*, or back carrying frame was used to carry, spool out or spool in the Heavy Field Cable. Two versions were made, a collapsible model and a full model



Figure 232: Collapsible carrying frame, folded

with a spooling facility. The collapsible model was lighter and was easier to store, for example in vehicles. Wartime documentation also mentions that it could be worn on horseback. The collapsible model is primarily suitable for carrying cable drums and dispensing cable while the full model in addition can be used to spool up cable neatly onto the drums.

Two clips fit neatly around the axle of the cable drum and are kept closed by spring loaded

locking lugs. On the left side of the frame is a drum brake with a leather sling, this allowed the user to keep the cable under tension while reeling it out which prevents it from coiling and snagging. Two leather shoulder straps are hooked into hooks on the bottom of the frame and a chest strap allows the carrying frame to be securely fitted.



Figure 233: Collapsible model Rückentrage complete with cable drum

On the full model, only the bottom part of the frame could be folded for storage. On the inside of this bottom part was a leather lumbar support, while on the outside a leather pouch to store the winding handle, cable guide and chain was fitted. The frame was fitted with two additional clips to take up the spooling axle. The drum brake mechanism was fitted on the right side of the frame.

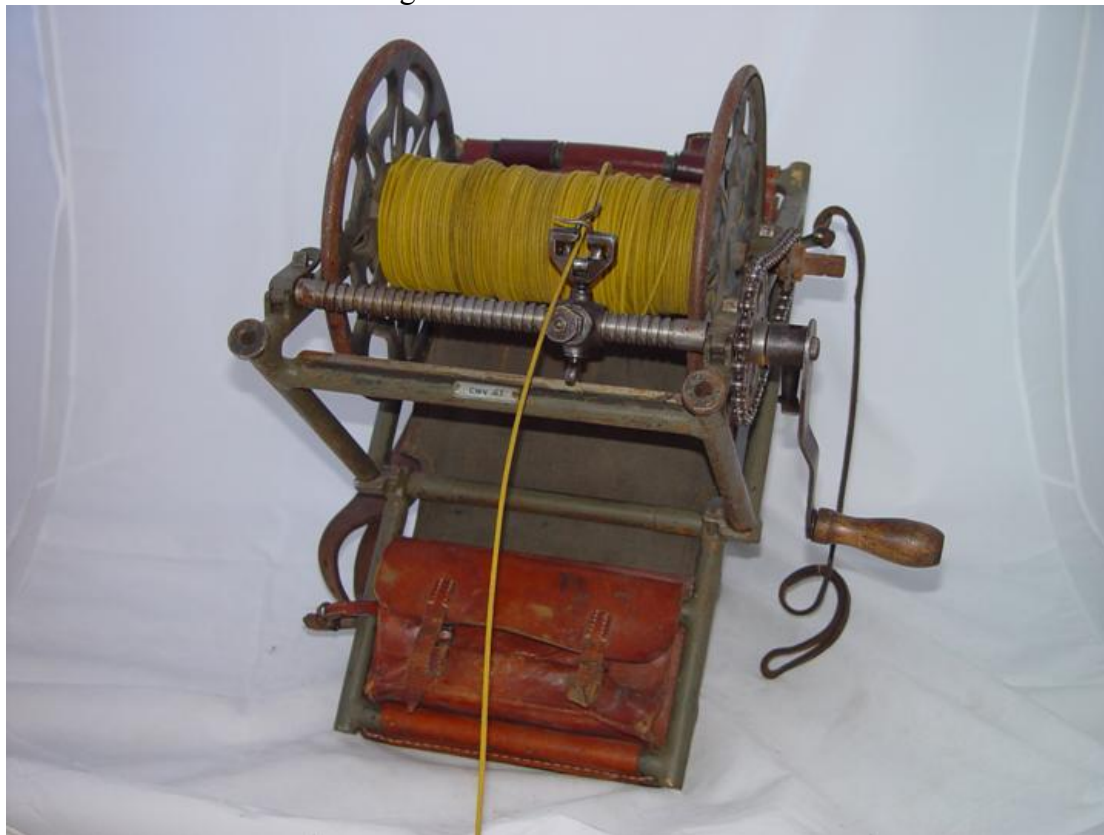


Figure 234: Full version Rückentrage. Note the holes in the end of the frame

The spooling facility consists of a cable guide, running from side to side on a grooved axle. The groove on the axle runs in both directions; a following cam in the cable guide automatically follows the groove and turns direction at each end of the groove.

A small loop of bicycle chain is fitted around gears on the cable drum and spooling axle. The gearing of the spooling axle is such that the cable will be neatly and evenly spool up onto the drum thereby maximizing the length of cable fitting on the drum.



Figure 235: Cable guide on spooling axle

A crank could be fitted on the end of the wire drum or on the end of the spooling axle. When dispensing cable the crank, chain and cable guide could be removed and stored in the leather pouch.

Two holes at the rear of the frame allowed the *Rückentrage* to be securely mounted to a frame, for example on the cable cart or on vehicles.

German Field Line Communication Equipment of WW2©



Figure 236: Rückentrage being worn on the chest. Note that the cable guide and chain are not fitted and cable gloves on the right hands

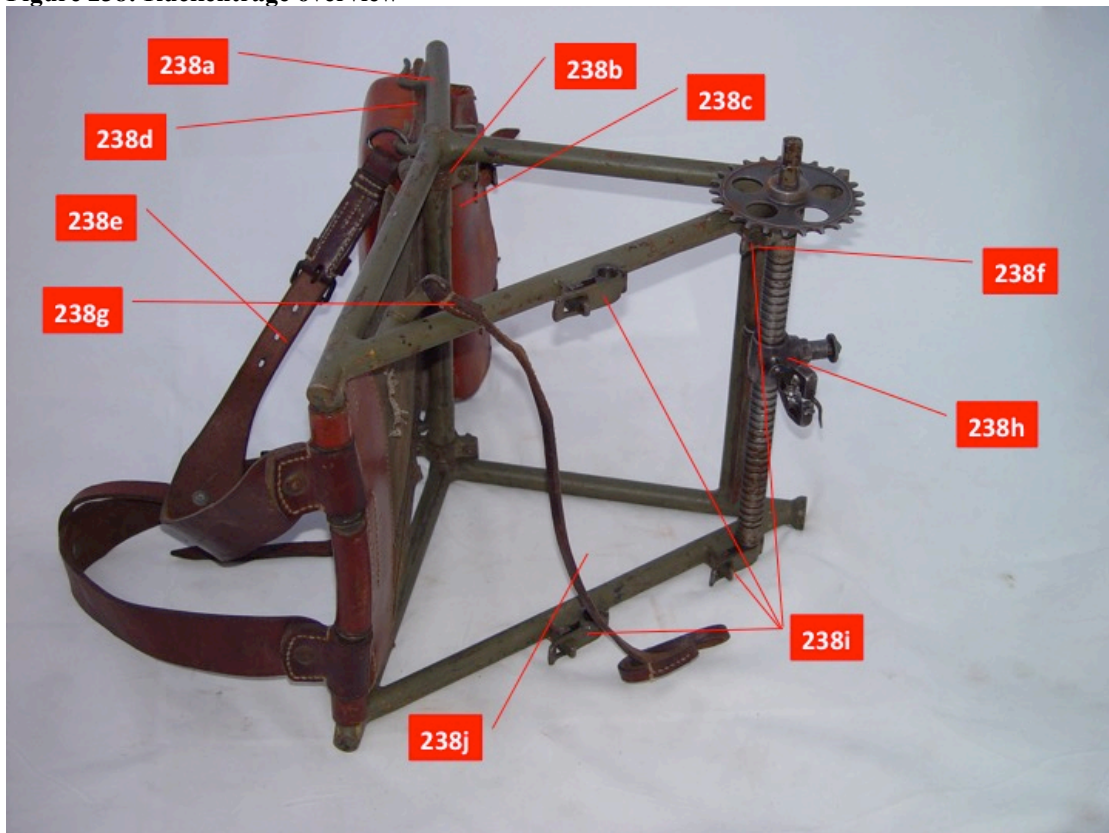
The *Rückentrage* could be worn both on the back and on the front. It was worn in the front for spooling or when the cable had to be tensioned.

The troops called the carrying frame the “*Strippenzieher*” (wordplay on “pulling strings”).



Figure 237: Close up of the drum brake

Figure 238: Rückentrage overview



238a Strap hooks
238b Bottom frame connection
238c Leather storage pouch
238d Lumbar support cushion

238e Shoulder straps
238f Spooling axle
238g Drum brake
238h Cable guide

238i Locking clips
238j Brake straps

Cable cart for *Schweres Feldkabel*

At 17 Kg, a full drum of *Schweres Feldkabel* is already a heavy load to carry over long distances, even when using a *Rückentrage*. Especially when more than one reel needed to be carried, a cable cart proved more practical. The cable cart could carry a *Rückentrage* with drum, two spare cable drums plus several sets of cable forks.

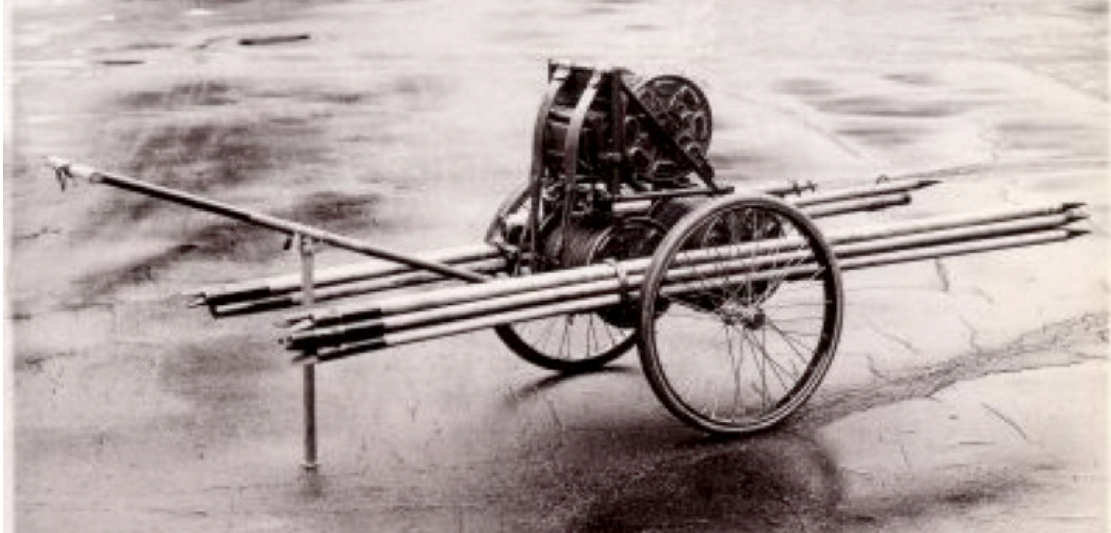


Figure 239: Period photograph of a complete cable cart loaded with Baustangen and a large screw-in earthing pick

The wartime model cable cart used by the Wehrmacht has two equal length supports for the *Rückentrage*, a straight handle bar and a long handle bar support.



Figure 240: Cable cart with *Rückentrage* mounted on top. Note how pins engage the holes in the *Rueckentrage*



Figure 241: Cable cart overview

The pull handle and wheels could easily be dismantled, allowing the cable cart to be stored in a vehicle or to be carried in parts over inaccessible ground.



Figure 242: Cable cart, view from the front

Cable cart for *Schweres Feldfernkabel*

Drums of *Schweres Feldfernkabel* were too bulky to be man carried, so a handcart had to be used if access by vehicles was not possible. The handcart for *Schweres Feldfernkabel* consisted of an “H” shaped frame that would take a drum of cable between the runners. Wheels on the outside of the runners were slightly larger than the drum diameter allowing the drum to free rotate above the ground. A brake handle was fitted to one of the handlebars to control the drum rotation if necessary.

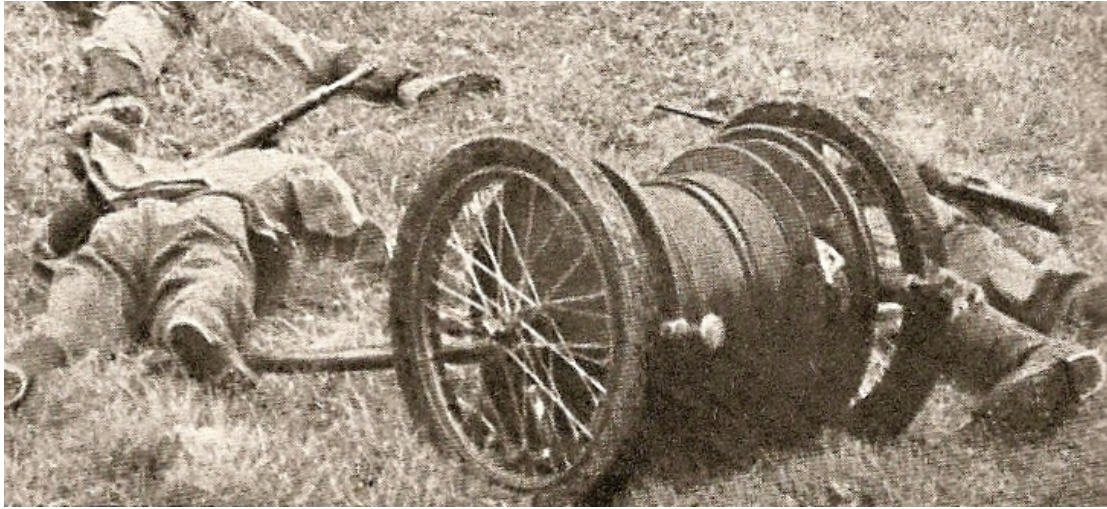


Figure 243: *Schweres Feldfernkabel* kart

Where possible however, *Schweres Feldfernkabel* would be built using vehicles.



Figure 244: *Schweres Feldfernkabel* being built. Note the cable cart on the right of the truck

Miscellaneous Telephone Equipment

Introduction

A number of functions have to be performed by specialist equipment, these functions include:

- Fault finding and dealing with interference
- Connecting different types of networks
- Multiple use of telephone lines
- Extending the range of telephone lines
- Interception of enemy telephone communication

Even though fault finding was a daily activity of front line troops, most other functions were executed by specialised communication troops.

A wide variety of equipment was developed and used, a sample of which is presented in this chapter.

Markers and flags

The location of the telephone station was often indicated by a red flag with a large letter "F" and an arrow on it. Further away from the station, wooden arrows, also with the letter "F" on it would indicate the direction where the telephone could be found.



Figure 245: "F" flag pointing at a telephone station



Figure 246: Wooden arrows pointing at a Telephone station

Testing equipment

Various types of testing equipment were available for telephone equipment, basic meters for testing batteries and cables using in the field to more complicated equipment for measuring handsets, cables and used at depots and maintenance parks.



Figure 247: various pieces of measuring equipment used by the Nachrichtentruppen

Elementprüfer battery tester

One of the most common test to be performed was a check of the batteries or “*Feldelement*”. Most field telephone equipment operated in “*Ortsbatterie Betrieb*” (OB) or local battery mode, so most equipment had a 1.5 Volt battery fitted. The *Elementprüfer* was used to check this voltage.



Figure 248: *Elementprüfer* in pouch

German Field Line Communication Equipment of WW2©

A rotating switch on the back allowed the user to select measurement of 1, 2 or 3 elements in series. The *Elementprüfer* was fitted with a measuring probe on the bottom of the housing with the other measuring probe connected by a short length of cable. This layout made it ideal to test the battery while situation in the equipment. The instrument probe was pushed against the – pole or connection screw while the cable probe was pushed against the + pole and instrument would indicate the voltage of the cell. By pressing a small button on the housing, a resistor was switched parallel to the indicator, allowing the battery to be tested under load.



Figure 249: *Elementprüfer* testing a *Feldelement*

Feldmesskästchen field tester

For basic fault finding of telephone equipment and lines, the *Feldmesskästchen* was useful tool. The tester could measure voltage and resistance. For resistance testing, the field tester held a 4.5 Volt battery in the bottom compartment. An instruction shield in the lid describes how the instrument can be used to test batteries, measure resistance and test telephone lines. Built in a sturdy wooden box with metal bottom and top protection, the instrument was clearly designed with rough field handling in mind.



Figure 250: *Feldmesskästchen*

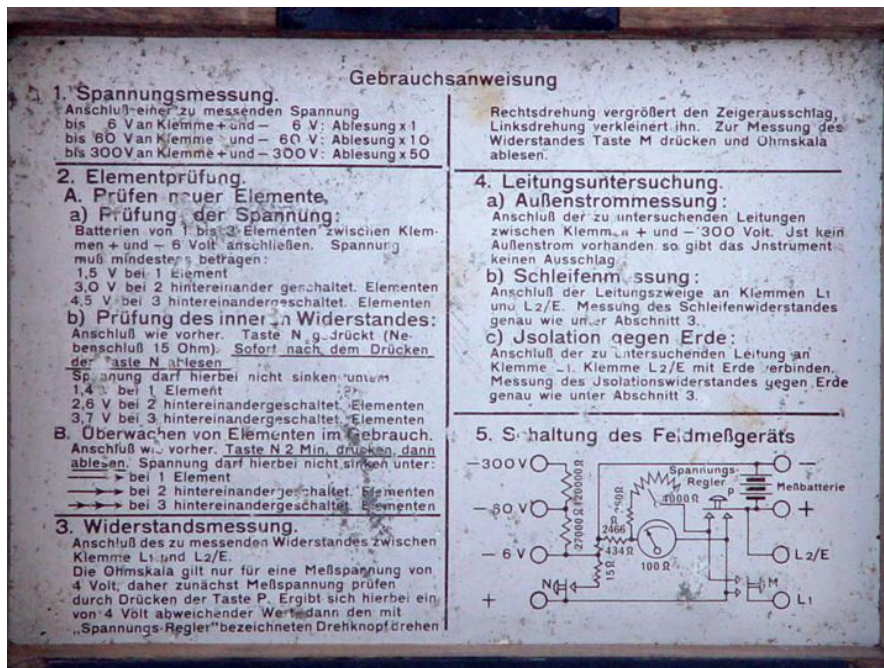


Figure 251: User instructions for the Feldmesskästchen

Kabelmessinstrument

The *Kabelmessinstrument* is a simple Ohmmeter containing an internal battery. The two wires of the telephone connection (one of which may run via earth) can be connected directly to screw terminals of the Ohmmeter. If the two lines are short circuited on the other side of the line, the Ohmmeter will indicate the resistance in the circuit. Resistance should be lower than (to the right of) the red line for the telephone connection to work; if not the connection needs to be improved or an *Erdsprechgerät* needs to be used.



Figure 252: Kabelmessinstrument

Mikrofon und Fernhörer Prüfgerät a

A more specialised piece of equipment was the hand and headset tester *Mikrofon und Fernhörer Prüfgerät a*. Two FF33 *Handapparate* can be connected to the test unit to test the microphones and earpieces. Signal strength can be verified using an instrument and a vibrating relay generates a test tone that can be used to test and adjust headphones



Figure 253: Mikrofon und Fernhörer Prüfgerät a

Headsets and handsets

various types of hand and headsets were issued with telephone equipment which were typically stored in leather pouches



Figure 254: Various types of hand and headset pouches

Handapparat 33

The *Handapparat 33* was the standard handset used with the various types of field telephone sets. Most handsets were issued with the telephone itself, but loose handsets issued in leather pouches were available for use with exchanges etc.



Figure 255: *Handapparat 33* with leather pouch

Kopffernhörer 33

Normally the *Handapparat 33* was used with the *Feldfernsprecher* but sometimes the telephone could be difficult to hear using only one ear. For this reason the *Kopffernhörer 33* could be used alongside the *Handapparat 33*. With the headphone covering one ear and the handset covering the other, conversations could be held even in noisy environments. The *Kopffernhörer 33* had a small two-prong plug that plugs directly into the FF 33 next to the plug of *Handapparat 33*. The pouch for the *Kopffernsprecher 33* could be looped to the carrying strap of the FF33 or to the belt of the wearer. A *Kopffernsprecher 33* was also carried in each *Fernsprechtornister*.



Figure 256: Kopffernhörer 33 with pouch

Brustmikrofon 33 mit Doppelkopffernhörer

For hands-free operation, a chest microphone with headset could be used. This was most typically used by telephone operators manning the larger telephone exchanges. The chest microphone was carried with a strap around the neck and a 5-prong plug connects the *Brustmikrofon 33* to the *Feldfernsprecher* or telephone exchange. Two *kopffernhörer* earphones could be plugged into the sides of the *Brustmikrofon 33* with two-prong plugs. A leather strap holds the two earphones in place.

When using the *Brustmikrofon 33*, care has to be taken since the microphone is continuously switched on (unlike the normal handset microphone, which only operates when the handset button is pushed). So not only caution “Feind hört mit!” but also the telephone’s battery will be drained quicker.



Figure 257: Brustmikrofon 33 and Doppelkopffernhörer with storage pouch

Übertrager Telephone Transformer

Development and Description

The section on cable describes that both single and double wire connections could be used, sometimes in a single line. The transfer from single to double cable connection requires an insulation transformer. This transformer was called the “Übertrager” or telephone transformer. It consisted of a wooden box with external connections containing a heavy ring-core transformer. Both primary and secondary windings are executed in two halves with mid point connections. In this way the transformer can act both as an insulation transformer and as a Balance-Unbalance transformer. The dimensions of the transformer are chosen quite large to allow the strong bell currents to be passed through without distortion.

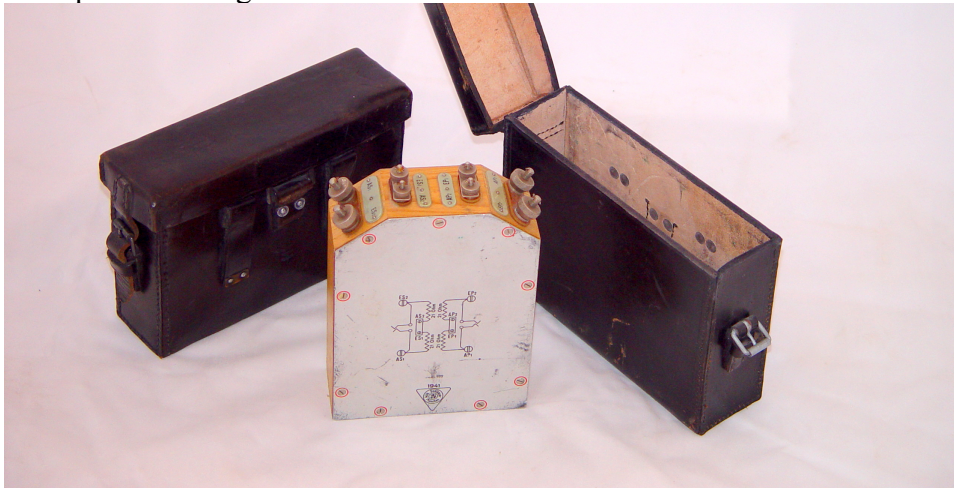


Figure 258: Übertrager with leather carrying case

On the top of the Übertrager are four large and four small screw connectors. Instead of the large screw connectors, two sockets for interconnection cables, placed on the side of the unit, can be used. The smaller connectors have jumpers fitted. When not in use the Übertrager was stored in a leather carrying case.

EP2	Eingang Primär 2	Primary input 1
AP1	Ausgang Primär 1	Primary output 1
AP2	Ausgang Primär 2	Primary output 2
EP1	Eingang Primär 1	Primary input 1
AS1	Ausgang Secundär 1	Secondary output 1
ES2	Eingang Secundär 2	Secondary input 2
ES1	Eingang Secundär 1	Secondary input 1
AS2	Ausgang Secundär 2	Secondary output 2

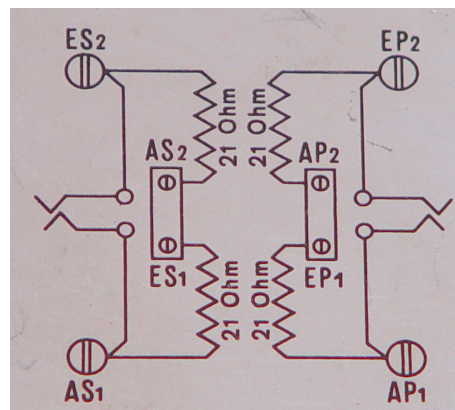


Figure 259: Übertrager schematic

German Field Line Communication Equipment of WW2©

A number of different circuits could be made using the *Übertrager*. As mentioned a one-wire to two-wire transfer could be made:

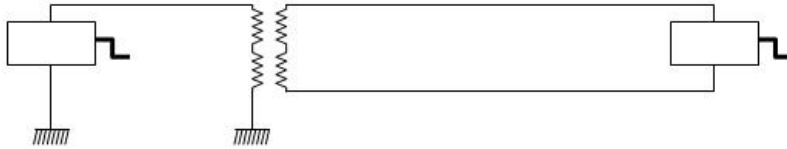


Figure 260: One-wire to two-wire transfer

The *Übertrager* also allowed an additional connection to be made over a two-wire line. In this case the signal from phones “A” will flow as differential mode current through the two wires while the signal from phones “B” will flow as common mode current through the two wires and return via earth. In the properly balanced line, users “A” and “B” can not hear each other. “B” could also be used for telex.

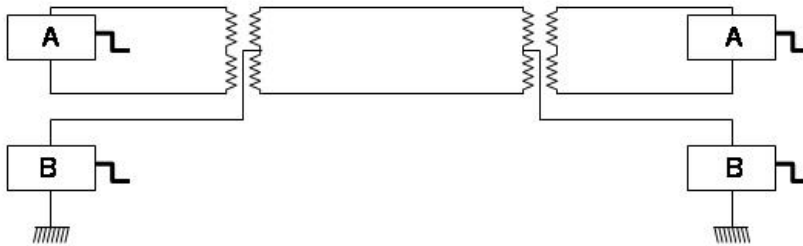


Figure 261: Double use of a two-wire connection

In order to explain this circuit, the currents through the transformer are shown. The differential mode current (Blue) is the only current that creates a magnetic field in the core and is seen at the secondary side of the transformer. The magnetic fields created in the core by the common mode current are in opposite directions and equal each other out.

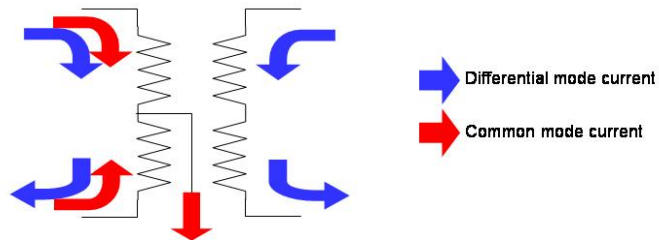


Figure 262: Currents through the *Übertrager*

The common mode current (Red) has to flow out via the mid point tab of the transformer.

The same trick can be repeated for four-wire *Schweres Feldfernkabel*:

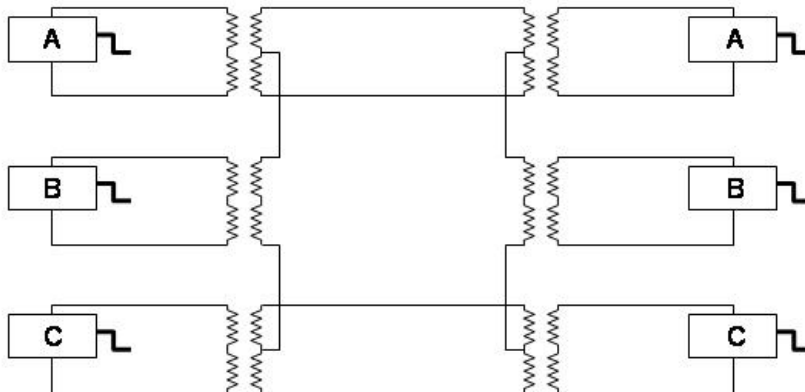
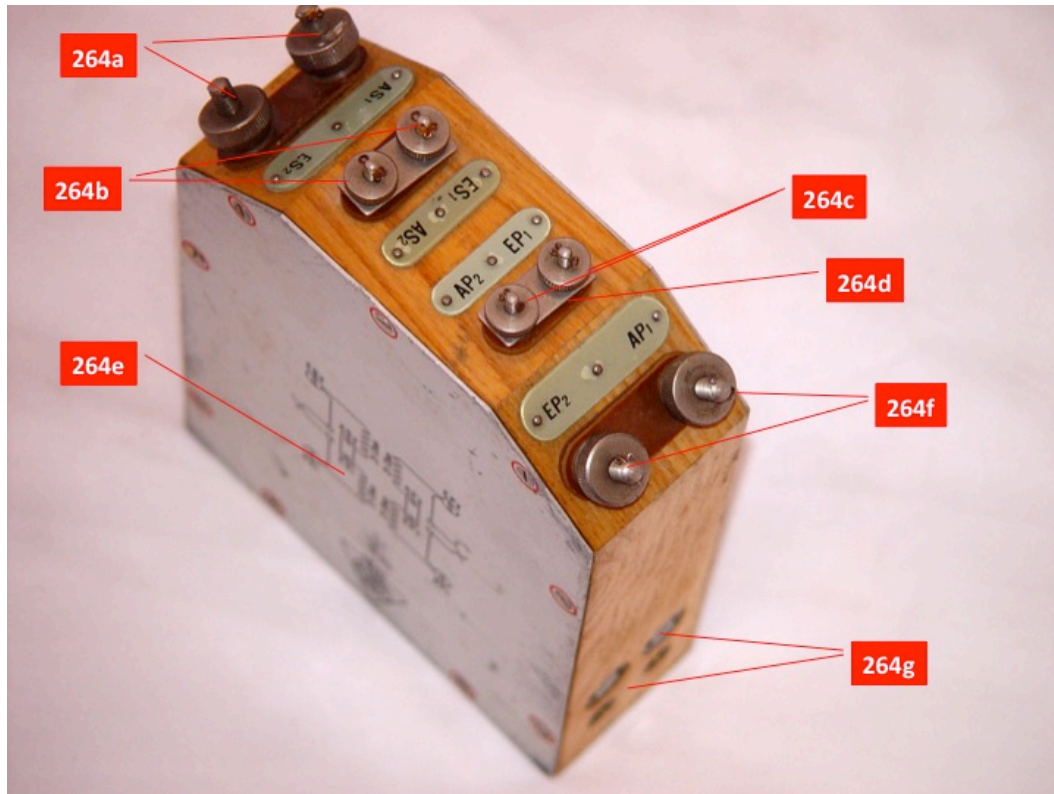


Figure 263: Triple use of a four-wire connection

In this way, for example two phone lines and a telex connection could be established using a single *Schweres Feldfernkabel*.

Construction

Figure 264: Übertrager outside view



264a Secondary winding connection screws

264b Secondary mid point connection screws

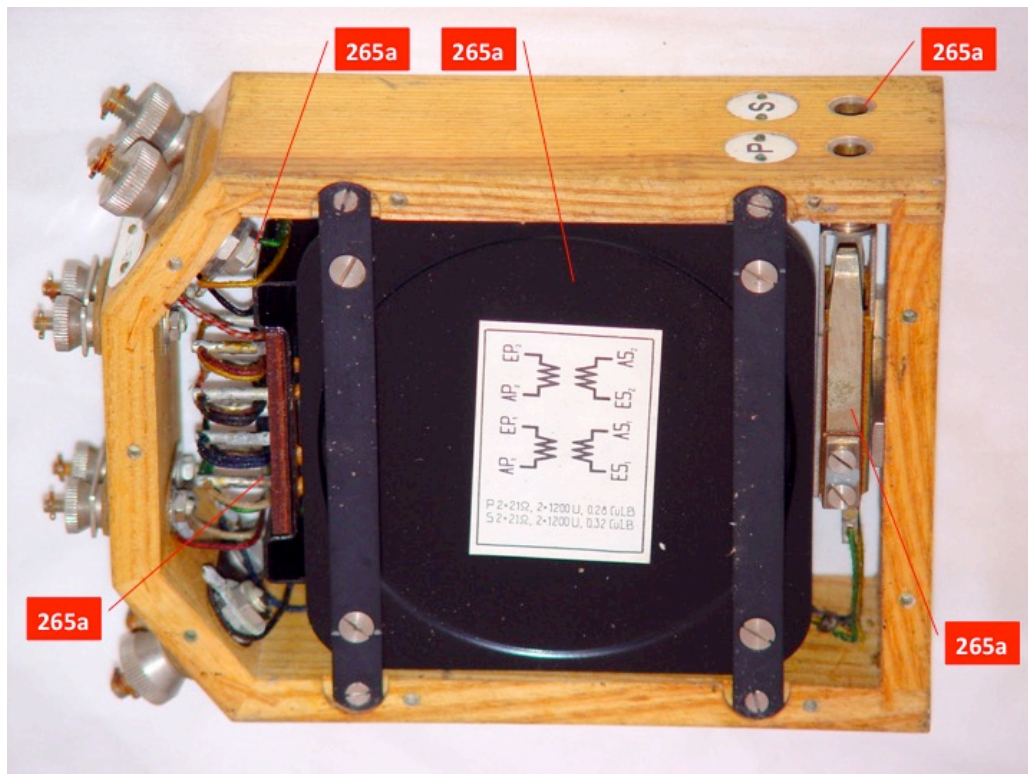
264c Primary mid point connection screws

264d Mid point Jumper

264e Primary winding connection screws

264f Interconnection cable sockets

Figure 265: Übertrager inside view



265a Internal connection points

265b Transformer housing

265c Interconnection cable sockets

265d Transformer connection board

265e Interconnection socket contacts

Operation

There are many different ways to use the *Übertrager*, so first it needs to be established what exactly has to be achieved. The most common uses are:

- 1) Transfer from two-wire to one-wire line
- 2) Solving imbalance caused by leakage in a two-wire line
- 3) Crossing an area of high common mode interference (eg near high voltage lines)
- 4) Creation of two channels on a two-wire line
- 5) Creation of three-channels on a four wire line

Once the use has been established, the appropriate connections can be developed. For example to achieve 1) Transfer from two-wire to one-wire line:

- Place the *Übertrager* so that it is protected from rain and dirt at the transfer point between the two- and one-wire connections
- Ensure both jumpers of the mid point tabs are closed
- Connect the single wire line to connection AP1
- Connect the earth pin to connection to EP2
- Connect the first wire from the two-wire connection to AS1
- Connect the second wire from the two-wire connection to ES2

In some cases the interconnection cable can be used to connect the *Übertrager* directly to a FF 33 field telephone. For example to achieve 2) Solving imbalance caused by leakage in a two-wire line, on each end of the line -:

- Place an *Übertrager* near the field telephone
- Place the interconnection cord into the socket of the FF 33 and in the “P” interconnection cable socket of the *Übertrager*
- Connect the wires from the two-wire connection to the AS1 and ES2 terminals



Figure 266: *Übertrager* connected directly to a FF 33 field telephone

Field Amplifiers

Several types of amplifiers were developed to increase the range of phone lines. The “*Feldverstärker a*” was two wire version, allowing the amplification of two way communication on a single telephone connection.

Feldverstärker a

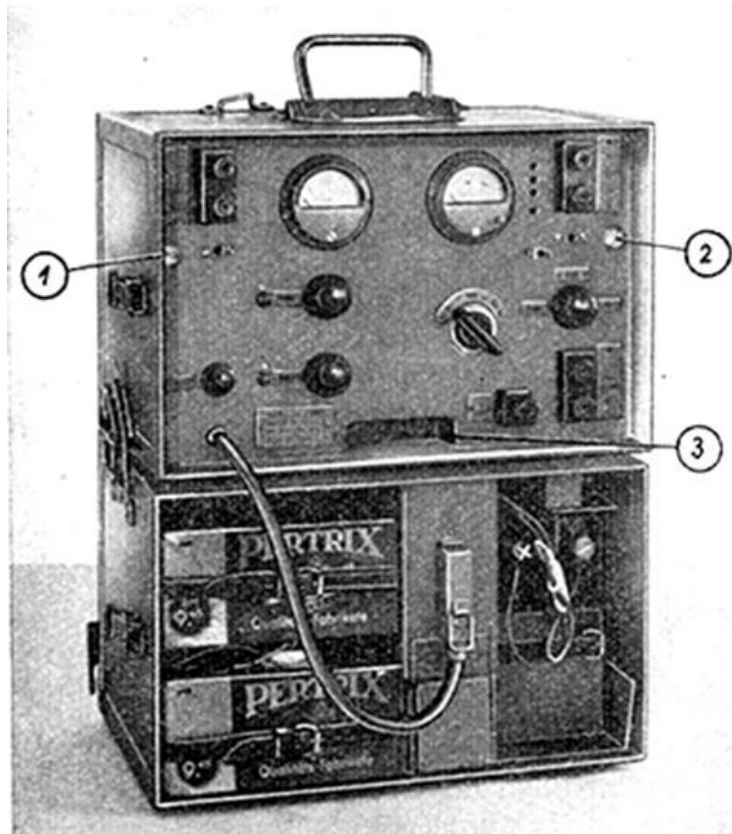


Figure 267: Feldverstaerker a with battery case

controls for the direction switch and filter controls.

Test buttons and an instrument allow the ringtone detection circuit to be tested and adjusted for proper operation. Another instrument is provided for testing the battery voltages.

The “*Feldverstärker a*” was a two wire field telephone amplifier. It consisted of an equipment box and a battery box that were mounted on top of each other. Two separate amplification circuits either provided amplification from left to right and from right to left. Input/Output transformers on both ends prevented signals to be fed back.

Ringtone detection circuits activate a polar relay which temporarily switches off the relevant amplifier and engages a ring tone generator.

The controls included a main switch, sensitivity

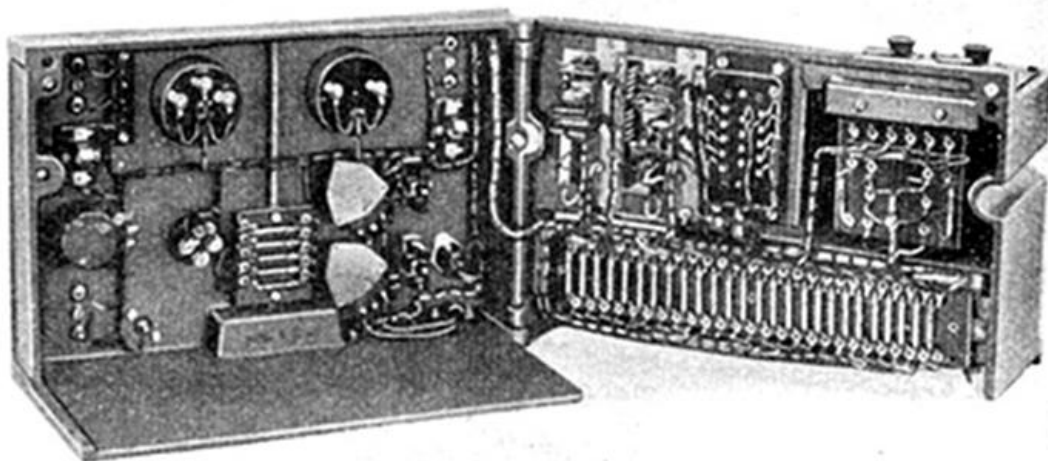


Figure 268: Feldverstaerker a internals

The amplifier could be removed from its casing by loosening screws 1 and 2 and pulling it out using handle 3. The unit could be swivelled open to provide access to the components.

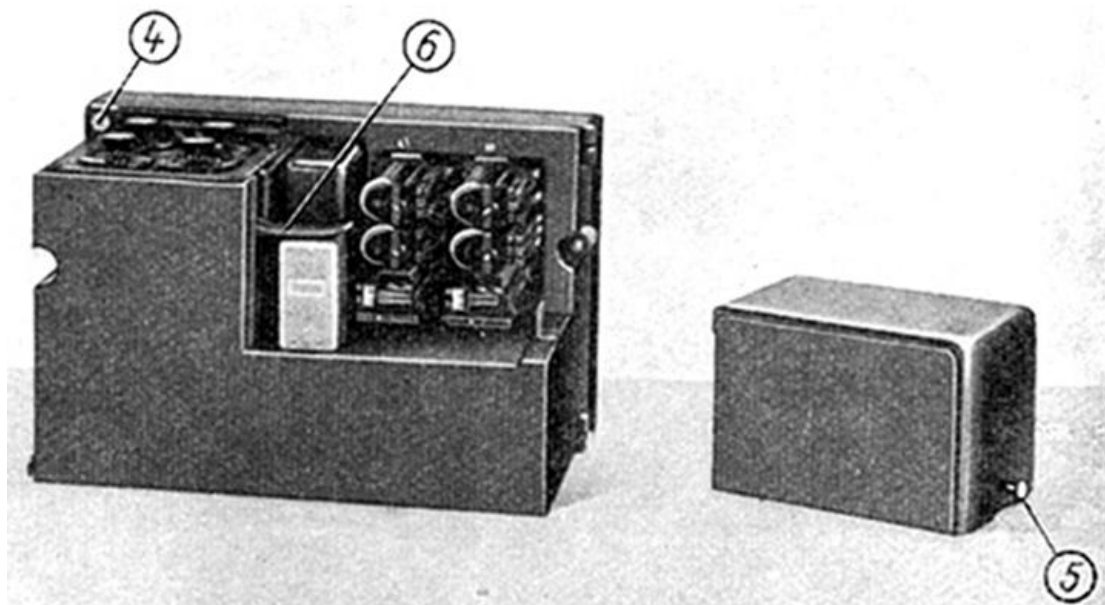


Figure 269: Feldverstaerker back view. On the top left the four amplification valves can be seen. The top right section contains the relays to switch the direction of amplification.

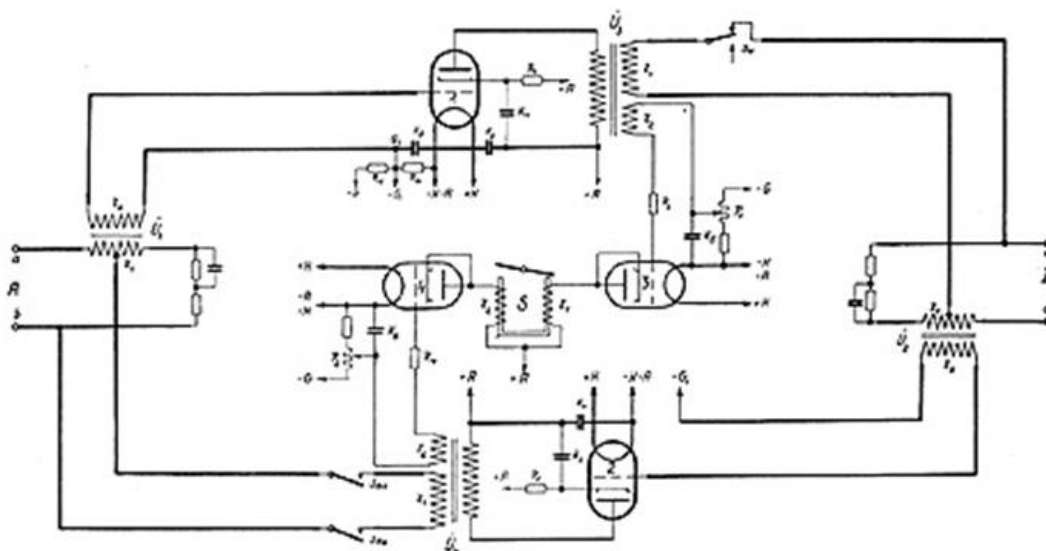


Figure 270: Feldverstärker a basic schematic

A FF 33 field telephone could be connected to monitor the proper functioning of the unit.

Other types of amplifiers include the Verstärker 38, a four-wire version that could be used with the Schweres Feldfernkabel.

Carrier wave equipment

Development and description

Carrier wave equipment serves to create multiple communication channels over a single wire connection. Speech signals generally only use a bandwidth from 400 Hz to 2 kHz. It is however possible to pass much higher frequencies through a cable.

By modulating a speech signal with a carrier wave, a lower and a higher sideband are created around the carrier frequency. This trick can be repeated several times, creating multiple channels that can later be unscrambled using band pass filters and demodulators.

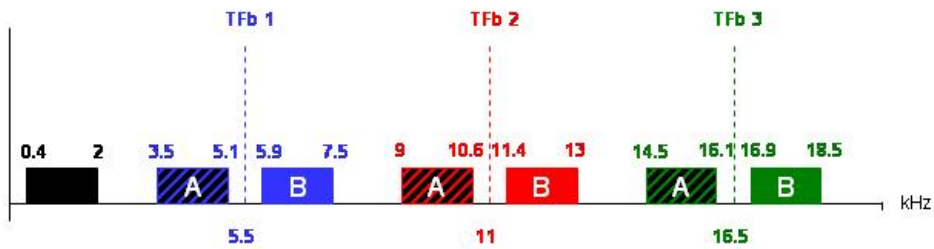


Figure 270: Signals generated when using 5.5, 11 and 16.5 KHz carrier waves

In the above figure, the black area is the normal speech bandwidth from 400 Hz to 2 kHz. The blue areas represent a speech signal modulated with 5.5 KHz. “A” is called the lower sideband, “B” is the upper sideband. The red and green areas show two more signals modulated at 11 and 16.5 kHz. The bands have sufficient distance to be filtered and demodulated again to recreate the original speech signal.



Figure 271: TFb 1

German Field Line Communication Equipment of WW2©

The Germans developed a variety of carrier wave equipment for single and multiple channels. A widely used type was the “*Träger Frequenzgerät b*” (TFb) series, a 12 V powered single channel carrier wave unit that was small and flexible enough to be used as field equipment. The units are numbered TFb 1 to 5, each with a carrier frequency incremented with 5.5 kHz.

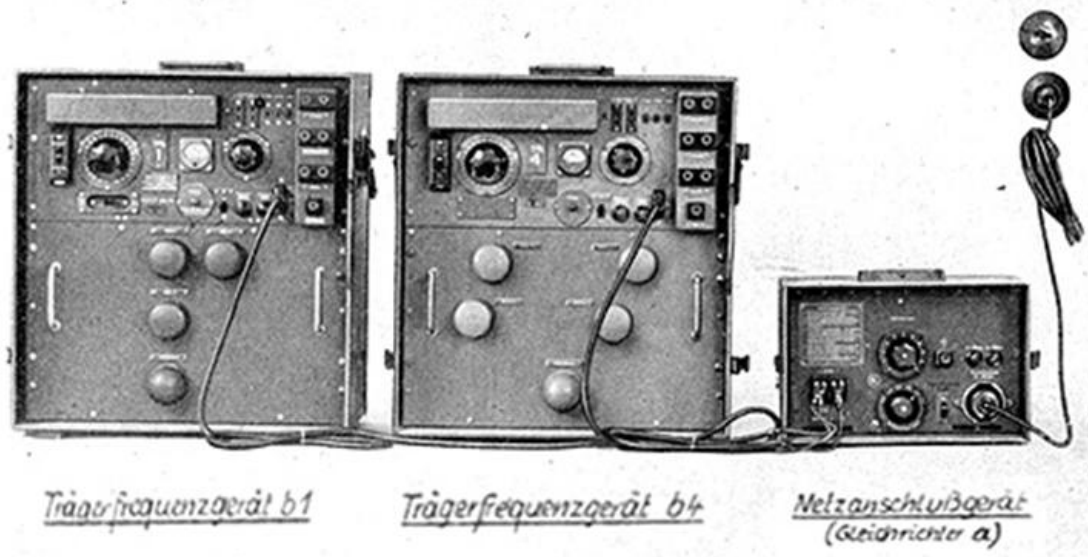


Figure 272: TFb 1 and TFb 4 used together. Note that the higher frequency TFb 4 has an extra valve

The types could be used on their own or in combination. By combining all five types a maximum of six communication channels could be created on a single line. The communication channels could be used for telephone or telex, allowing a single connection to do the job of six.

The working principles are explained using the next figure. Each TFb unit contains a transmitter and a receiver for the speech signal:

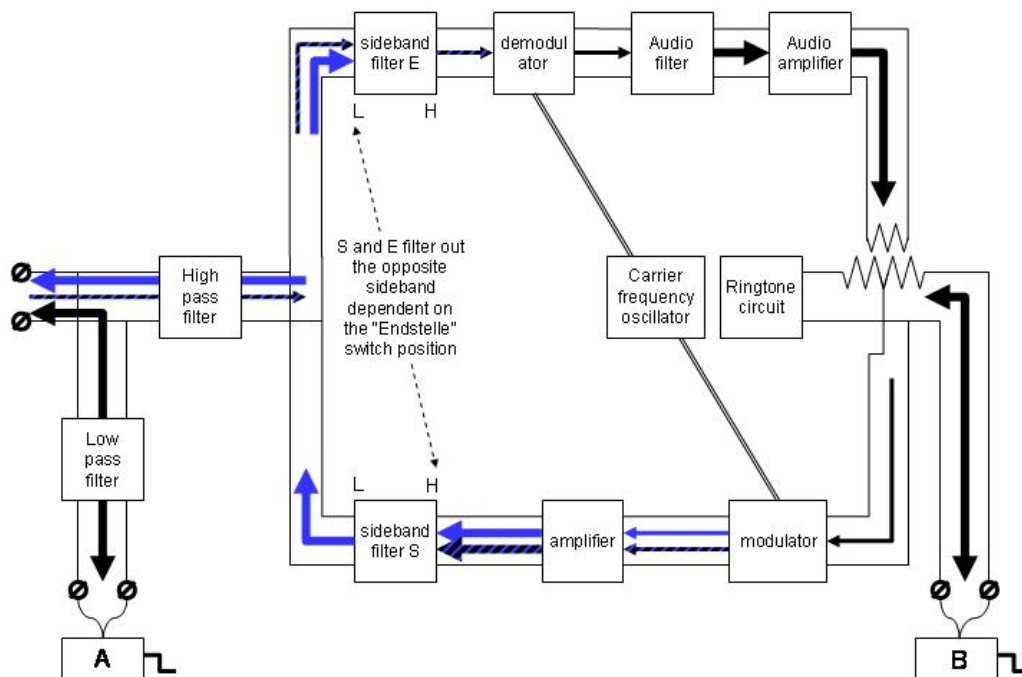


Figure 273: TFb working principles

Transmitter: The signal from telephone B enters the unit via an input/output transformer towards the transmitter and is mixed with the carrier frequency in the modulator. The signal now consists of a lower and an upper sideband as indicated in figure 230. The signal is amplified before it is passed through a band pass filter that either filters out the lower or the upper sideband. The two TFb units at either end of the connection need to be set to a different “*Endstelle*” so that one unit transmits the lower sideband while the other transmits the upper sideband. The signal now passes through a high pass filter and is combined with the normal speech signal from telephone A onto the outgoing line.

Receiver: The signal arrives at the unit, the normal speech signal is filtered through a low pass filter to telephone A. The carrier wave signal passes through the high pass filter into the receiver. The signal passes through a band pass filter which selects either the lower or upper sideband. Since the receiver filter is filtering the opposite sideband from the transmitter, feedback from the own transmitter is prevented. The signal passes through a demodulator and an audio filter, recreating the original speech signal. This signal is amplified and fed via the input/output transformer to telephone B. The input/output transformer prevents the signal from the receiver to enter the transmitter.

Ringtone circuit: A separate circuit was used to detect and modulate the 20 Hz bell frequency. If telephone B rings turns the alarm generator, a special detection circuit operates a number of relays that temporarily switch off the receiver and -dependent on the “*Endstelle*” selection- either reduce or increase the carrier frequency by 500 Hz (in the TFb1 to 5 kHz). This unmodulated reduced carrier frequency is amplified and transmitted on the line. On the other end the carrier signal passes through the high pass and sideband filters and enters the receiver, where it is mixed with the normal carrier frequency, creating a 500 Hz tone. After filtering in the audio filter and amplification, this 500 Hz signal is detected by the ringtone circuit. Again via relays, the transmitter is temporarily switched off and a ringtone generator is activated, causing the bell of Telephone B on the other end to ring.

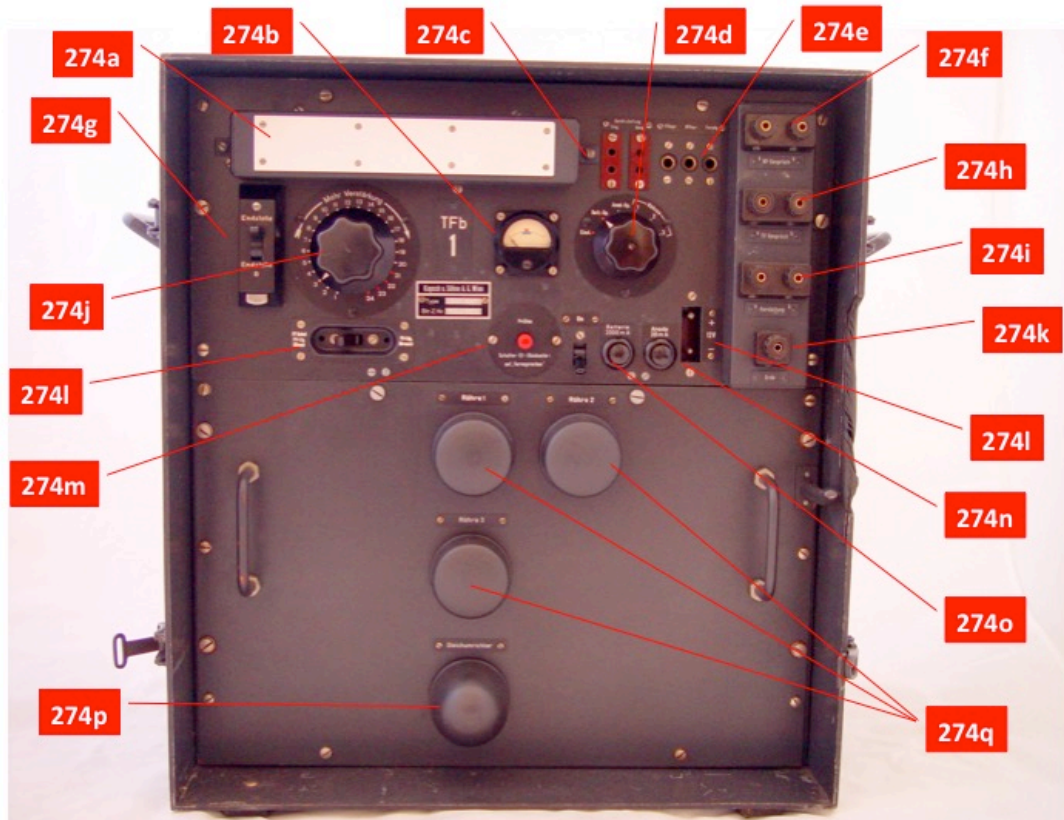
A drawback of using higher frequencies in a line connection is that the stray capacity of the line is starting to play a greater role, limiting the range of carrier wave equipment. The largest ranges could be achieved using overhead lines. For example 3 mm solid copper overhead conductors, the TFb 1 had a range of 500 km, the range of the TFb 2 about 400 km. As can be seen the range decreases with increasing frequency.

With Heavy field cable the range of the TFb 1 would be about 22 Km, with Light field cable the range would reduce to 15 Km. Likewise, the higher frequency units would have shorter ranges still.

Another limitation were lines fitted with Pupin coils as these have a poor high frequency response. So if *Schweres Feldfernkabel* (FFK) was to be used in combination with carrier wave equipment, the Pupin coils had to be removed. In most cases however, the gained communication channels outweighed the loss of range.

Construction

Figure 274: TFb 1 controls



- | | | |
|---|--|--|
| 274a Relay cover with writing tab | 274f Connections for normal speech signal | 274l Cable type selector |
| 274b Test voltage instrument | 274g "Endstelle" switch | 274m Test button |
| 274c Interconnections used for multiple carrier waves | 274h Connections for carrier speech signal | 274n Fuses |
| 274d Test voltage selector | 274i Connections for outgoing line | 274o Main On/Off switch |
| 274e Interconnection cable sockets | 274j Amplification adjustment | 274p Cover for power supply vibrator |
| | 274k Earth connection | 274q Cover for oscillator and amplifier valves |



Figure 275: Ring tone generators (left) and relays (right) with relay cover

German Field Line Communication Equipment of WW2©

The TFb units have a modular design. The top section is reserved for all controls and connections while the bottom of the unit contains power supply module, carrier frequency generator, filters, amplifiers, modulator, demodulator and ringtone circuits.

The modular design allowed for a quick exchange of faulty modules



Figure 276: Right-rear internal view

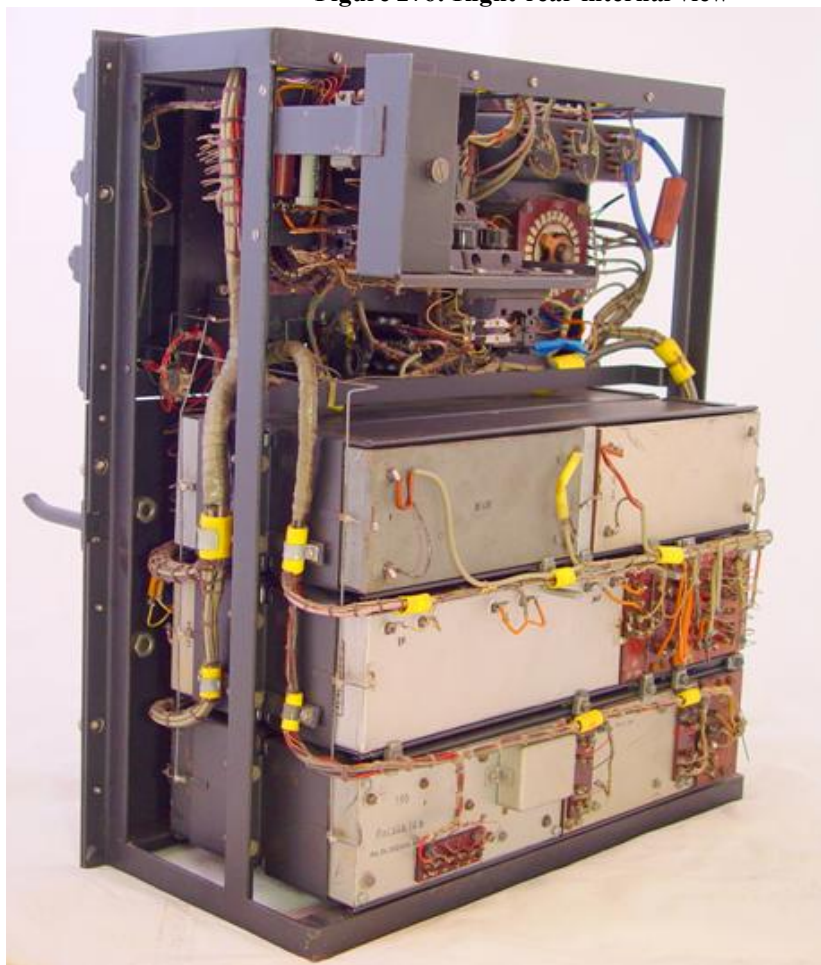


Figure 277: Left-rear internal view

Operation

Before operation study the operation instructions inside the lid of the unit:

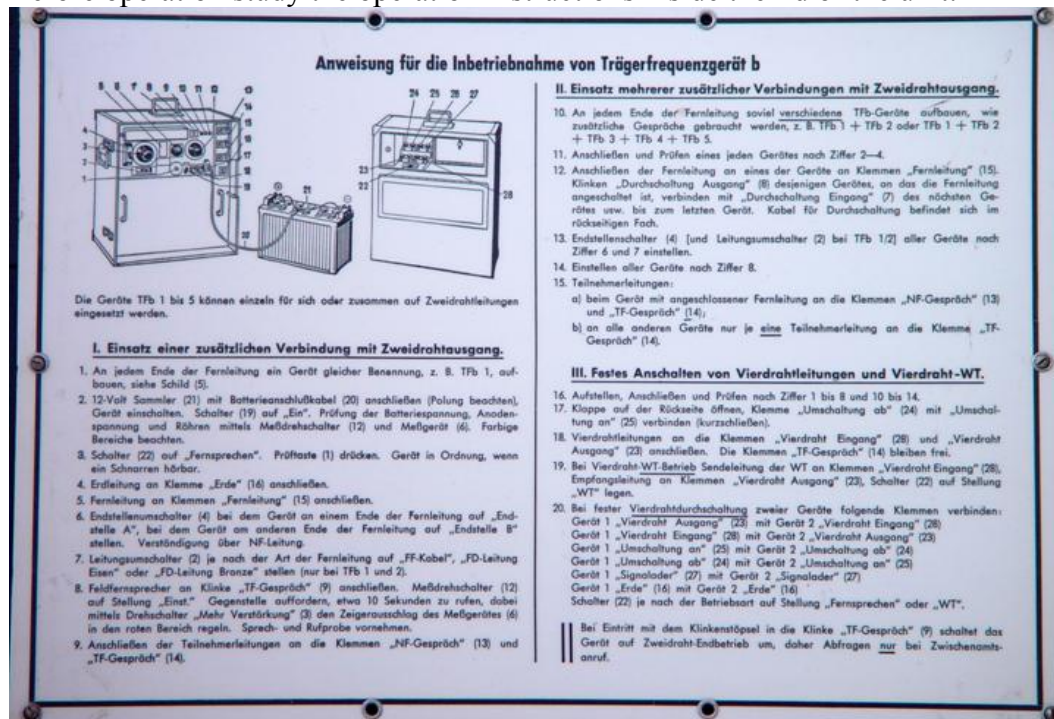


Figure 278: Operating instructions inside the lid

To bring a single carrier frequency connection into operation, the following steps have to be taken:

1. On both ends of the line connection, place a unit of the same type, e.g. TFb1
2. Connect a 12 V battery with the battery cable. Switch on the unit and check the voltage and the valves using the test control selector
3. Ensure that the switch in the back compartment is set to “*Fernsprechen*”. Push the test button. The unit is functional when a buzzing sound can be heard.
4. Connect an earth line to the earth connection
5. Connect the wires of the line connection to the “*Fernleitung*” connectors
6. Place the “*Endstelle*” selector on one end on “*Endstelle A*” and on the other end on “*Endstelle B*”. Use the unmodulated telephone to communicate to the other end.
7. Place the cable type switch on “*FF-kabel*”, *FD-Leitung Eisen*” or “*FD-Leitung Bronze*” dependent on the cable type used
8. Connect a field telephone to the “*TF-Gespräch*” interconnection cable socket and set the test control selector on “*Einst*”. Call the other end for about 10 seconds, while moving the amplifier control until the needle of the test instrument sits on the red area. Test the alarm circuits and voice communication from both ends.
9. Connect the end users to the “*NF-gespräch*” and “*TF-Gespräch*” connectors



Figure 279: The Telephony - Telegraphy selection switch in the back compartment

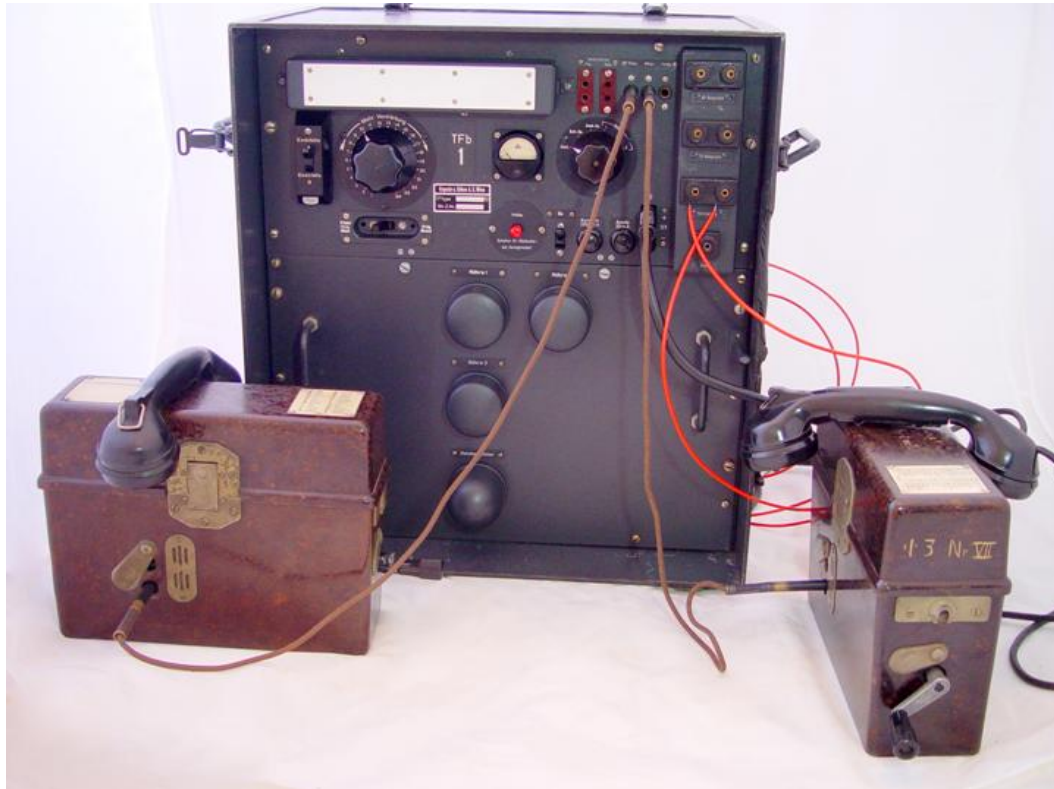


Figure 280: TFb 1 connected and ready to operate

If several carrier wave connections are used on a single line, the following steps have to be taken:

10. On both ends of the connection, place as many different units as required, eg TFb 1 + TFb 2 for three channels, TFb 1 + TFb 2 + TFb 3 + TFb 4 + TFb 5 for six channels
11. Connect and test each unit as per steps 2 -4
12. Connect the wires of the line connection to the “*Fernleitung*” connections on one of the units and plug in the special two-plug cable (The two plug cable is stored in the back compartment) into the “*Durchschaltung Ausgang*” socket of this unit. The other end of the cable is plugged into the “*Durchschaltung Eingang*” socket of the next unit. Repeat the interconnection with all subsequent units
13. Place the “*Endstelle*” switch and the cable type switch (TF b 1 and 2 only) as per steps 6 – 7
14. Adjust all units as per step 8
15. Connect the end user

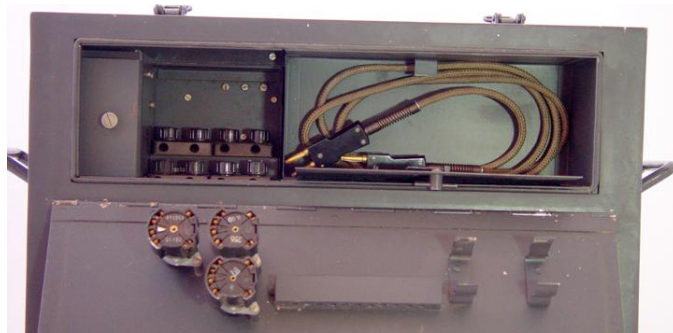


Figure 281: Two plug cable stored in back compartment

- a. On the unit to which line connection is made, connect two users using the “*TF Gespräch*” and “*NF –Gespräch*” connections
- b. On all other units only use the “*TF Gespräch*” connections

The connection in the back compartment could also be used for four-wire telephony or four-wire AC-telegraphy connections (WT or “*Wechselstrom Telegrafie*”)

A number of filter units were supplied so that telephones could be connected directly to a carrier frequency line. The “*Anschaltfilter*” or connection filter allowed a single telephone to tap into the line:

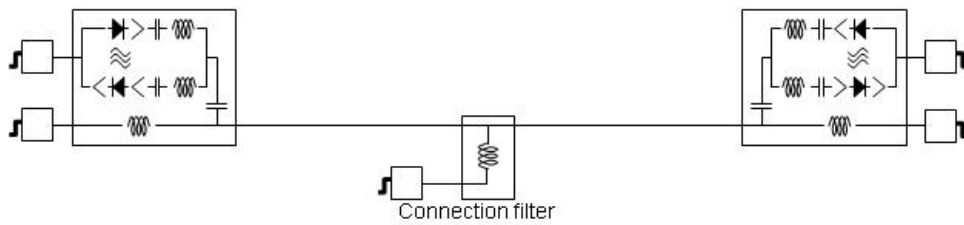
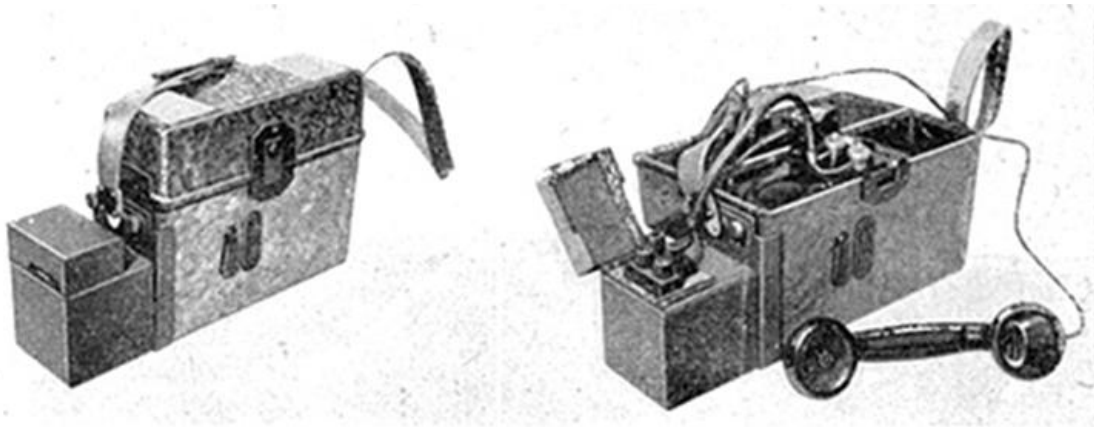


Figure 282: “*Anschaltfilter*” connection filter

Another type was the “*Umgehungswieche 3.3 T*” or Ring filter. This allowed the carrier frequency to pass through, but the speech frequency (smaller than 3.3 KHz) was segregated. Two telephones could be connected to the ring filter, each would provide a separate connection to opposite ends of the line.

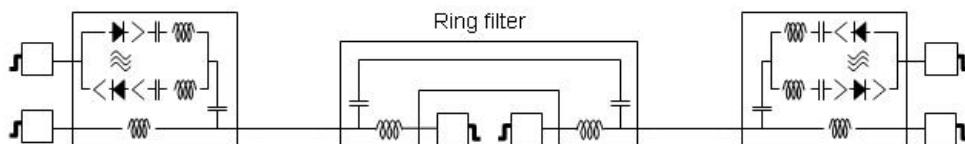
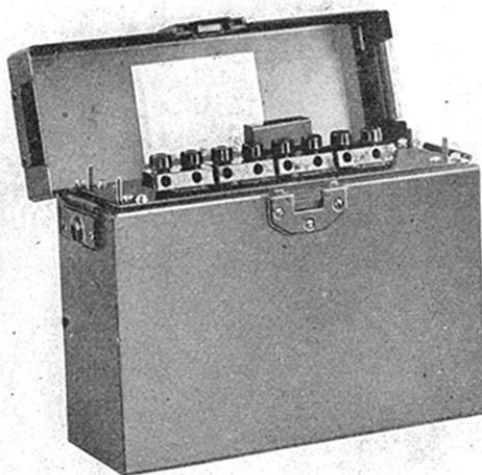


Figure 283: “*Umgehungswieche 3.3 T*” ring filter

Li 80 Lichtsprechgerät

Development and Description

In case natural obstacles like rivers or swamps could not be easily crossed with telephone wire, a secure wireless connection was required. The *Lichtsprechgerät 80* was well suited to this role, as it could transmit a voice signal over a distance of about 5 km using a narrow light beam.

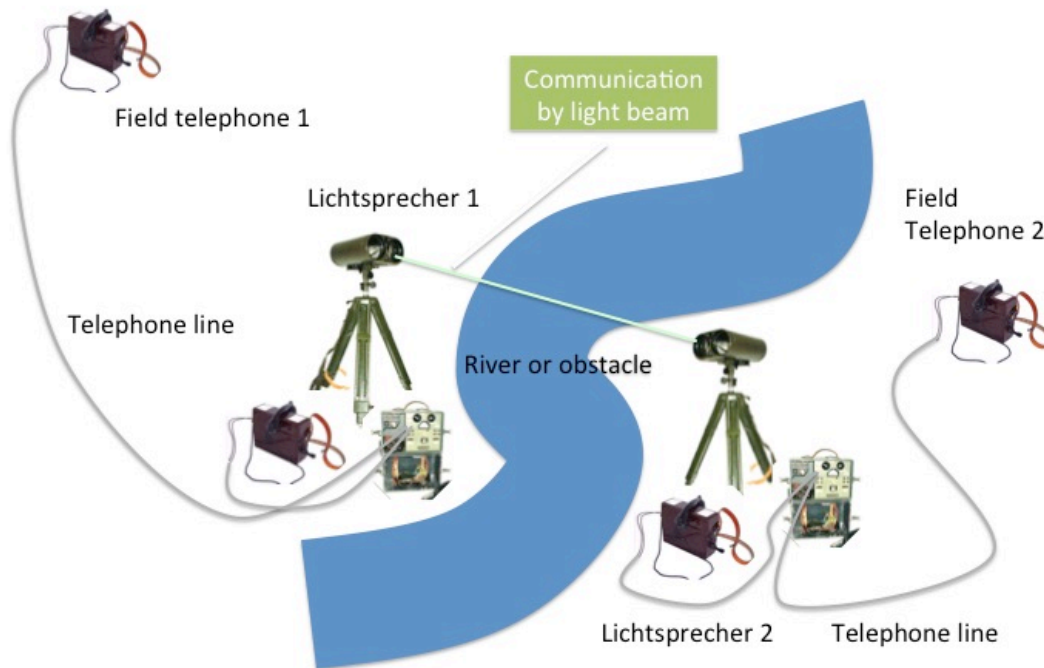


Figure 284: Use of a Lichtsprechgerät in a telephone connection

The narrowness of the lightbeam made it a secure means of communication, as any interception equipment would have to be placed exactly between the two optical heads. Infrared filters could be used rendering the lightbeam invisible.

The use of the *Lichtsprechgerät* in a telephone connection is illustrated in the above figure. Field telephone 1 is connected with a telephone line to *Lichtsprechgerät 1* which transmits the signal via a lightbeam to *Lichtsprechgerät 2* on the other side of the obstacle. *Lichtsprechgerät 2* then transmits the signal via a further telephone line to Field telephone 2. A local *Feldfernspeicher* was placed at each *Lichtsprechgerät* so that the *Lichtsprechgerät* operator could monitor calls. The ring tone signal could not be transmitted directly over the lightbeam, so operators were needed to relay the call between the telephone line and *Lichtsprechgerät*.

At least four different types of *Lichtsprechgerät* were developed by Zeiss with differing lens sizes (larger lenses and stronger lights mean longer range) but the *Lichtsprechgerät 80*, denoting 80 mm diameter lenses was the most prevalent type. The *Lichtsprechgerät 80* consisted of an amplifier in box, a battery box and an optical head placed on a tripod.



Figure 285: Complete *Lichtsprechgerät 80*

The amplifier and battery boxes could be clipped together to make a single carrying load which could be carried on the back. The optical head could be carried by a sling in a leather or ersatz-leather container with the tripod slung across the shoulder making the complete *Lichtsprechgerät 80* a two-man load.

First produced in the mid 1930's, the initial *Lichtsprechgerät 80*'s were powered by three batteries, a 2 Volt lead-acid battery, a 60 Volt anode battery to power the valves in the amplifier plus a 4.8 Volt battery to power the lightbulb in the optical head. Soon the 2 Volt lead acid battery was omitted, with the 2 Volt filament voltage created using a series resistance from the 4.8 Volt battery instead. Around 1940 the battery arrangement was changed again, it now used a single 2.4 Volt NiCd battery to power the valve filaments and the lightbulb in the optical head and a 60 Volt anode battery. A series resistance reduced the filament voltage to 2 Volt.

The simplified battery arrangement allowed an internal redesign of both the battery and amplifier boxes, with the anode battery moving from the amplifier to the battery box. The later 2.4 Volt type is marked with a yellow circle on boxes, optical head and lightbulbs. Care had to be taken as the lightbulbs were not exchangeable between the two types.

The interconnection cables between the amplifier and the optical head was stored inside the lid of the battery box, with further storage of headset, microphone, keying button, power cables and spares in various compartments.



Figure 286: 4.8 Volt version (right) and later 2.4 Volt version (left) of the *Lichtsprechgerät 80*

The optical head looks a bit like a large set of binoculars with two 80 mm lenses, one for the transmitter and one for the receiver. A smaller lens reveals the aiming optic used to align the two optical heads.



Figure 287: Optical head of the *Lichtsprechgerät 80*

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The receiver lens bundles the incoming light onto a photoelectric cell. This cell changes its resistance with the amount of light falling on it, this variation can be further amplified and turned into an audible signal. The transmitter lens hides a rather clever electromechanical device for modulating the lightbeam. Two prisms with slightly convex surfaces are pressed onto each other by an electromagnet. Because glass is actually slightly liquid, the contact surface is deformed dependent on the pressure. This alters the contact surface – and with it the amount of light that passes between the two prisms – depending of the force applied. The electrical signal is fed to the electromagnet and thus converted into a modulated lightbeam, which is concentrated by the transmitter lens into a narrow beam. Scatter, red or infrared filters can be selected to help with alignment and make the light beam invisible during operation.

Construction

Figure 288: Lichtsprechgerät 80 with battery case



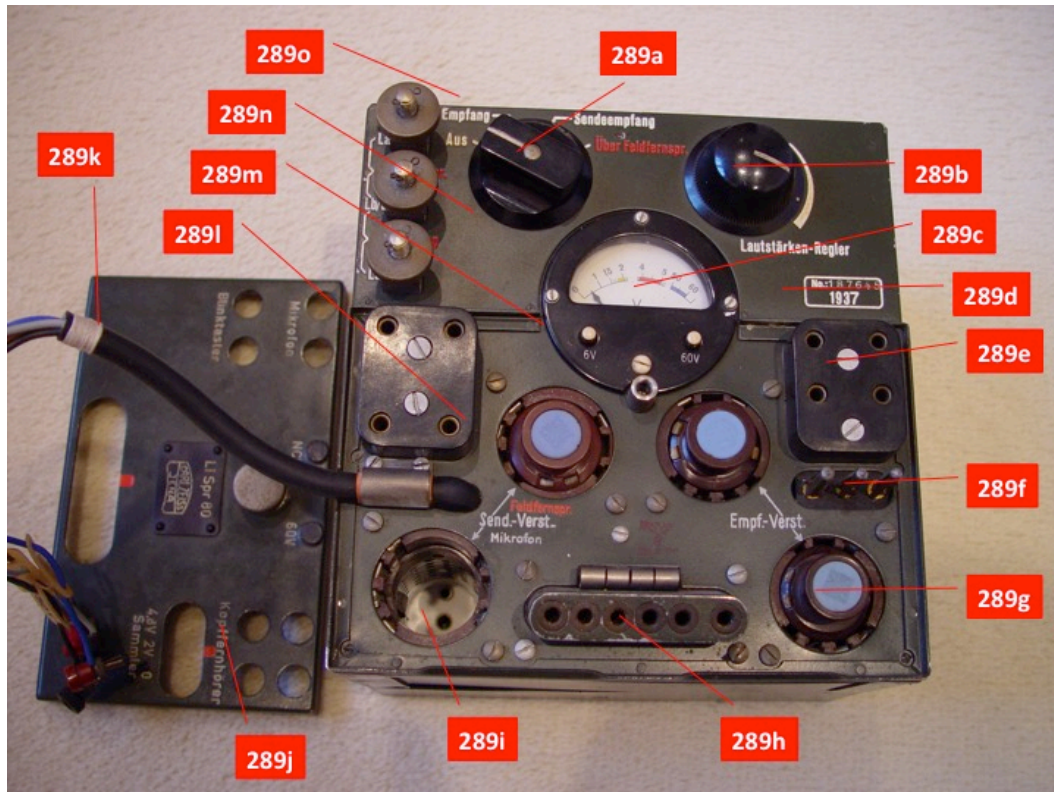
288a carrying handle
288b Amplifier unit
288c LV Power connection (fixed
cable on 4.8 V types)
288d NiCd battery (2.4 Volt)

288e Storage for interconnection
cable to optical head in lid
288f Anode battery (60V)
288g HV power connection
288h Storage area

288i Spares drawer with spare
lightbulbs, light cells and
valves

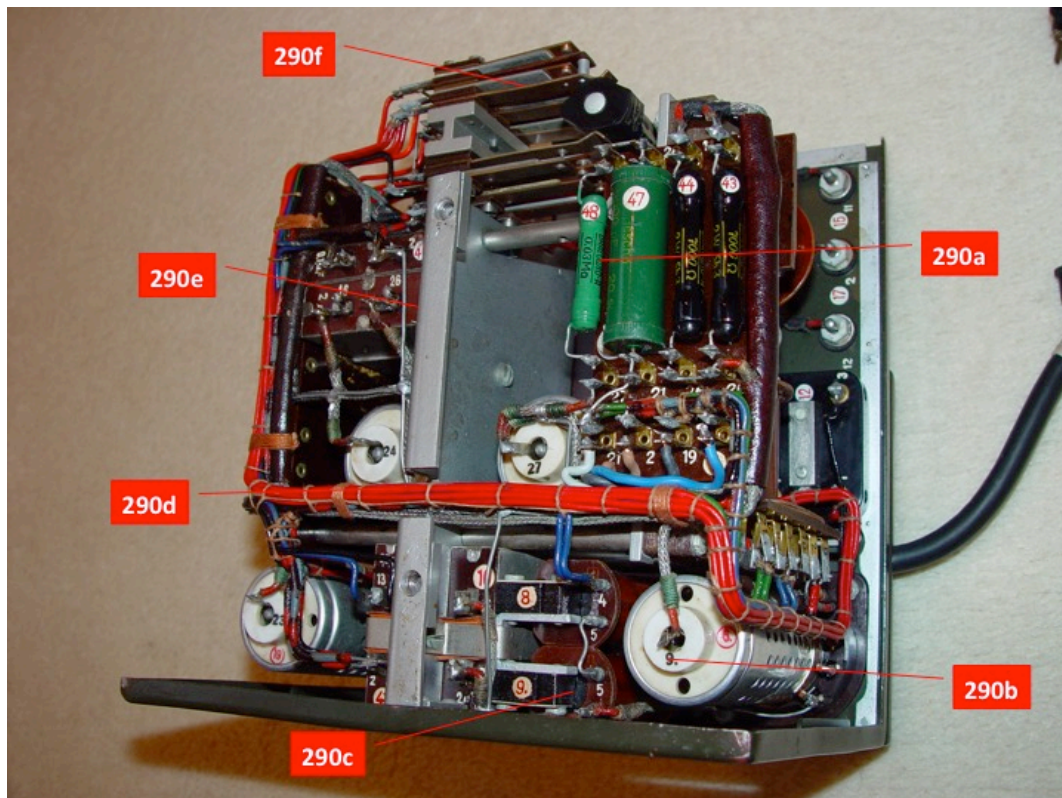
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Figure 289: Lichtsprechgerät amplifier with front lid removed



- | | | |
|---------------------------------|--|-------------------------------------|
| 289a Main switch | 289g Radio valve | 289k HV power cable |
| 289b Volume control | 289h Socket for connection cable to optical head | 289l Morse key socket |
| 289c Battery voltage instrument | 289i Valve socket with valve removed | 289m Microphone socket |
| 289d Date and serial number | 289j Removed front cover | 289n External phone line connection |
| 289e headphone sockets | | 289o Local telephone connection |
| 289f LV battery socket | | |

Figure 290: Lichtsprechgerät amplifier internals



- | | | |
|--------------------|---------------------|---------------------------|
| 290a Resistors | 290c Induction coil | 290e Capacitor block |
| 290b Valve housing | 290d wiring loom | 290f Main switch contacts |
- Note: Compare red circled component numbers and white or black node numbers to schematic

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Figure 291: Optical head of the Lichtsprechgerät 80



291a Aiming scope

291b Transmitter filter selection switch

291c Carrying handle

291d Cover of modulator

291e Control lights (lights up when transmitter is on)

291f Cover of light cell

All electronic components are clearly marked so that they can easily be traced on the schematic. Note that the first stage amplifier valve 18 for the light cell is housed in the optical head (under 291d cover of modulator). Amplifier Valve 14 (marked *Feldfernspr.* on the front panel) is only switched on when using an external telephone line, so the *Lichtsprechgerät 80* will use slightly more power in this mode.

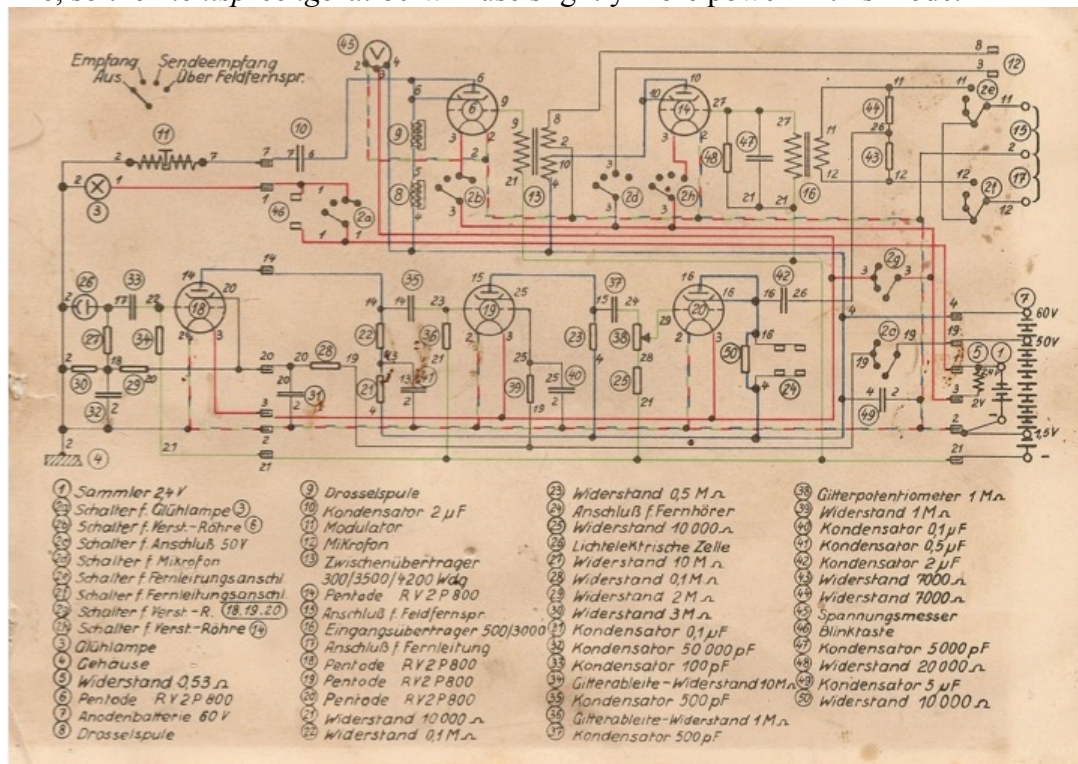


Figure 292: Schematic of the later 2.4 Volt Lichtsprechgerät 80

Operation

Identify a good location for the *Lichtsprechgerät* on both ends of the obstacle, e.g. a river bank. There should be an unobstructed line of vision between the two optical heads and both stations should be hidden from enemy view. The distance between the two *Lichtsprechgeräte* should be as short as possible, up to a distance of 5 km.

Telephone lines are build to both *Lichtsprech* stations; if the two *Lichtsprech* stations are in close proximity, a two line connection should be used for the final kilometer or so.

- Connect the power supply cables and connect the optical head to the amplifier, check correct battery voltages using the instrument. Plug in microphone and headpone
- With the transmitter filter set to “*Gestreut*” and the amplifier set to “*Sendeempfang*”, point the optical head to the opposing station. The red pointer visible in the aiming scope should lign up with the light of the opposing station
- Open the modulator cover. With the microphone held close to the mouth, slowly speak or blow into the microphone. Adjust the modulator knob until the green modulation light visible in the aiming scope clearly shows variation with speech.
- Listen for a test message on the other side. Make fine adjustments to alignment and modulation until two-way signal is clear.
- Switch the transmitter filter to “*Unsichtbar*” and check the signal both ways.
- Switch to “*Empfang*” and keep monitor incoming calls from the opposite *Lichtsprechgerät*
- Connect the incoming telephone line to the two terminals marked “*Fernleitung*” and connect a FF 33 *Feldfernsprecher* to the two terminals marked “*Feldfernspr.*”
- Turn the ring tone generator on the *Feldfernsprecher* and check the connection to the remote telephone. If working report that to the remote operator that the connection is in service.
- Monitor both the *Lichtsprechgerät* and *Feldfernsprecher* for incoming calls. When no calls are received, test the *Lichtsprech* connection every half hour.



Figure 293: Lichtsprechgerät 80 connected to telephone line

Incoming call from the telephone line:

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- Answer the call and ask him to wait a few moments
- Switch the *Lichtsprechgerät* to “*Sendempfang*” and call the opposing *Lichtsprech* operator using the microphone and headset of the *Lichtsprechgerät 80*
- When communication is established, switch the *Lichtsprechgerät* to “*Über Feldfernspr.*” Inform the telephone caller using the *Feldfernsprecher* that the link is ready
- Monitor the call using the headset of the *Lichtsprechgerät*, adjust volume if required.
- When the call had ended (the remote caller would ring-off), switch the *Lichtsprechgerät* back to “*Empfang*”

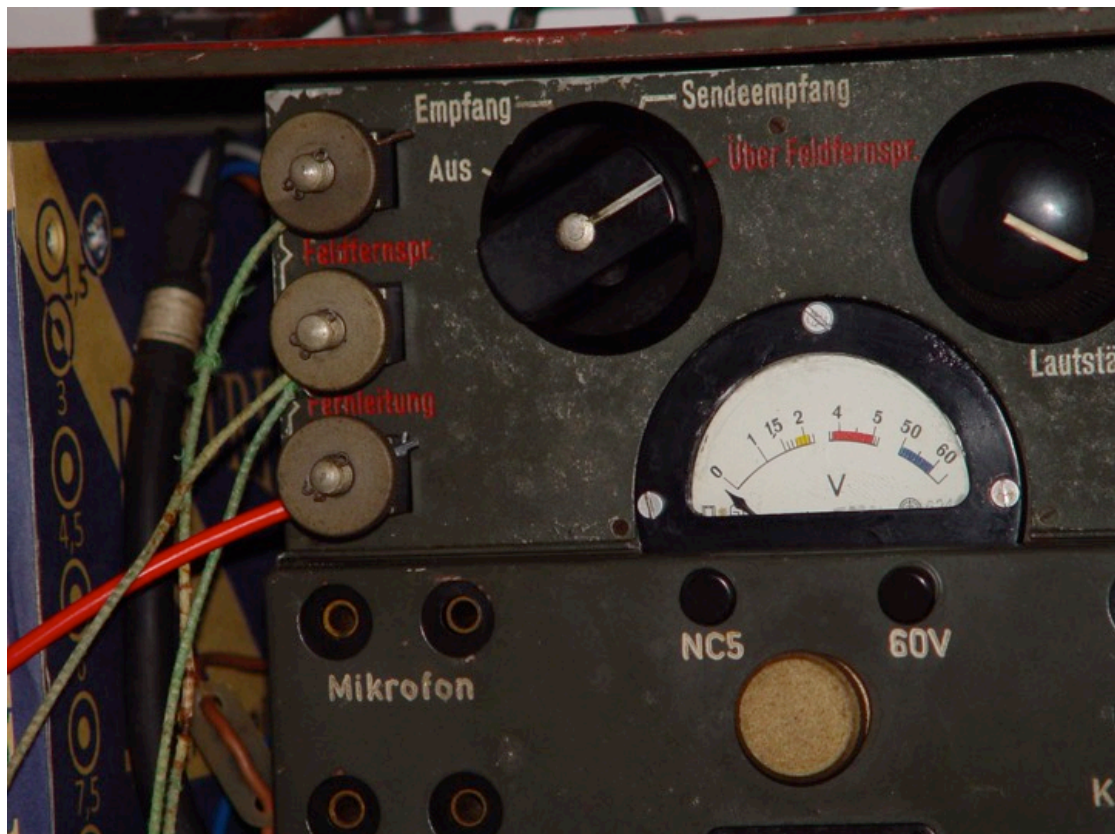


Figure 294: Telephone line connections and main mode switch on the amplifier of the *Lichtsprechgerät 80*

Incoming call on the *Lichtsprechgerät*

- When an incoming call is heard through the headphones, switch the *Lichtsprechgerät* to “*Sendempfang*”
- When the *Lichtsprech* connection is established, use the *Feldfernsprecher* to call the remote telephone operator
- When the telephone connection is established, switch the *Lichtsprechgerät* to “*Über Feldfernspr.*”. Use the microphone of the *Lichtsprechgerät* to report to the opposite *Lichtsprech* operator that the connection is ready.
- Monitor the call using the headset of the *Lichtsprechgerät*, adjust volume if required.
- When the call had ended (ring off the remote telephone operator if necessary), switch the *Lichtsprechgerät* back to “*Empfang*”

Lauschempfänger Intercept Receivers

Development and Description

During the First World War it was found that enemy field telephone connections in forward areas could be intercepted and that important tactical information could be learned. The German signal troops tapped into the allied lines either directly or by picking up earth currents and amplifying the signal using the “Moritz” intercept receiver.

When the German Armed forces started their rapid expansion in the early 1930’s a new line intercept receiver , the “*Lausch Empfänger 35*” (L.E. 35) was developed.

In 1940 the intercept receiver was replaced by the “*Lausch Empfänger 40*” (L.E. 40). The L.E. 40 was a portable line intercept amplifier, together with batteries in one enclosure. It employed a three stage amplifier using *RV2P800* Pentode tubes. It contained a filter for 50 Hz and higher harmonics to reduce mains interference and a switchable band pass filter.

The output signal could be switched to up to eight output lines, presumably so that lines using carrier wave or telex signals could be unscrambled by switching them to different Tfb units or telex modems.



Figure 25: Lausch Empfänger 40



Figure 296: Lauschemfänger 40 control panel

An interesting auxiliary was the “*Lausch Zange 35*” (LZ 35), a pick up coil that could be clamped around a line, without the need to make a physical connection.

In 1942 the final development of a compact intercept receiver was made: the “*Draht Lausch Empfänger (Klein)*” *D.L.E. (kl)*. A marvel of miniaturization, the unit only measures 17 x 9 x 5 cm with a battery box of the same size. The *D.L.E. (kl)* is essentially a two stage audio amplifier using two RL 2.4 P 45 Pentodes.

The receiver has all its controls on the top section, made out of bakelite. It has three controls:

- Left: On/Off switch and sensitivity control;
- Middle: Input balance control;
- Right: “*Lautstärke*” volume control.

It has a three pin headphones jack which can be used by either the



Figure 297: Draht Lausch Empfänger klein

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standard headphones, or the smaller plug of the telephone headphone

Three spring loaded wire terminals marked e (earth), a and b (line connection) complete the control panel of the receiver.

A lid on the bottom of the receiver can be opened for access to the two valves. Connections and locking pins to attach the battery box are mounted on the left side of the receiver.



Figure 298: D.L.E. (kl) with accessories in leather carrying bag

The D.L.E. (kl) consists of the receiver and battery box which are linked together when in operation. The receiver, battery box and accessories were stored in a leather bag when not in use.

The battery box has the same size and has lids on top and bottom leading into two separate battery compartments taking 3 V cells, very similar in size to current AA batteries. In the top section eight cells are placed in series to make 12 V anode voltage. In the bottom section the eight batteries are placed in parallel to make 3 V filament voltage. A resistor is used in series with the tube filaments to reduce this to 2.4 Volts.

The signal is led through two attenuation resistors and two decoupling capacitors into a balancing circuit. The signal then passes through a low pass filter and a transformer into the first amplification stage. Via a coupling capacitor and a



Figure 299: D.L.E (kl) battery box

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 volume control resistor the signal enters the second stage amplifier. An output transformer allows headsets with different impedances to be used.

The high input impedance of the receiver will not weaken the original signal strength of the tapped line, so the line user will not know that he is being listened to.

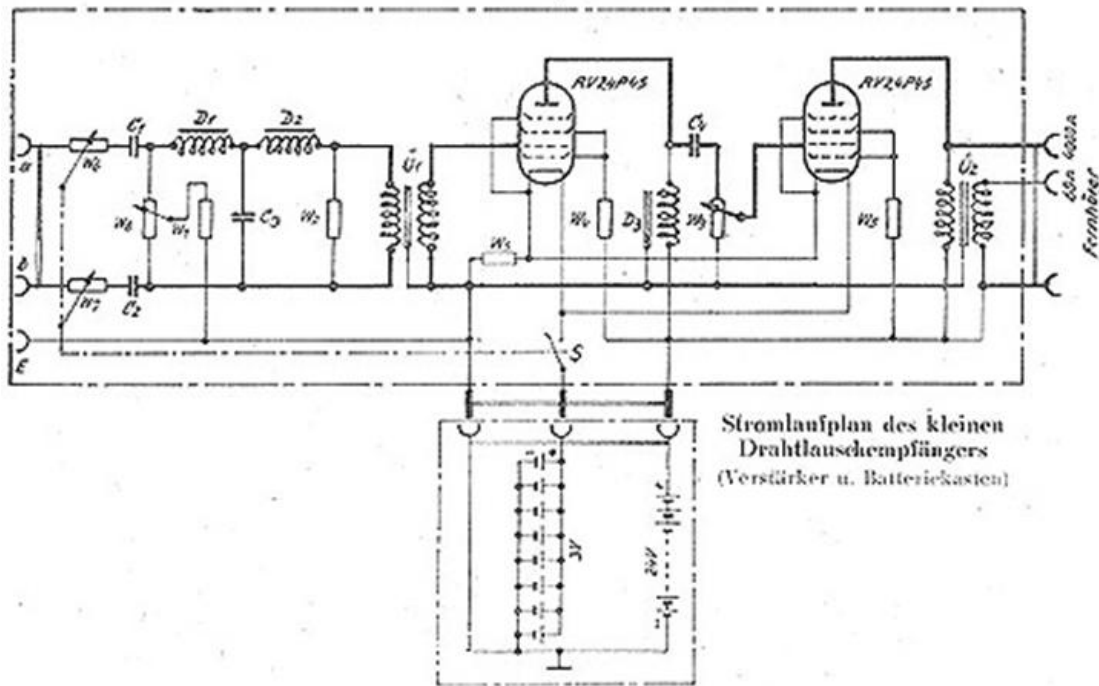
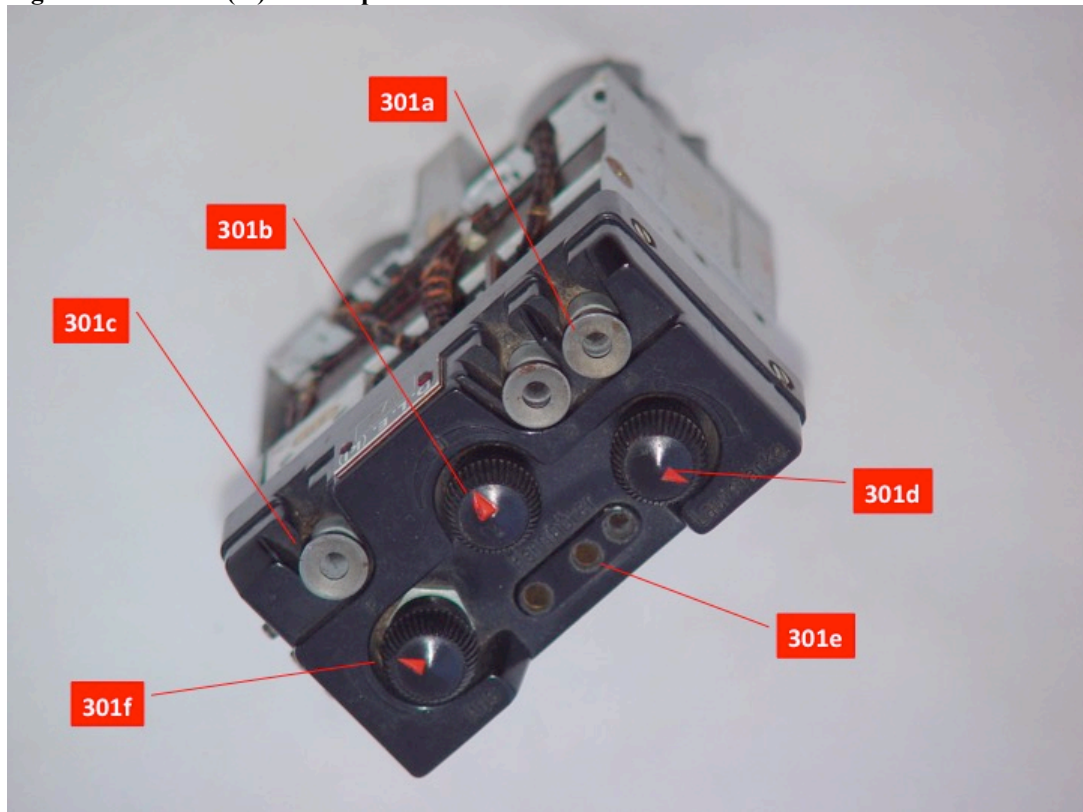


Figure 300: D.L.E. (kl) schematic

Construction

Figure 301: D.L.E. (kl) control panel

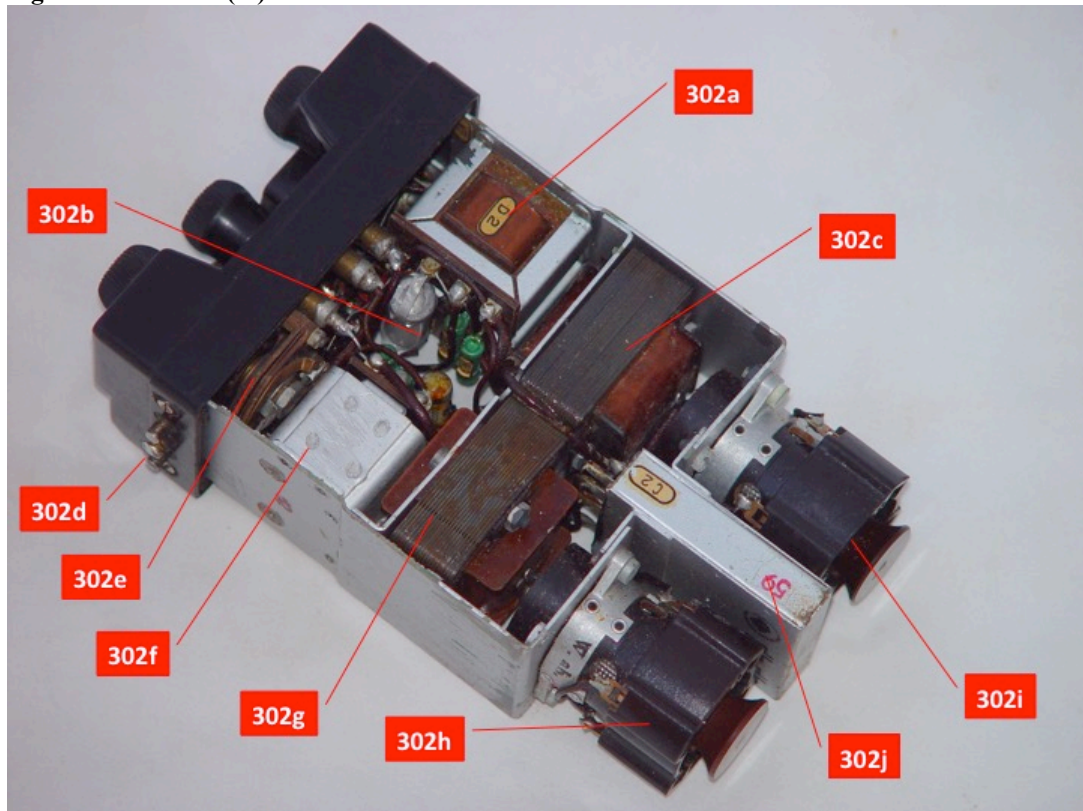


301a Connections for intercepted telephone line
301b Balance control

301c Connection for earth wire
301d Volume control
301e Headphone socket

301f Input attenuation control

Figure 302: D.L.E. (kl) interior



302a Input filter self inductions D1/D2
302b Small passive components
302c First stage input transformer

302d Battery contacts
302e On/Off and input attenuation control
302f Output transformer
302g Amplifier self induction D3

302h Second stage amplifier valve
302i First stage amplifier valve
302j Input decoupling capacitor block

Operation

Find a suitable location to place the *Drahtlauschempfänger* near the line to be intercepted. Prepare two wire of sufficient length to connect the receiver to the line. Carefully strip some insulation from the line to be intercepted. Alternatively two *Lausch Zange 35* can be clamped around each wire of the line to be intercepted. Place an earth pick near the receiver and prepare a length of wire to connect the receiver to earth

To bring the receiver into operation:

- 301b Place the batteries in both compartments of the battery box and connect the battery box to the receiver
- 301c Ensure that the receiver is switched off before making any connections
- 301d Connect the intercept wires to the line terminals of the receiver first and carefully connect them to the prepared area of the line to be intercepted. Be careful not to shorted the wires as this will give away that the line is being tampered with
- 301e Connect the earth wire to the earth terminal
- 301f Connect the headset
- 301g Switch on the receiver

It is likely that 50 Hz mains interference is heard. Use the balance control to minimize this interference. Turn the attenuation control clockwise until the signal is maximized without distortion. Retune the balance if required. Tune the volume control for the desired strength.

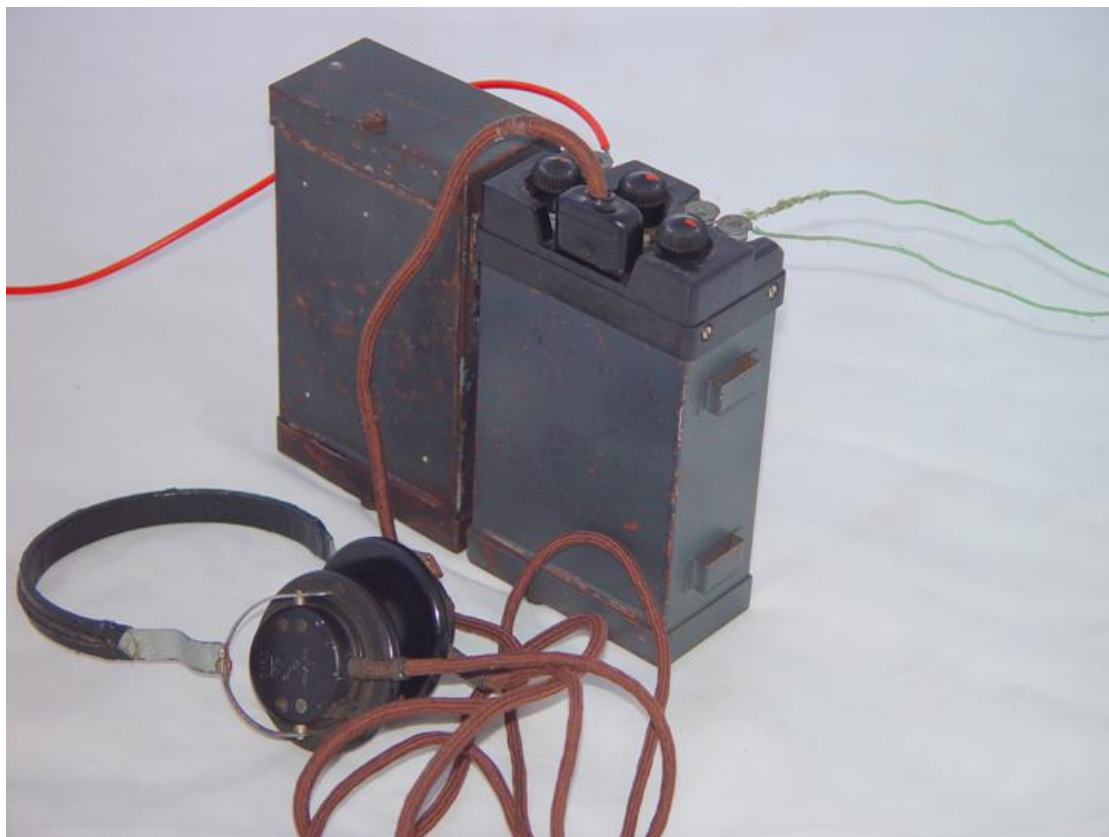


Figure 303 D.L.E. (kl) in operation

Glossary

Term	Abbr.	Explanation
<i>Abfragen</i>	Abfr.	To Enquire
<i>Abspuler</i>		Cable dispenser
<i>Ackerschnacker</i>		Colloquial term for field telephone
<i>Amtsanschiesser</i>		Unit to connect a field telephone network to a public telephone exchange
<i>Amtszusatz</i>		Accessory to connect a field telephone network to a public telephone exchange
<i>Anschaltfilter</i>		Low pass filter to connect a field telephone directly to a line using carrier frequencies
<i>Anschlußleiste</i>		Connection panel/strip
<i>Aufspuler</i>		Cable spooling device
<i>Aus</i>		(Switched) Off
<i>Ausgang</i>		Output
<i>Bedienungsanweisung</i>		Operating instructions
<i>Bereit</i>		Standby, ready
<i>Betriebsvorschrift</i>		Operating instructions
<i>Bronze</i>		Bronze
<i>Brustmikrofon</i>		Chest microphone
<i>Doppelpolwechsellschalter</i>		Double ringtone generator
<i>Draht</i>		wire, cable
<i>Drahtgabel</i>		cable fork
<i>Doppelkopffernhörer</i>		headset with two earpieces
<i>Dunkelgelb</i>		dark yellow
<i>Durchschaltung</i>		Interconnection
<i>Ein</i>		(Switched) On
<i>Eingang</i>		Input
<i>Eisen</i>		Iron
<i>Empfang</i>		Receive/Reception
<i>Empfänger</i>		Receiver
<i>Endstelle</i>		End point, terminal
<i>Erde</i>	E	Earth
<i>Erdsprechgerät</i>		Telephone device using earth currents
<i>Feind hört mit!</i>		the enemy listens in!
<i>Feldfernkabel</i>		Long distance field cable, a twisted four core cable used for building long distance connections
<i>Feldfernschreiber</i>		Field telex using the "Hell" principle
<i>Feldfernsprecher</i>	FF, Feldfspr.	Field Telephone
<i>Feldkabel</i>		Field cable; single core cable used for field telephone connections
<i>Feldklappenschrank</i>		Field telephone exchange, field switchboard
<i>Feldverstärker</i>		Field telephone amplifier
<i>Fernanschlußgerät</i>		Remote connection unit

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Term	Abbr.	Explanation
<i>Fernleitung</i>		Long distance line
<i>Fernsprechanschlusstrupp</i>		Telephone connection troop
<i>Fernsprechen</i>		To use telephone communication
<i>Fernsprecher</i>		Telephone
<i>Fernsprechtornister</i>		Signals backpack
<i>Fernsprechtrupp</i>		Telephone troop
<i>FF Kabel</i>	FFK	Heavy long distance field cable
<i>Flusskabel</i>		River cable
<i>Geschlossene Bau</i>		Closed construction; construction type where the laying of cable and suspension above ground is done simultaneously
<i>Gespräch</i>		Conversation
<i>Getrennter Bau</i>		Split construction, construction type where the laying of cable is done first, followed by the suspension above ground
<i>Gleichstromwecker</i>		DC ringer
<i>Grosse</i>		Large
<i>Handapparat</i>	Hap	(telephone) receiver
<i>Hochbau</i>		Construction type where cables are suspended 3.3 meters above ground
<i>Hebelumschalter</i>		Kellogg switch; a toggle switch used to control the use of the interconnection cable in a telephone exchange
<i>Kabel</i>		Cable
<i>Kabelmessinstrument</i>		Cable meter
<i>Kettenkrad</i>		Tracked motorcycle
<i>Klappenschrank</i>		Telephone exchange, switchboard
<i>Kleiner</i>		Small
<i>Kontroll Batterie</i>	KB	Control battery
<i>Kopf(fern)hörer</i>		Headphones
<i>Kraftfahrzeug</i>	Kfz	Motor vehicle
<i>Kriegsmarine</i>		German Navy
<i>Lauschen</i>		to Listen, to eavesdrop
<i>Lauschempfänger</i>		Telephone Intercept receiver
<i>Lautstärke</i>		Volume
<i>Leichtes</i>		Light
<i>Leitung</i>	L, Ltg	Connection, cable, line
<i>Lichtsprechgerät</i>	Li.Spr.	“Light speaker” communication device
<i>Mikrofon Batterie</i>	MB	Microphone battery
<i>Mit</i>		With
<i>Mithören</i>		Listen in, monitor
<i>Mittlere</i>		Middle, medium
<i>Nachrichten truppen</i>		Communication troops
<i>Niederfrequenz</i>	NF	Speech frequency
<i>Ohne</i>		Without
<i>Ortsanschlußgerät</i>		Local connection unit
<i>Ortbatterie Betrieb</i>	OB	Local battery operation

German Field Line Communication Equipment of WW2©

Term	Abbr.	Explanation
<i>Ortfesten Betrieb</i>		Static use
<i>Parallelfeld</i>		Scribner field; a connection field used on large exchanges so that all operators had access to all lines
<i>Polwechselfalter</i>		Ring to generator
<i>Primär</i>		Primary
<i>Prüfen</i>		Testing, measuring
<i>Prüfgerät</i>		Testing unit
<i>Pupiniert</i>		Line fitted with Pupin coils
<i>Pupinspule</i>		Pupin coil
<i>Rückentrage</i>		Back pack telephone cable carrying frame
<i>Ruf Taste</i>	RT	Calling button on a telephone exchange; connects to the activation contact of the ringtone generator
<i>Rufen</i>		To call
<i>Schlusszeichen Betrieb</i>	SB	End-pulse operation; used in networks where the end of a phone call was automatically signaled to the switchboard so that the connection could be reset as quickly as possible
<i>Schwere</i>		Heavy
<i>Schweres Feldfernkabel</i>	FFK	Heavy long distance field cable
<i>Secondär</i>		Secondary
<i>Selbstanschlussbetrieb</i>	SA	Automatic dialing network
<i>Sendeempfang</i>		Transmit/Receive mode
<i>Senden</i>		Transmit mode
<i>Signal</i>		Signal
<i>Sprechspule</i>		Microphone transformer
<i>Strippenzieher</i>		Colloquial term of back pack telephone cable carrying frame
<i>Tasche</i>		Pouch, bag
<i>Tiefbau</i>		Construction type where telephone cables were laid on the ground or build into trenches
<i>Tischfernsprecher</i>		Table telephone
<i>Ton</i>		Tone
<i>Tonsieb</i>		Tone filter
<i>Träger Frequenzgeraet</i>		Carrier wave unit
<i>Träger Frequenz</i>	TF	Carrier wave
<i>Trennen</i>		Isolate, disconnect
<i>Über (Feldfernspr.)</i>		Via (telephone line)
<i>Überwachung</i>		Monitoring
<i>Überwachungsschrank</i>		Monitoring station
<i>Übertrager</i>		Transformer
<i>Umgehungswieche</i>		Ring filter, allowing the speech frequency component of a carrier wave line to be segregated
<i>Untersatz</i>		Base unit, bottom unit

German Field Line Communication Equipment of WW2©

Term	Abbr.	Explanation
<i>Verbindungskabel</i>		Connection cable
<i>Vermittlung</i>		Telephone interconnection
<i>Vermittlungskästchen</i>		Telephone interconnection box
<i>Vermittlungsklinke</i>	Vk	Telephone interconnection socket
<i>Vermittlungsschnur</i>		Telephone interconnection cable
<i>Verstärker</i>		Amplifier
<i>Verstärkung</i>		Amplification
<i>Wahlbetrieb</i>		Dialing network
<i>Wechselstrom Telegrafie</i>	WT	Tone telegraphy
<i>Wecker</i>	W	Alarm bell
<i>Wecker batterie</i>	WB	Alarm bell battery
<i>Zange</i>		Clamp
<i>Zentralbatterie Betrieb</i>	ZB	Central battery operation
<i>Zusatz</i>		Accessory