Navigational timepieces of the Luftwaffe

War requires much from man and machine. In this series, Dr Konrad Knirim considers the heirarchy of these critical navigational tools

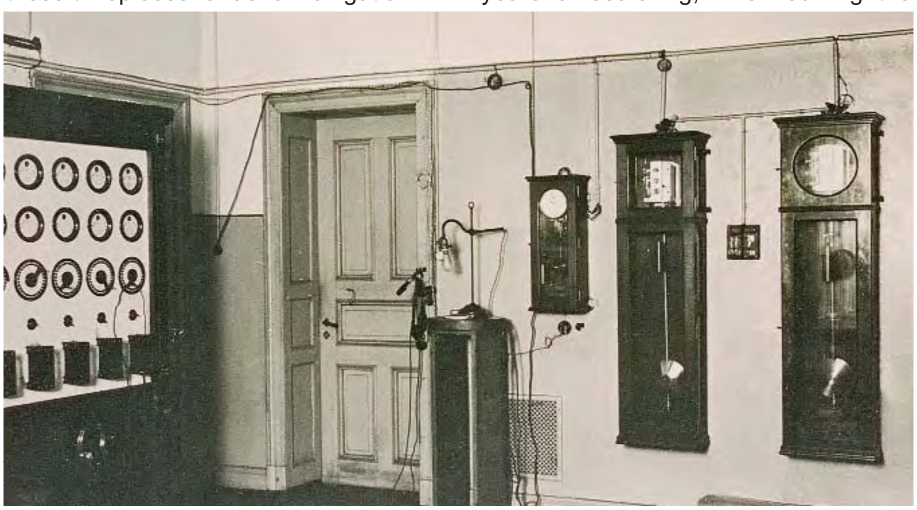
The purpose of this article is to summarise the details already known, and to provide information from newly found documents. The timepieces are only shown as examples, without details of the movements or caseback marks. The huge variety is shown in detail in my book *'Military Timepieces'* with its thousands of pictures, and I do not want to compete with that here. Here, like so often in a technical history, maybe 20% of the models represent 80% of the items used.

Another reason for this article is that I have in my possession the *Luftwaffe* (Air Force) service manual *Luft 1255/2d*, which describes the use of these timepieces for aerial navigation.

Briefly, the time was communicated from a precision pendulum clock at the *Deutsche Seewarte* (German Naval Observatory) in Hamburg by radio from the time signal station in Nauen to the Luftwaffe chronometer in the flight preparation room on the airfield. From the chronometer, the time indication was transferred to the aerial navigation watches, *B-Uhren* (Navigators' watches) and from there to the wrist watches of the flying personnel, as well by 'transport watch' to the clocks on the instrument panels of the aircraft.

Basics of Aerial Navigation

As was the case during the golden years of seafaring, when solving the



Nerve centre. The time-service room at the German Naval Observatory in Hamburg. The most important job done here was to trigger and monitor the radio-telegraphic time signal broadcast from Nauen; the signal was crucial for setting chronometers and navigational watches in flight preparation rooms across the country. Visible at left is the transmission switch board.

'problem of longitude' meant that ships were equipped with clocks that kept time with the greatest possible accuracy, so too it was during the early years of aeronautical navigation: aviators needed consistently accurate, robust and readily legible timepieces aboard their aircraft to determine their location and flight times. Marine chronometers that kept time aboard ships were augmented by deck watches, which were used on deck while making navigational observations and also to transfer the precise time indicated by the regulators in naval observatories to the ships while at port. These deck watches were high-grade pocket watches and kept safe inside sturdy wooden or metal containers.

Additional information was provided by a former commander of an aerial Marine Reconnaissance Group, Lieut. Hellmut Nagel. From his lively memories, the use of the chronometer, watches, instruments and astronomical tables, in conjunction with those contemporary navigation procedures, became clearly understandable. In his group, *Fern-Aufklärungs-Gruppe 5* (FAG 5), based in Mont Marsan in Southern France, there was a surface chronometer and 45 aerial navigation watches for the pilots and navigators (observers).

It is important to explain the structure of the use and application of time keepers as well as the hierarchy of precision in distributing the exact time.

High Command. Regulators such as this one by Riefler, no. 368, defined the standard time, disseminated by the Observatory, and used for rating military chronometers.

Pilots, by comparison with seamen, were typically only airborne for relatively brief spans of time, and deck watches in pocket watch format were not the optimal solution. An aviator needed a watch that he could read quickly and unambiguously, with to-the-second accuracy, while allowing him to keep his hands free to operate his aircraft. A wrist watch format was ▸▸

A Lange & Söhne no. 650; an early timing instrument for the German Airforce, four-pillar movement, with hour angle dial, and an external safety hand-setting device. Suplied as a surface chronometer for airfields.

A later Lange & Söhne Luftwaffe hour angle watch, gilt three-quarter plate movement, base cal. 43, in a silver case, marked 92665. Luminous hands for degrees, minutes and radial four-degree indication.

therefore preferred. An Observer's navigation watch also had to have a very long strap so that he could wear it on the outside of the sleeve of his flight suit. It wasn't until the mid-1930s that the first watches were developed in Germany to meet the specific needs and requirements of aviators.

Decisions and developments by the German Air Ministry in the 1930s

The defeat of the German airforce during World War One, and the terms of the Treaty of Versailles, which prohibited German aeronautics, meant that the development of aeronautical technology, navigational instruments and precise timepieces languished in the doldrums during the subsequent years, and was further exacerbated by the severe economic recession of the 1920s. Not until the 1930s, in response to political demands and new modes of transportation, was more attention and R&D funding invested towards this technical environment. The Luftwaffe was established as an armed force in its own right in March 1935. Afterwards, the *Reichs-Luftfahrtministerium* (RLM, Imperial Air Ministry) collaborated with the Deutsche Seewarte to call for and encourage further development of precise timepieces.

This was preceded by efforts to improve navigational instruments used by the navy. A document from the Deutsche Seewarte, dated 5 January 1935, invites watchmakers to participate in the 'Fifth Competitive Test of Precision Pocket Watches', in which the suitability of timepieces '...for scientific purposes and for nautical and aeronautical applications' will be tested.

The submitted watches, which had to be of German origin, were first tested, and the entrants were assigned to three classes: Special Class, First Class and Second Class. Special requirements with respect to accuracy of rate and degree of perfection of the movement were meticulously defined by the relevant German offices and commanding authorities during the Second World War.

Before a watch could be shipped to the military, it had to undergo testing in accordance with these standards and had to receive a rate certificate from the Deutsche Seewarte or other official testing institution. These standards stipulated that nothing but the best materials, impeccable components and the most precise adjusting were to be used in these watches. They had to be equipped with a high-quality balance (usually made of nickel-steel) and a specially treated balance spring (with an outer and an inner terminal curve).

Furthermore, each watch had to undergo fine adjustment in six positions and at three temperatures. As a rule, only watches which had been subjected to the aforementioned treatment were able to satisfy the test conditions for the Special Class or the First Class categories for precision pocket-watches.

Few documents about the *RLM's* collaboration with the Deutsche Seewarte and the watch industry survive from this era. Many records were no doubt destroyed during the night-time aerial bombardments that occurred between 1942 and 1945.

The specifications to be fulfilled by a special pilot's watch were listed, perhaps for the first time, on a document from the *RLM*. Dating from 1935, this document was recently discovered at the Military Archive in Freiburg. Bearing neither a title nor a signature, it appears to be the notes of a meeting. The text begins with a terse 'in regard to' line which reads as follows: 'Re: watches, chronometers, dials.' The document probably refers to the plans for a new Nautical Yearbook of Aeronautics and to a suggestion contained therein about the kind of

A Lange & Söhne Luftwaffe chronometer no. 659, supplied on 24 June 1936. Spring detent escapement, nutwood box with sliding top. There are no gimbals but the clock is pivoted along it 12-6 axis.

watches that would be needed for purposes of celestial navigation.

These recommendations can be regarded as heralding the birth of specially developed watches for the German air force:

1. The watches should include hour angle indication. Later, the decision was made to dispense with hour angles as all astronomical tables and yearbooks would have had to be changed.
2. The dial of a deck watch or ground-based chronometer should have clear numerals, and be unambiguously, easily legible. Interestingly, a design like that used on the face of the Longines Lindbergh was tested (Fl. 22604), but was rejected because of the double set of indications for hours and degrees and because it could be inadvertently reset.
3. Deck watches should be equipped with mechanisms to halt their seconds hands so that these could be precisely set to show Greenwich Mean Time.

Notice the vulcanised rubber suspension fitted to this chronometer. These instruments were designed for use in the flight preparation room, and not at sea, so gimbals would have been an extravagance on a device which, at 830 Marks, was already costly. The invoice is illustrated right. Chronometer no. 1102, supplied by A Lange & Söhne on 19 January 1939. Lever escapement, electrical contacts, an external hand-setting device, and 32 hour power reserve.

Pulling the crown stopped the watch so its hands could be set exactly. The watch would began running again when the crown was pushed back in. This mechanism also enabled such timepieces to be used for measuring brief intervals of time. This 'hacking' mechanism was not included in naval deck watches.

4. In accord with their purpose, only chronometers with lever escapements and hacking mechanisms were used as ground-based chronometers. These specifications defined the Luftwaffe's ground-based chronometer.

5. Further requirements for deck watches included resistance to vibration, reliability at low temperatures (–20°?C.) and regularity of rate. Furthermore, all aerial navigation watches had to be crafted as wristwatches.

The aforementioned document essentially defines all of the specifications that would later characterise Observers' watches for the Luftwaffe. Not all details were specified, e.g. the use of hour angles and the as-yet incomplete testing of sidereal time watches. The now rare and consequently avidly coveted hour angle chronometers and navigation watches were undoubtedly created in the response to these military specifications.

In their final form, all movements were housed in grey brass or steel cases measuring 55 mm in diameter and fitted with snap-on case-backs. The inside of the case-backs were marked with the following information: type of construction, device number, movement number, order mark, and the name of the watch manufacturer. The dials were black; large Arabic numerals coated with radium-based or non-radioactive luminous material indicated the hours; strokes marked the minutes and seconds. The hour hand, minute hand and seconds hand were coated with radium-based luminous material; the seconds hand had a counterpoise. Furthermore, all watches had a centre-seconds hand, as well as a hacking mechanism.

The German Naval Observatory in Hamburg

The Deutsche Seewarte in Hamburg wasn't only responsible for testing watches for the Luftwaffe. This observatory also administrated, monitored and disseminated the precise time for civil aviation. The prime reference time for all events at sea and air was kept by precise one-second pendulum regulators.

The following main clocks were kept either in the time-service room at the observatory or atop granite foundations in the building's cellar: Knoblich No. 2090, Strasser & Rohde No. 219, Riefler No. 223, Max Richter No. 101 and 102. All precision timepieces were tested here, e.g. chronometers and navigation watches for the navy and the air force.

The time service's most important task was to trigger and monitor the radio-telegraphic Nauen time signal, which was used to set the timepieces in the radio rooms and operations rooms of military airfields, as well as the ground-based chronometers at flight-preparation rooms.

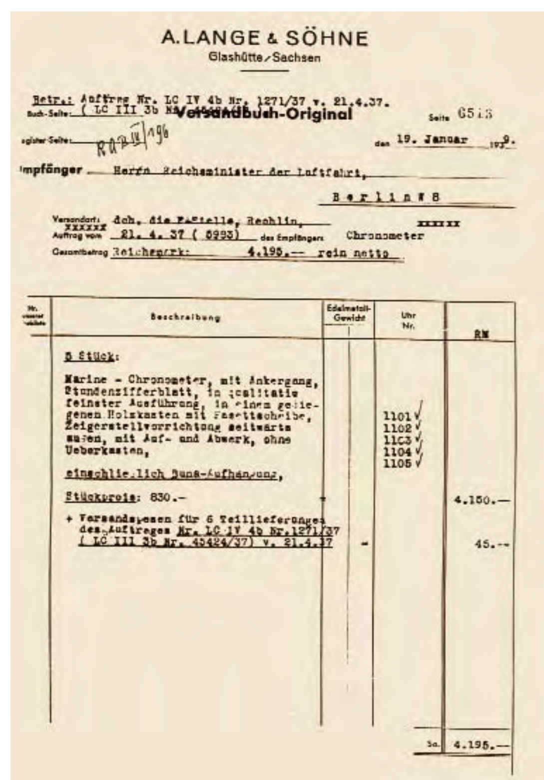
Production and Suppliers

Our knowledge of watches and clocks of the Luftwaffe comes from existing items. Due to destruction during the war, the requisition by allied forces after the war and the severe downturn of the watch and clock industry in the 1970s, there are only a few extant documents relating to orders, production and shipments.

Precision Timepieces

At first the only manufacturers of chronometers and navigation watches ⏩

Wempe Chronometerwerke Hamburg, no. 2389, c1940, rubber suspension, two-point axial balance-locking mechanism, external safety hand-setting device, 89mm four-pillar movement with Alfred Hellweg's main-spring barrel, and Griesback integral balance. The Luftwaffe 'Manual for Aerial Navigation' has a photograph of the Wempe chronometer no. 2385, where it prescribes the necessary equipment and techniques for astronomical navigation.



A.LANGE & SÖHNE
Glashütte/Sachsen

Betr.: Auftrag Nr. LC IV 4b Nr. 1271/37 v. 21.4.37.
Buch-Seite: (LC III 3b Nr. ...
Versandbuch-Original
Seite 6513
Register-Seite: RA 2 B IV/196
den 19. Januar 1939.
Empfänger Herrn Reichsminister der Luftfahrt,
Berlin W 8
Versandort: dch. die E-Stelle, Rechlin,
Auftrag vom 21. 4. 37 (6993) des Empfängers Chronometer
Gesamtbetrag Reichsmark: 4.195.-- rein netto

Nr. unserer Liste	Beschreibung	Edelmetall-Gewicht	Uhr Nr.	RM
	5 Stück:			
	Marine - Chronometer, mit Ankergang, Stundenzifferblatt, in qualitativ feinster Ausführung, in einem gediegenen Holzkasten mit Facettscheibe, Zeigerstellvorrichtung seitwärts außen, mit Auf- und Abwerk, ohne Ueberkasten,		1101 ✓ 1102 ✓ 1103 ✓ 1104 ✓ 1105 ✓	
	einschließlich Gummi-Aufhängung,			
	Stückpreis: 830.-			4.150.—
	+ Versandspesen für 6 Teillieferungen des Auftrages Nr. LC IV 4b Nr.1271/37 (LC III 3b Nr. 45424/37) v. 21.4.37	-		45.--
			Sa.	4.195.—

Chronometer invoice from A Lange & Söhne.

'Einheitschronometer' - This example of the Unified three-pillar chronometer is by Gerard D Wempe. By 1942, the production of surface-bound chronometers had been standardised and simplified. Now all makers built their devices according to one pattern, the specification 'Fl. 23881'. Features included the lever escapement, external handset, and balance locking device. The outer box with leather binding straps is still present on this example.

▸▸ were in Glashütte, the foremost being A. Lange & Söhne. To a lesser extent there were some manufacturers from the Black Forest, for example Junghans. Test items were ordered from Swiss makers such as Longines and Zenith. *The Chronometerwerke* in Hamburg regained economic stability after Gerhard D. Wempe took it over in 1938. Wempe were then able to produce chronometers and watches in large numbers.

Chronometers

Due to destruction of Hamburg in 1942-43, the production and shipment data from Wempe are not available, so we cannot know exactly when and to whom specific items were shipped. We do know that as late as 1938, they made a detent chronometer, no. 2074, without gimbals, but with a vulcanised rubber suspension to minimise the impact of vibrations and shocks. Only after this, with the help of the Watchmaking School in Glashütte, did they develop a lever chronometer. It was boxed with the same rubber suspension. No. 2385 is mentioned and shown in the *Luft 1255/2d* manual, and no. 2389 is in the author's collection.

The Luftwaffe service orders of 1935 and 1937, no. 268/1 for ground-based chronometers 'BC 1010', show A. Lange & Söhne as the supplier. Only in 1940 was the 'Wempe Chronometerwerke Hamburg' added. The shipment documents of A. Lange & Söhne are still available and the whereabouts of the relatively small number of detent and lever chronometers delivered to the Luftwaffe are known. From 1934 to 1937 only thirty-eight detent chronometers, and from 1938-39 only twenty lever chronometers, were shipped to the RLM. After that no Glashütte, but only Hamburg chronometers, went to the Luftwaffe, obviously according to agreements between the *RLM* and the manufacturers.

One protocol of the Committee for Chronometers and Navigation Watches of the Deutsche Seewarte from 8 August 1942, lists the total number of chronometers to be shipped: Wempe commits forty chronometers per month, twenty-five for the *Kriegsmarine* (German navy) and fifteen for the Luftwaffe.

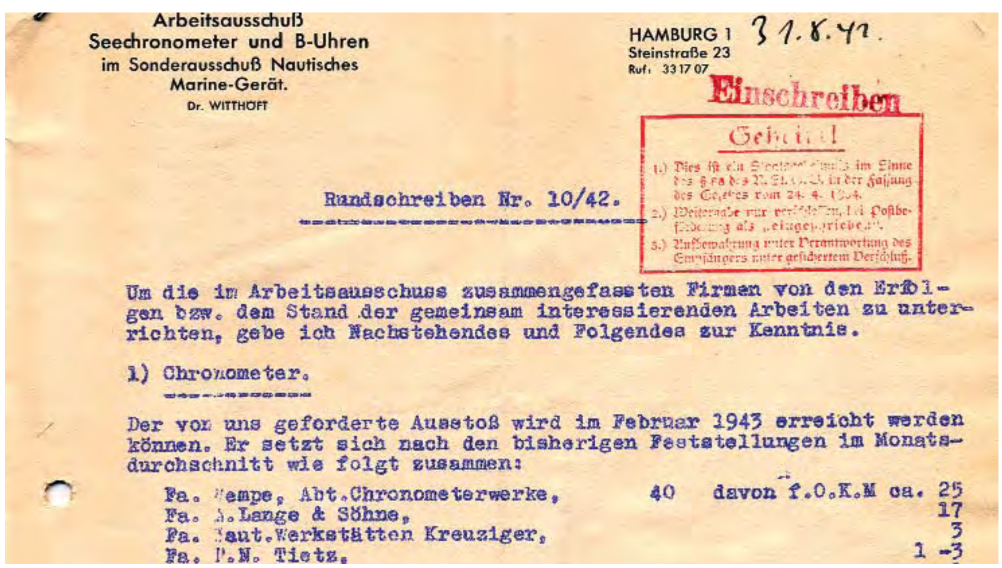
The production of the classic German four-pillar chronometer ended at that time, by order of the High Command of the *Wehrmacht* (German Military) and the *RLM* at the end of 1942, demanding a common design and production of standardised chronometers by several manufacturers.

This resulting *Einheitschronometer* (Unified Chronometer) was developed under the guidance of Lange and Wempe. Only Wempe and his partner Leutert produced the lever chronometer version for the Luftwaffe with fusee and provisions for external adjustment and stop mechanism, and rubberised ring suspended on the 3-9 axis of the timepiece.

After the war, this Luftwaffe chronometer would become the base for the Kirov lever chronometer of the Soviet Air Fleet, used until 1990, just as the detent Einheitschronometer was the base for the Wempe marine chronometer as well as for the Soviet Fleet. Glashütte did reactivate the 4-pillar design after the war.

German airmen synchronise their navigation watches.

To be continued in December's HJ.



Arbeitsausschuß
Seechronometer und B-Uhren
im Sonderausschuß Nautisches
Marine-Gerät.
Dr. WITTHOFT

HAMBURG 1 31.8.42.
Steinstraße 23
Ruf: 33 17 07

Einschreiben

[illegible]

Rundschreiben Nr. 10/42.

Um die im Arbeitsausschuss zusammengefassten Firmen von den Erfolgen bzw. dem Stand der gemeinsam interessierenden Arbeiten zu unterrichten, gebe ich Nachstehendes und Folgendes zur Kenntnis.

1) Chronometer.

Der von uns geforderte Ausstoß wird im Februar 1943 erreicht werden können. Er setzt sich nach den bisherigen Feststellungen im Monatsdurchschnitt wie folgt zusammen:

Fa. Wempe, Abt. Chronometerwerke,	40	davon f.O.K.M ca. 25
Fa. A. Lange & Söhne,		17
Fa. Naut. Werkstätten Kreuziger,		3
Fa. P.N. Tietz,		1 -3

Minutes of a meeting, showing that Wempe were expected to deliver 40 chronometers per month.

Navigational Timepieces of the Luftwaffe, 2

Dr Konrad Knirim continues his series on these critical navigational tools

Aerial Navigation Watches

These big 55mm wrist watches, known as B-Uhren (Observers' watches) are precision timekeepers to be taken aboard aircraft and worn over the flight suit. Wempe had shipped a great number of these aerial navigation watches (specification 'Fl. 23883') first with movements from Glashütte (Präzisionsuhren G.m.b.H., cal. 43.1) called BL (B-Uhr Luft) and then from Switzerland (Thommen cal. 31) called BLT. The watches for the navy were named BM (B-Uhr Marine, cal. 43) or BMT (Thommen cal. 31). It would be interesting to compare the developments for the navy and air force seperately. Wempe also assembled and regulated watches from Lange and Laco/Durowe in an unknown quantity.

There is a second type of aerial navigation watch in the standard 55 mm casing marked 'RLM Nav. B-Uhr' with numbers up to 2000. All movements were adapted Swiss pocket chronograph movements like Valjoux cal. 61 or Minerva cal. 19-9CH, where the chronograph mechanism were stripped and the chronograph second was changed to going centre-seconds. These were not precision timepieces in the traditional sense, but could meet the need when the radius of Luftwaffe action became increasingly limited in the later years of the war. There is no documentation available on this type of watch.

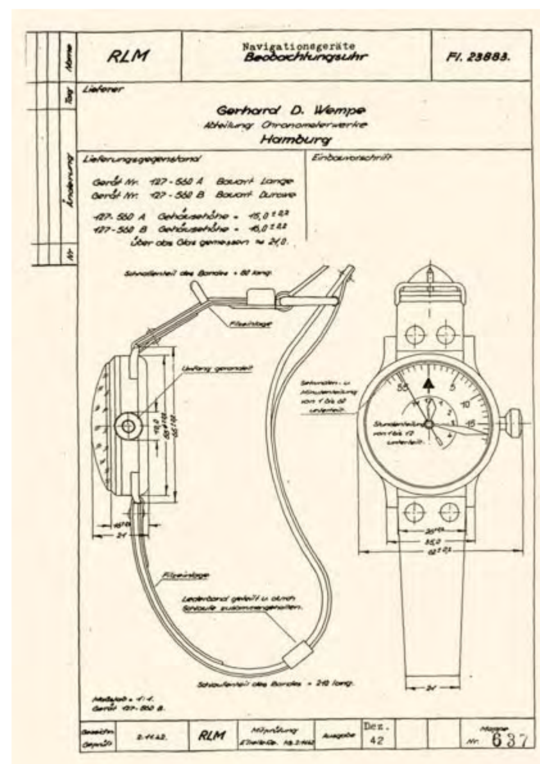
Early test specimen watches, beginning in 1935, were designed as hour angle instruments, and also as timers, with pocket watch cases adapted for the wrist with wire lugs. The author has not found any documents relating to the design specifications for the 55 mm casing, the black dials for early or late versions with inner hour circle or the extremely long leather straps.

Astronomical positioning on a long-range flight using a bubble octant and an aerial navigation wristwatch.

Lange did make at least 189 aerial navigation wrist watches with ¾ plate movements, cal. 43.1 and 45.1 and also with the Union cal 45.1. Beginning in 1937, Lange worked on the big cal. 48 movement. The production of the Luftwaffe version cal. 48.1 with black dial, stop-seconds mechanism and central seconds hand had started in autumn 1940, a month before the Navy version cal. 48 with white or luminous dial, small seconds and up-and-down indicator were shipped. Up to the end of the war at least 6904 Luftwaffe watches with cal. 48.1 were produced.

In addition to Lange and Wempe there were manufacturers from the Black Forest: Lacher & Co. (Laco) with cal. 5, Durowe (Deutsche Uhren-Rohwerke GmbH) in Pforzheim and Walter Storz (Stowa) with the Swiss Unitas cal. 2813.

In 1940, IWC in Switzerland shipped 1000 watches with the 55 mm cases, cal. 52TS.C., with two different crowns, to Siegfried Heindorf of Berlin. Two hundred of these movements were also used as deck watches for the British Royal Navy, showing that Switzerland did supply both sides of the conflict with precision timers.



B-Uhren, the oversized navigation watches. All models except those supplied by IWC were fitted with a choice of dial: standard or small hour ring. They all have with hacking seconds, to allow airmen to synchronise their watches. The specification was supplied by the RLM to Wempe, who were assembling the Lange and Laco/Durowe watches as well as their own.

'Observation watch', as made by Junghans, to convey the time from the surface chronometers to clocks aboard the aircraft.

Luftwaffe communications centre clock. This model, the Junghans J30D, is an early version, in steel.

An aircraft instrument-panel clock; this one, an Omega, number 592721 is dated 9 August 1936. Made to specification Fl.22601.

Message Centre and Aircraft Clocks

Eight-day clocks, supplied by Junghans and Kienzle, were used in communication rooms or trucks and command centres. In the early years the cases were of nickelled brass with a natural wood housing, later they were made of an alloy and wood painted grey. Small numbers came from Bäuerle and Köhler. There was a great demand for these timepieces and it is known that upwards of ten thousand were supplied, although quantities expressly for the Luftwaffe are not known.

The vast number of aircraft clocks by many manufacturers in the '30s, for example Askania, who used the twin-barrelled, eight-day Omega cal. 59D8, were reduced in 1938 to just a few models. Junghans produced the standard 'blind flight' chronograph clock, spec. BoUk1, Fl. 23885 with stop mechanism, and Kienzle the eight-day BoUk2, Fl. 23886-1. Schlencker-Grusen and Köhler in Laufamholz (BoUk3 and BoUk4) did not play a major role. Numbers produced are not known, but a late Junghans BoUk1 with coded manufacture marking 'nas' is numbered 646192, giving an idea of production quantity for the entire German military forces of WWII.

Wrist Chronographs and Service Wristwatches

Until the beginning of WWII, the pilots and test aviators, e.g. of the Rechlin test centre, were equipped with Swiss wrist chronographs, partly marked 'RLM-Nav.' and a four-digit number. Producers were Lemania, Leonidas, Minerva and Universal. When and how, and with which development specifications the pilots' chronographs of Hanhart and Tutima were developed, is still unknown to the author as there are no documents available. By 1941 they were already being given to the foremost flying personnel. In 1942, Lieutenant Nagel's entire JU88 crew, the pilot, the co-pilot, the navigator and the communicator, were all issued these wrist chronographs. In the JU290 also: both pilots, the navigator and the radio operators received these watches.

For the use of these stop devices there is the same description as for the 'blind flight' instrument panel clock: the chronograph has to show the time of day and the elapsed flight time. Additionally, it must be capable of determining timing intervals accurate to the second, e.g. for the landing process under zero-visibility conditions. The device has a marked rotatable bezel and a central chronograph hand. The mono-pusher wrist chronograph was initially used by the Kriegsmarine, who later used mainly pocket chronographs. The fly-back function is used after one manoeuvre ceases and another simultaneously starts.

Existing Hanhart chronographs have numbers from 100,000 to 125,000. Tutima range from 200,000 to 218,000. The watches have no military markings at all, no 'RLM' and we do not know of any 'Flieg' or 'Fl.' documentation. ▸▸

Message center clocks of the airforce - clock in a radio truck of the Luftwaffe in Badofoss Norway 1943.

Cockpit of a Me 110. The instrument panel has, on the left, a Junghans Bo UK 1 spec Fl. 23885, movement J30BZ with 15 min or 30 min counter.

A Junghan blind-flight clock, with chronograph function and fifteen-minute recorder. The specification number is visible on the box lid.

Since about 1942-43, when not enough service wristwatches for the German military could be imported from Switzerland, mainly due to lack of convertible currency, the Luftwaffe enforced the home production by Black Forest manufacturers, especially those in Pforzheim. A round case with a dial similar to the design of the big navigation watch was fitted with a rectangular UROFA Glashütte ('Uhren-Rohwerke-Fabrik G.m.b.H.') movement, cal. 58 or 581, and in some examples, the less robust tonneau-shaped PUW (Pforzheimer Uhren Werke GmbH) cal. 500 was fitted. The assembly was performed by local watch factories such as Aeschbach, Aristo, Bauer, Berg, Exita, Nila, Para, Stowa, Wagner and others. The cases were made by Kutter Pforzheim, the dial by Weber & Baral and an unknown 'WC'.

A document showing the specifications and accuracy demands is not available. Many watches, but not all, are marked with 'RLM' on the back, the numbers span the range 600,000 to 800,000, but these include Kriegsmarine watches with white dials. The numbers were given in blocks to the manufacturers, so the span may not reveal the actual production.

Stop Watches and Instrument Timers

Apart from their use for tests and education, stop watches were mainly built into adjusting and measuring devices, and bomb-timers, eight-day movements were used as the foundation for solar compasses, triggers and radio devices. A few examples of the many applications for these mechanisms are listed here:

-Timer for bubble octant or gyro sextant (Plath)
- Stop watch in bombing equipment (Görtz)
- 'X-Uhr' for the radio guidance system (Wotan)
- Trigger in the distance measuring tool (EMEG)
- Timer in radio identification on airfields (MGZ2)
- Timer SU7 in the communication device (FuGeVII)
- Timer in cargo parachutes - Timer in radio buoy
- 24h clockwork in the solar compass
- One week timer in barographs and altigraphs.

Pilots' wrist chronographs for the Luftwaffe were produced by Hanhart in Schwenningen and Tutima in Glashütte. This one has a gilt movement and bezel index. No documents are known giving the design or the supply order for these watches. A Tutima can be seen on this pilot's wrist.

Service wristwatches with the rectangular Urofa calibers 85 and 851. The signature 'Berg' is that of a watchmaker in Pforzheim. Design specifications are not known for this model either. Crewmen can be seen synchronosing their service wristwatches with the Navigator's B-Uhr.

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Viktor Pröstler, 'Zeitsignale für die Seefahrt', Klassik Uhren, 2/98

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Above left: A target finding device with two Junghans special stop watches marked with the Luftwaffe test centre Redchlin no 85065 and 850657. This device was used for training pilots.
Above right: Clocks for speed by measuring while crossing two radio beams and deriving the right moments to get the 'bombs away' (the procedurue is called X). X clock by T Bäuerle & Söhne.

Above left: Sun compass C Plath Hamburg. There is an integrated 24h clock, Junghans cal J30 E, 8 days, device no 127-1676A1, no 510, producer code, 'gtl', on top of the clock.
Above right: Timer for radio signalling 'MGZ2, Ln 25536 with timer', producer Pintsch Berlin descripted by the 'Telefunken' company in a manual for radio navigation in December 1939.

Dr Knirim, a resident of Dusseldorf, is a mechanical engineer and collector of military timepieces, and is documenting the complete range of German military timepieces from c.1850.

www.knirim.de

Part three of this series will be featured in January 2007's HJ.

Navigational timepieces of the Luftwaffe, 3

Dr Konrad Knirim concludes his series on military watches and clocks.

Extract from the *Manual for Aerial Navigation*, *D (Luft) 1255/2d, Part 2. Application in Navigation with astronomical position lines, August 1942 (partial).*

'The experiences in the area of aerial navigation showed that navigational procedures based on dead reckoning navigation mentioned in D (Luft) 1255/2b and /e are not sufficient for performing special tasks...

1) The accuracy of these procedures decrease with the elapsed flight time and increasing distance from the air base...

2) The use of communication support may be disturbed or prevented by the enemy...

3) The support of the ground organisation may not be available to a sufficient extent...

4) The accuracy and availability of the application may depend on the time of day.... These disadvantages do not exist when applying the procedure of astronomical positioning to the guidance of an aircraft. In order to determine of the astronomical baseline, the aircraft has to be equipped with the necessary surveying and calculating devices. The astronomical height of at least two stars (or the sun), whose positions should differ by about 90°, equivalent to the procedure in radio positioning, should be determined.

I. The Astronomical Baseline

In aerial navigation, the astronomical baseline is the line along base of the angle of observed elevation upon which the aircraft is located. The equipment to determine the astronomical position line consists of: observation devices, calculating devices, tables and forms, accessories.

'To get the angle of elevation of a star a bubble octant is used. The accurate time is determined by an aerial navigation wrist watch (B-Uhr).

'Accessories: lighting device, calculating forms, the Astronomical Yearbook, the celestial globe (surface equipment), the chronometer (surface equipment)

'The chronometer is used to control the navigation watch at any time before flight. It is located in the flight operation room at the airfield. The going and the daily rate must be determined daily by observing the time signal and documented in the chronometer diary).


D. (Luft) 1255/2d

17.7.43.

155

Leitfaden der Flugnavigation

Teil 2

Angewandte Navigation

d. Koppelnavigation
in Verbindung mit astronomischen
Standlinien

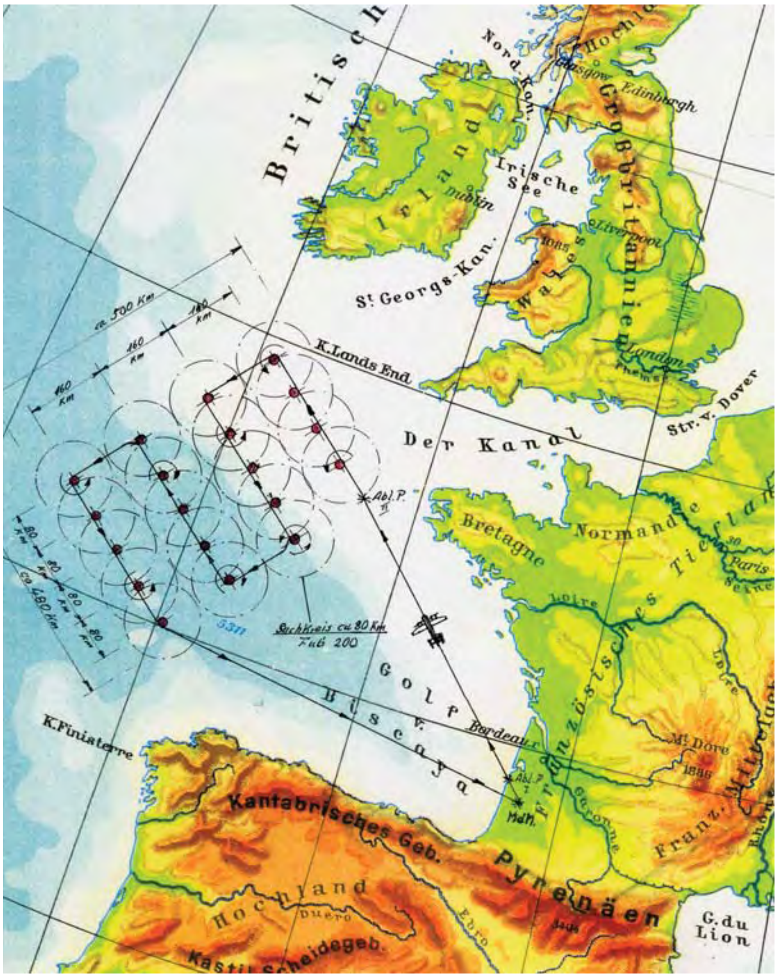
August 1942

II. Navigational Flight Preparation

Due to the delicate nature of the octant it makes sense to take two devices aboard. The aerial navigation watch is synchronised with the chronometer. The deviation of the chronometer has to be taken into account.

'Example:

Suppose the navigation watch for an upcoming flight has to be synchronised with the chronometer at



5:30 am on the morning of 9 January 1942. According to the chronometer diary, this timepiece had had an indication of –14s at 2:00 pm on the afternoon of 8 January 1942. According to the data, the daily rate was calculated at +1.5s. This resulted in a rate of –13s for January 9, so the navigation watch should be set at 05h30m00s. The navigation watch is started when the chronometer showed 05h30m13s, so that indication of the navigation watch would be [reset, in accordance with its rate]. The observer's navigation watch is then be used to adjust the watches of all other crew members. The navigation watch was thus the most precise timepiece aboard the aircraft.

A report of the experiences of Ltnt. H. Nagel (Extract)

Crew members: Uffz. Wischelow, Lt. Nonnenberg, Uffz. Elies, Uffz. Heeg, OLt. Vaupel, Uffz. Roller, Lt. Nagel, Fw. Justel, Fw. Berndt and Fw. Leimenkühler.

Mission: long distance reconnaissance at sea, January 1944. Location base: Mont-de-Marsan, southern France.

Area of action: West coast Spain, Azores, southern Greenland and Ireland

Flight commander: Lt. Nagel, Observer and action leader OLt. Vaupel.

Flight no: 1686 of the log book of 18 February 1944. Search for escorted ships' convoys up to 26° West.

Start: 01h17, return on 19 February, 07h57.

Flight range: c5,500 km, duration 18 hours.

The entire crew was set on standby alert since the afternoon of 17 February. At about 10h00, a motorcyclist arrives with the orders: takeoff time 14h00. My observer and I are collected at 12h00 by the crew bus. In the operations room the crew is given instructions about the operation plan. Two escorted convoys of ships have to be investigated; all details of the first, and some of the second, which would only be discovered at night. Positions and course have to be observed.

The navigation watches are set to the chronometer in the operations room, then we go by bus to the Junckers 290 already prepared for takeoff. The technical servicemen announce their 'ready' report. Including the two weathermen, we are 11 crew members. The second pilot, Lt. Nonnenberg declares: 'All ready for takeoff!' Gyro and course steering are checked. The onboard communications line is checked by name, the four engines have already been checked by the co-pilot.

Flight commander Lt. Nagel, pictured here in January 1943, was permitted to keep the IWC Luftwaffe navigational wristwatch used on his flights. This model differs from that of other makers in that the movement is shielded by an extra inner antimagnetic case. Only 1000 pieces were made, and shipped to Siegfried Heindorf of Berlin. This early model is identifiable by the cylindrical crown. Case: 55mm in diameter, strap width 25.5mm, fixed with spring bars. Movement: IWC cal. 52, no 1013833. The watch was given to the author by Lt. Nagel.

Start: flaps in takeoff position, brake shoes away, windows closed and announcement on the onboard line: We are going! Throttles full forward, the co-pilot and I get the steering tight in our hands to guarantee a safe takeoff. It is fascinating when a 42-ton colossus like the JU290 starts rolling. The radar station 50m behind the strip speeds towards us. The landing gear is retracted at 50m, followed by the flaps, and the engines are reduced to cruising power.

Our two radio communicators put the antennae out to tune the communication devices and the first check call from the base station is received. Meanwhile the observer OLt. Vaupel prepares his navigation table and fixes the first time stamps on the sea map. All navigational events, actions, radio direction findings and course changes as well as astronomical fixes are copied onto the map by the observer.

The Long Distance Reconnaissance Group 5 (FAG 5) consisted of two squadrons, each with ten Junckers 290 aircraft. There would have been at least 45 navigational watches in use between them. On the far right of this small group is Lt. Nagel.

The first gunner surveys the airspace between the starboard side and the rear from his turret, beneath his 2cm machine gun. The second gunner in his turret in the after third of the plane watches the port side, and the rear gunner covers the aft. At 100m altitude we are welcomed by a Biscay low pressure area. An escort by the fighter squadron JG 101 (Novotny) is not necessary due to the weather. The British long range Mosquitos may not be expected in this weather. The three gunners and the onboard mechanic have to test their weapons by shooting some salvos into the sea, after 10 minutes the 'weapons clear' notice is given.

The mechanic controls fuel and oil consumption and performs the pumping activities between the tanks, calculating the fuel needed by the use of course data and fixes by long- and short-wave radio direction findings. All is evaluated and noted on the map. The very short duration of the radio transmissions for these findings should make the observation of this flight by enemy reconnaissance difficult.

After the second geographical release point, we switch on the FuG 200 radio investigation system to search for naval targets. With two tuning ranges it is possible to locate ships, their number and displacement up to 35 km or 120 km away. The observer is busy on his navigation table and communicates results, figures and orders with the two radio operators, who receive and transmit to the BdU (U-Boat High Command) in Paris or to the Norddeich radio weather station in the North Sea.

We are now airborne for 2 hours and south, on the port side, should be Cape Finisterre, in Spain. For the direction and location finding we use the Elektra radio guidance system with its base stations in Stavanger (Norway) and Seville (Spain). These radio bases give the navigation base for the location and our start point into the Atlantic: our position is 11° West, 43° North. The communicators pull in the long range antennae. Based on our electric altimeter we change our altitude to 20m over NN.

We are now approaching the area of the convoys; it is from southern England to the Azores to Gibraltar and back. The low flight altitude gives the best shelter against surprise encounters. For a half-hour we climb to 300m and fly in a ▸▸

Oberleutnant Vaupel, the observer and commander of the operation, pictured here with Hanhart mono-pusher chronograph on his wrist. This is the early version with the triangular marker on the rotatable bezel, and the airforce dial. The army version of the dial had a red telemeter scale to calculate the distance of canon fire.

circle and apply the FuG 200 in steps. Thereafter, we immediately descend to 20m. By doing this, we avoid being discovered by the ship's radar of the convoy's escort vessels. In deep flight we move to a level were the radar radiation is reflected by the rough surface of the sea, so we may not be discovered this way. At the following search circle at 300m, the FuG 200 detects unnumbered targets ahead. The circle is stopped immediately and we descend to 15 or 20m and adjust our course directly towards the centre of the convoy. By our onboard communication system, 'heightened alarm' is communicated to the whole crew.

The operator announces the convoy centred on the display of the FuG 200. He detects about 30 to 40 ships along with a very big target. Shortly thereafter the visual detection confirms a medium aircraft carrier. In very good visual conditions, we detect the entire convoy by their many smoke clouds: merchant vessels and their armed warship escorts.

As we approach the 18 km mark, with the convoy still on course, we get noticed by them. Some smaller escort ships move towards us in a broad front, with visible prow waves they confront us, firing all their guns.

The carrier on the west side starts his attacks well. In these conditions, we continue flying, to 2 km from the boats, to the impacts of the shells on the water surface, while observing the carrier, and then turn north on a 50° course. The observer, the operators and the gunners try to count the number of ships in detail. With our camera robot and its 7cm lens, the observer photographs some of the ships. We cannot see whether the carrier aircraft have started, therefore we fly for half an hour, for about 80 sm this course, because carrier aircraft can only move 50 sm from the carrier. In the approaching dawn the observer and the operators will encode the messages to the BdU in Le Bourget near Paris. A new fine tuning of the radio signals has to be made to perform a new location and direction finding with the radio base stations in Stavanger and Seville.

We have now been away 17½ hours, and should encounter the area of the second convoy. It is westbound, headed for the USA. In the Ei-V, the onboard communication system, the voice of the first operators is heard: 'Ship targets 50 sm ahead!' All combat stations are manned immediately. Our FuG 200 allows us to adjust our course exactly to meet the convoy. We are now detectable by the radar of the escort vessels, but we are not visible due to clouds. By the different green marks on the display of the device the communicator can detect 35 targets.

The convoy makes course with its broad keel line 215° Southwest by south. We fly from the end to the top, along the convoy, and drop a parachute with light bomb at both points. They fall through the stratus cloud layer and spread a harsh light all over the sea to give attention to the German submarines around.

After that we turn back and head towards Mont-de-Marsan. A clear sky filled with stars is the best condition in which to perform an astronomical location-finding. The second pilot takes the controls and my observer and I go take the bubble octant our navigation watches and stand in the middle of the aircraft, [to the area] topped with a clear Plexiglas cover, to 'shoot a star' crossways and front. With the octant, an extra bright star front and across has been fixed for some seconds and the levelled angles are noted on the pre-prepared form. A standardised calculation allows us to cross two lines on our map, which gives the exact location at the time of observation. Our two operators also determine, at the same time, as an additional means of location, two secret radio stations, one on the south Irish coast and one near Cape Finnisterre in Spain.

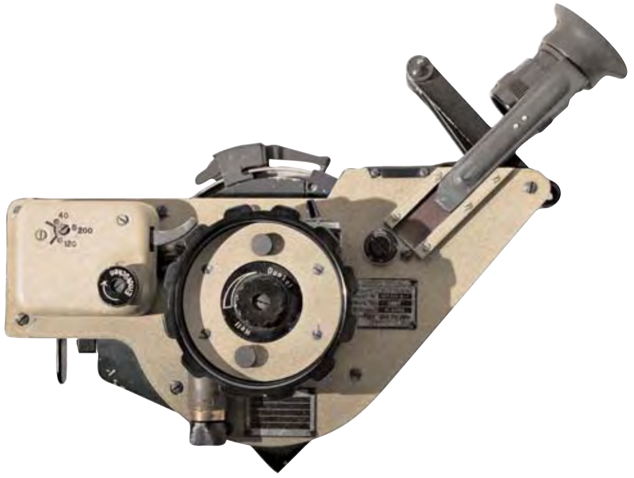
Our onboard mechanic and the second pilot start some fuel pump actions for the trip home. The operators encode the messages with the support of the observer. He also controls the navigational data of the course changes in the recent hours. A new day, 19 February 1944 dawns. It is 01h30 and seven hours' flight are left to Mont-de-Marsan.

About 05h00 we leave the altitude of 2000m and enter Biscay at 100m, just North of the eastward low pressure area. We choose this uncomfortable altitude, as we get within reach of the British long-distance fighters. We try to detect the German Kriegsmarine coast guard boats early enough to give our notification code in time.

Just before we overfly the coastal border, the comparison of the positioning is performed together with increased radio transmission to get: QFE, QFF and some weather notes from the airfield base at Mont-de-Marsan. Voice radio connection: 'All OK'. Message from the airfield, no 'MYO Bordeaux'.

We two pilots navigate the JU 290 based to the navigational data of the airfield radar. Via airfield centre-point we proceed at 200m to the releasing 'QTH Mont-Marsan'. Finally, landing gear is deployed, and in bad visual conditions we get visual contact with the airfield lights. In front of the guidance hut stands the waving landing manager and gives the awaited 'Z'!

The landing succeeds and we let the Junckers roll out without braking, engines shut down and at once we have complete silence. The crew bus follows us, ground personnel help us and our crew disembark and aboard the bus. The service personnel asks about the status of the aircraft and the engines, and we roll to the command centre to hand over the operation reports. The end of a long, busy flight!



Bubble octant, supplied by C Plath of Hamburg. Device number 127-134B1. This type of instrument would have been used in submarines and long-distance aircraft to aid astronomical navigation, by measuring the declination, or angular height of a star. This is also an accurate way of telling the time. An artificial horizon is provided by a bubble, similar to a spirit level, measuring times are regulated by a small integrated timer.

Astronomical navigation with precision watch and octant on a JU290 over the Atlantic Ocean by H Nagel.

Precise time-setting was essential for accurate astronomical navigation. Aircraft commander Hellmut Nagel, a pilot who served in a naval reconnaissance group, recorded how astronomical positioning was accomplished using an aerial navigation watch and a bubble octant during a mission over the Atlantic. The watch used by his team was an IWC cal. 52T SC.
The participants in this event aboard one of the FAG 5's JU290 aircraft were the commander, who kept the aerial navigation watch, and the observer, or navigator, who operated the bubble octant. On the upper surface of the fuselage of the JU290, between two pivoting protective stands and at approximately the mid-point of the aircraft, was a transparent cover, free of all optical distortions. Beneath it, on the floor of the fuselage, was a rotating platform approximately one meter in diameter. This platform could be raised and lowered.
The observer stood on this platform with his octant in hand. The wearer of the watch stood nearby. The two men communicated via the onboard voice-communication system. When the observer had the octant, the square of the crosshairs and a star (which could also be the sun, during daytime navigation) in view, he would say, 'Attention: zero' and then switch on his octant timer for the corresponding observation interval of 40, 60, or 90 seconds. The moment the wearer of the watch heard the word 'zero', he would read the hour, minute and second indication of his watch. Prior to every mission, navigation watches were synchronised with a ground-based chronometer kept in the operations room. The measured values to be read from the octant were: ten-degree setting, degree drum, degree disk in the integrator and minute drum, height of the star observed, half of the octant's running time added to this, and the current time. When this data was entered into a calculating form that had been previously prepared by an astronomer, the result was a location line which intersected with the course that was being flown if the observed star was situated ahead of the aircraft, or which ran parallel to the course if the star was situated to the right or left of the current course.

Dr Knirim, a resident of Dusseldorf, is a mechanical engineer and collector of military timepieces, and is documenting the complete range of German military timepieces from c.1850.
www.knirim.de