

GROUND RADAR

German ground radar sets can be classified into four main categories:

(1) German Air Force early-warning sets operating at 120 to 130 mc (nominal wavelength $2\frac{1}{2}$ meters) including: Freyas (Pole and Limber types), general purpose, transportable sets; and Hoardings (Mammut) and Chimneys (Wassermann), fixed-station, long-range warning sets.

(2) Würzburgs, sets designed for Flak control and operating on 550-590 mc (nominal wavelength 53 cm). As successive improvements have been made on this set, previous models have been released for height-finding with the Aircraft Reporting Service, etc. The Lorenz set is a nonstandard variant of the

Würzburg, believed to have been relegated to coast-watching duties with the German Navy.

(3) Giant Würzburgs, sets primarily used for interception control and also now used for general purposes, including sea watching and Flak control.

(4) Coastwatchers (Seetakt), German Navy sea-watching sets operating on 370 to 390 mc (nominal wavelength 80 cm); these are naval sets on the same mountings as Freyas. Some of these frequency bands have been modified. Freyas, for example, are known to operate between 90 to 190 mc, and the Würzburgs between 500 and 600 mc.

Note. Measurements on the following illustrations are shown in meters. 1 meter = 3.28 feet.

FREYA (LIMBER TYPE) EW RADAR

The Freyas (Pole type and Limber type) are heavy, general purpose, transportable ground radar sets, differing primarily in their mounting. Manufactured by Gema, the equipment is used to provide early warning of approaching aircraft in the form of range and azimuth at ranges up to 100 miles and also to detect shipping up to small ranges. Azimuth of a target is determined by rotation of the operating cabin and the antenna structure.

The standard Freya has no height-finding facilities, although rough estimates of height based on pick-up range are possible with later modifications. The inability of the Freya to measure height is made good by the use of one or more Würzburgs sited in the same vicinity. In conjunction with one or two Giant Würzburgs, the Freya, with AN attachment, may be used for ground control of night fighter interception. Day fighters are frequently controlled on Freya plots.

Since performance figures vary with the elevation of the site and the altitude of the aircraft (in addition to atmospheric effects), being better at high elevations, high siting is probably the normal policy for early-warning radars. Freyas are usually sited at elevations of at least 200 feet.

The so-called "Limmer type" Freya is an early model and is distinguished by an operating cabin on a modified 88-mm Flak (antiaircraft) gun mounting, provided with two detachable two-wheel "limbers" for road transport. The rotating cabin contains the radar equipment and supports the superstructure which carries the separate transmitting and receiving antenna arrays; each array is 20 feet wide and 8 feet high and carries six full-wave vertical dipoles. When IFF facilities are required, a third and smaller array is mounted above the receiving antenna. The transmitter, transmitter modulator, and filament supply units are mounted in a cabinet carried within

the thickness of the transmitting antenna frame. The transmitter cooling fan is mounted nearby.

The heart of the Freya, according to some German reports, is the master oscillator or "Summer." This is a very stable triode-connected pentode audio oscillator. It has several output sections, one of which feeds through a phase-shifter to the transmitter modulator, which provides the 2-microsecond pulse modulation for the grids of the transmitter tubes.

The Freya receiver, which is similar to that used in the Coastwatcher radar, has a frequency coverage of 120 to 128 mc with one signal frequency stage, two 15-mc i-f stages, two 7-mc i-f stages, detector, and video amplifier. It is built in two units, the three-stage r-f section with its stabilized power supply being independent of the i-f amplifier to which it is attached.

The 125-mc input from the receiving antenna is inductively coupled to a tuned circuit in the grid of the r-f amplifier tube, and the output from the tuned circuit in its anode is mixed with the 110-mc output from the local oscillator on the grid of the output tube. The 15-mc beat frequency is fed to the output socket from the tuned circuit in the anode of the output tube.

An interesting feature of the r-f unit is the special ceramic holders and mountings for the input and output tubes, which slide into position and engage with the circuit and supply terminals. The ceramic plate which fits into the grooves is sprayed on one side with copper and assures complete screening of the compartment. Decoupling capacitors for the tubes are built in the ceramic holders.

The rectified output of the receiver is fed to two presentation units. These consist of a general search unit (main presentation unit NB) with fast and slow timebase CRT's and a single tube unit with fast nonlinear timebase for precision ranging (fine range presentation unit

OB). All the cathode-ray tubes are of the double-beam type, the second trace being used for display of the IFF signals. This equipment was introduced into service in 1939.

The characteristics of the Limber type Freya are as follows:

RANGE (miles): From 80 to 150, depending upon height of aircraft.

FREQUENCY RANGE (mc): Normally 120 to 150 mc. Band now extended from 90 to 190 mc, signals being heard from 90 to 110 mc and from 175 to 190 mc. IFF receiver frequency, about 155 mc.

PULSE RECURRENCE FREQUENCY (cps): 500; 1,000 (older models).

PULSE LENGTH: 2 to 3 microseconds.

ANTENNA: Vertical stack of two rectangular frames of wire netting each having six full-wave vertical dipoles, the bottom frame for transmitting and the upper for receiving. A third array with half-wave dipoles is mounted at the top if the set is not in the IFF band. Effective beam width of transmitting and receiving array: about 20°.

TYPE OF PRESENTATION: Two units having 10-cm double-beam CRT's (AEG Type HR2/100/1.5A) with straight traces viewed through magnifying lenses. Main unit has two tubes with slow and fast timebases for general observation and approximate range. Second unit has one high-speed trace for precision ranging.

DATA OBTAINED: Range and azimuth (plus altitude with some models).

ACCURACY: Good. Reported to be probably 110 yards in range, better than 1° in azimuth, 0.2° in relative azimuth.

POWER SOURCE: Power lines or stand-by 380-volt three-phase a-c motor-generator trailer. Radar equipment operates on 220 volts single-phase ac; 400 volts dc required for motor and field windings.

SIMILAR SETS: There are several known types of Freya: the original Limber type (FMG 39G and FMG 40G, also known as Dete-Gerät I (DT I) and Dete-Gerät II (DT II), respectively); the demountable Pole type (LZ, known also as Pole Freya); the Freya AN (Freya with AN unit for GCI); and the Coastwatcher (Seetakt) which is a naval installation.

POWER OUTPUT: 15 to 20 kw (peak).

TUBES (type and number): Transmitter (T 106): two RS 391 pentodes, two TS 41 triodes, and one STV 280/40. Receiver (NE 103): r-f unit (NA 100) uses two acorn pentodes Philips type 4672 for amplifier and mixer, triode RL 12 T 1 as local oscillator; i-f unit (NZ 102) uses eight pentodes AF 100 and power pentode RL 12 P 10 for video amplifier.

TOTAL WEIGHT OF FREYA: 6.82 tons.

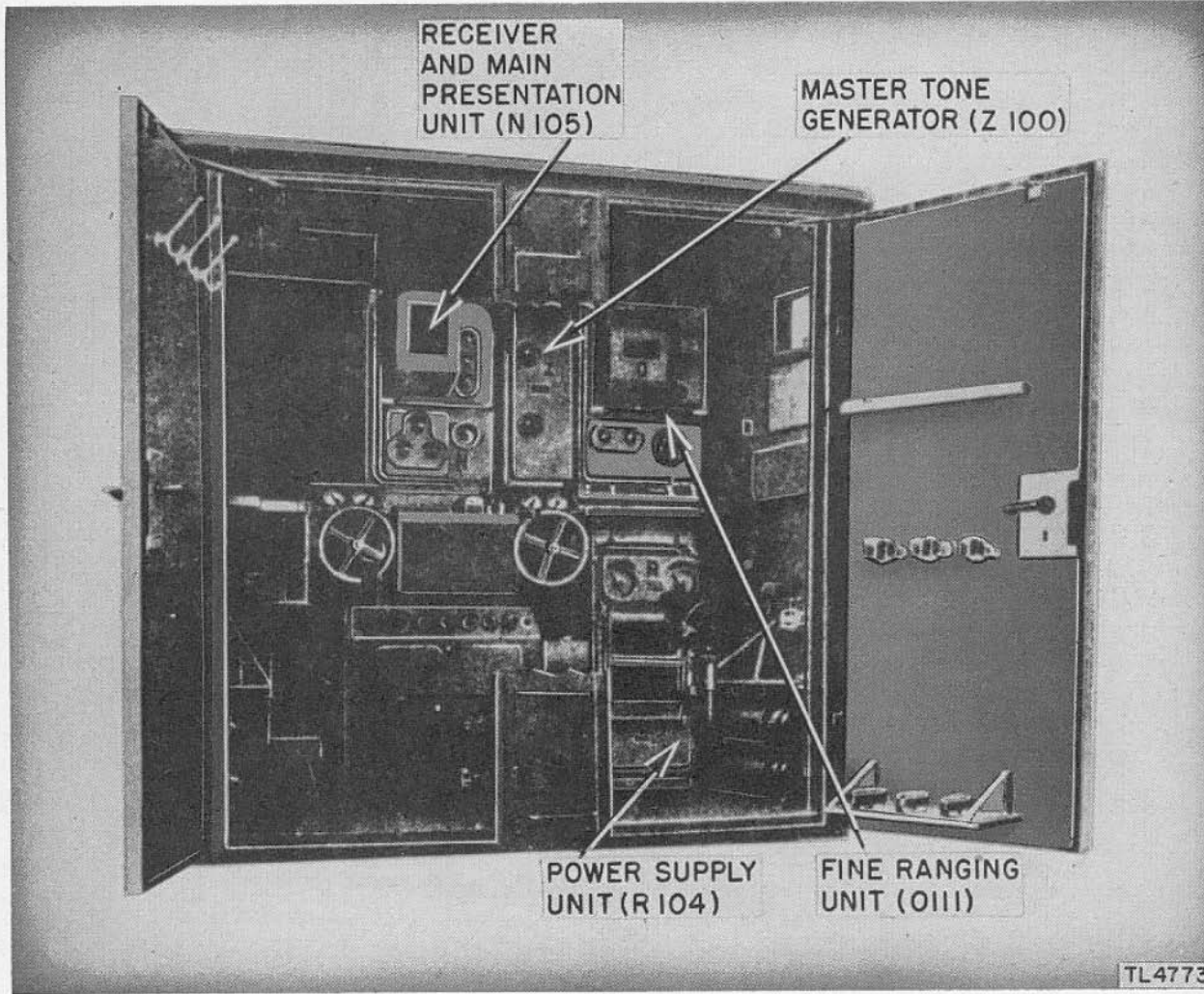


Figure 15. Interior of Freya (Limber) cabin.

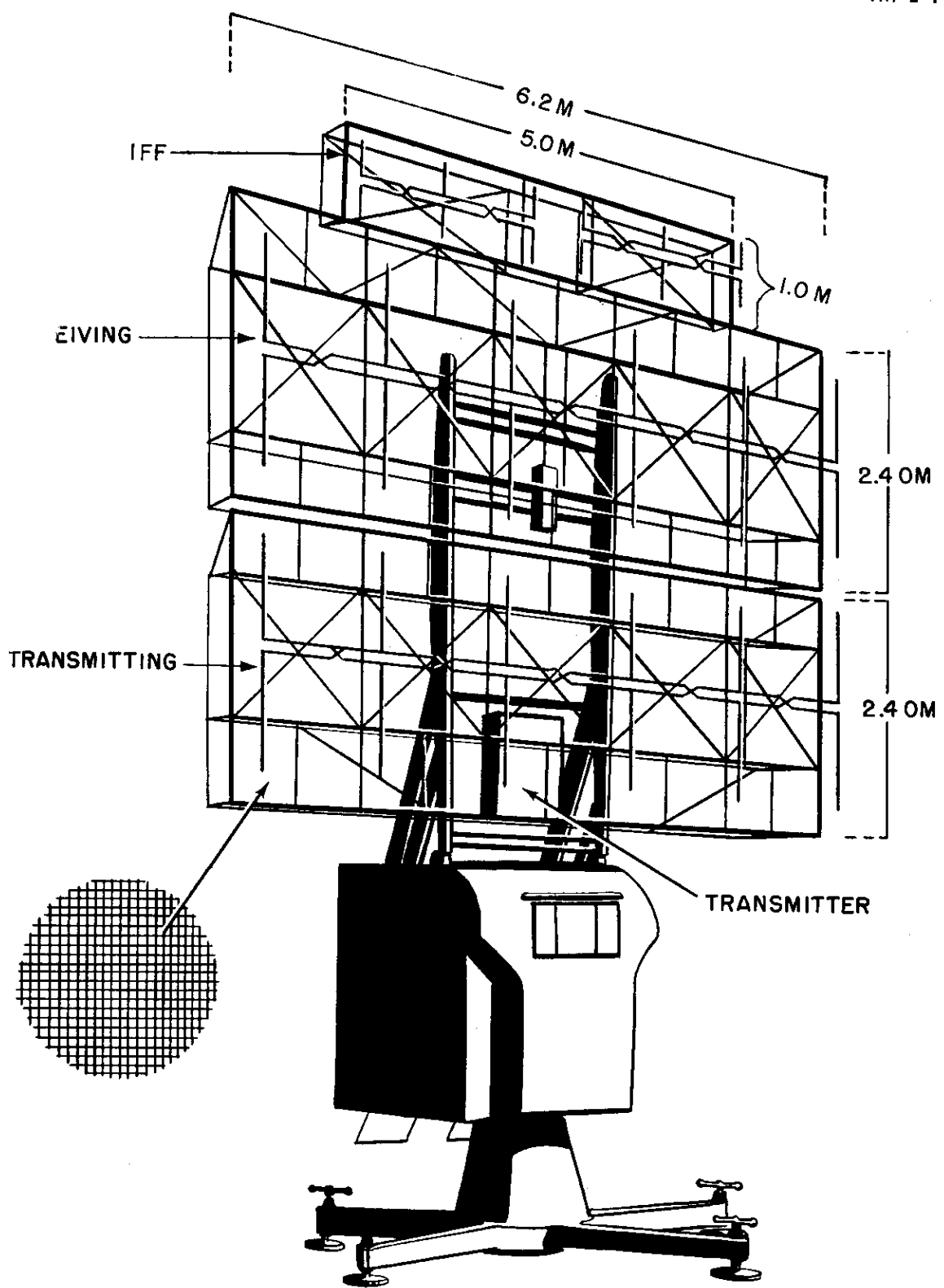


Figure 16. Limber Freya.

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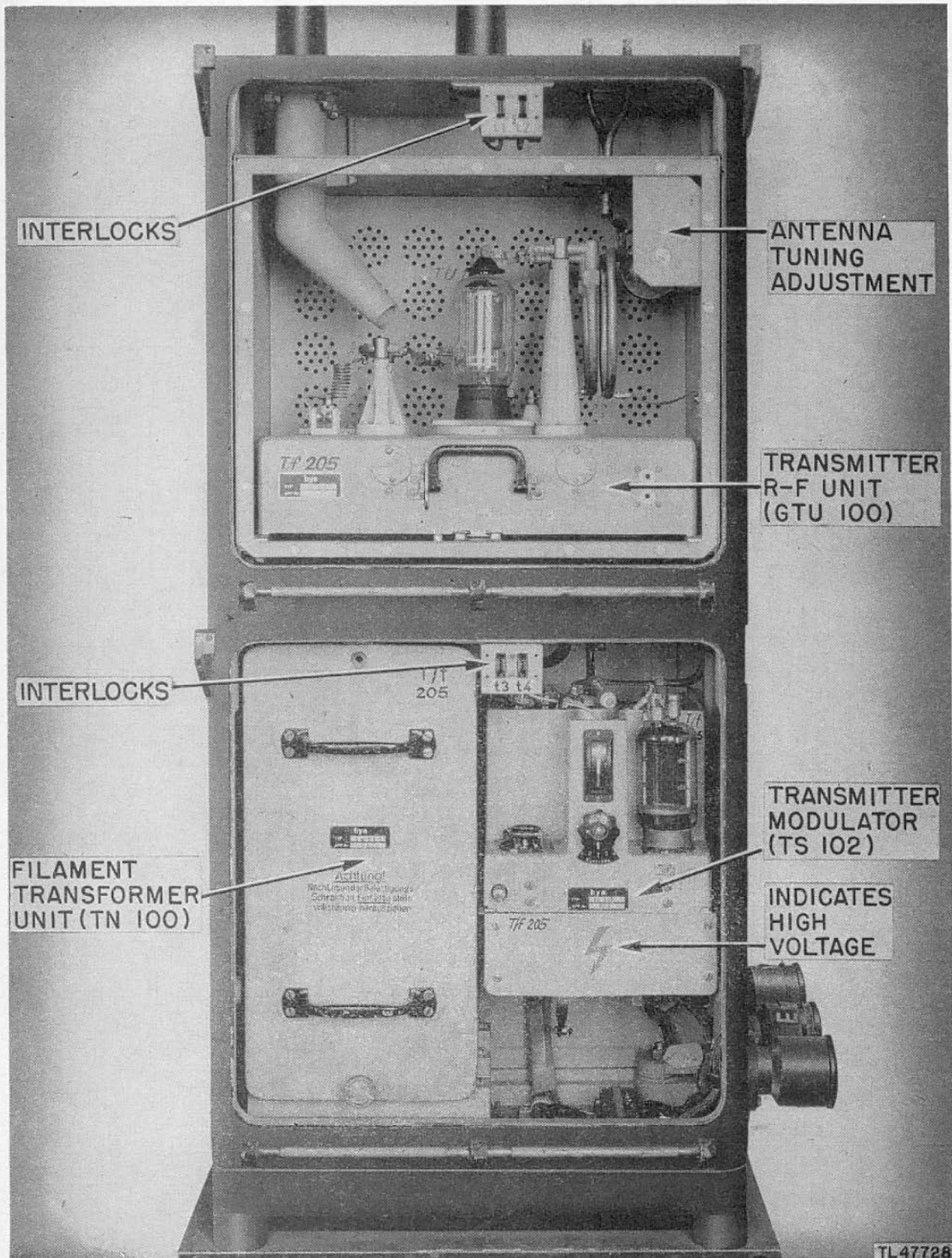
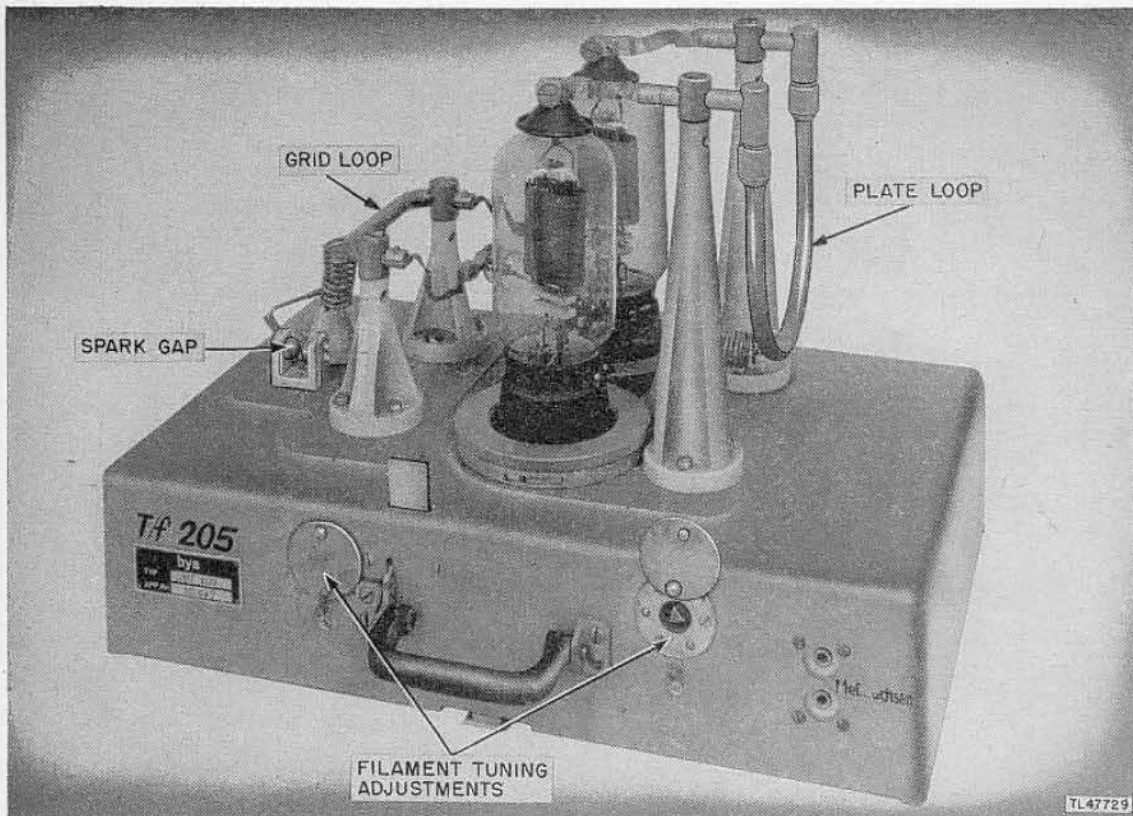
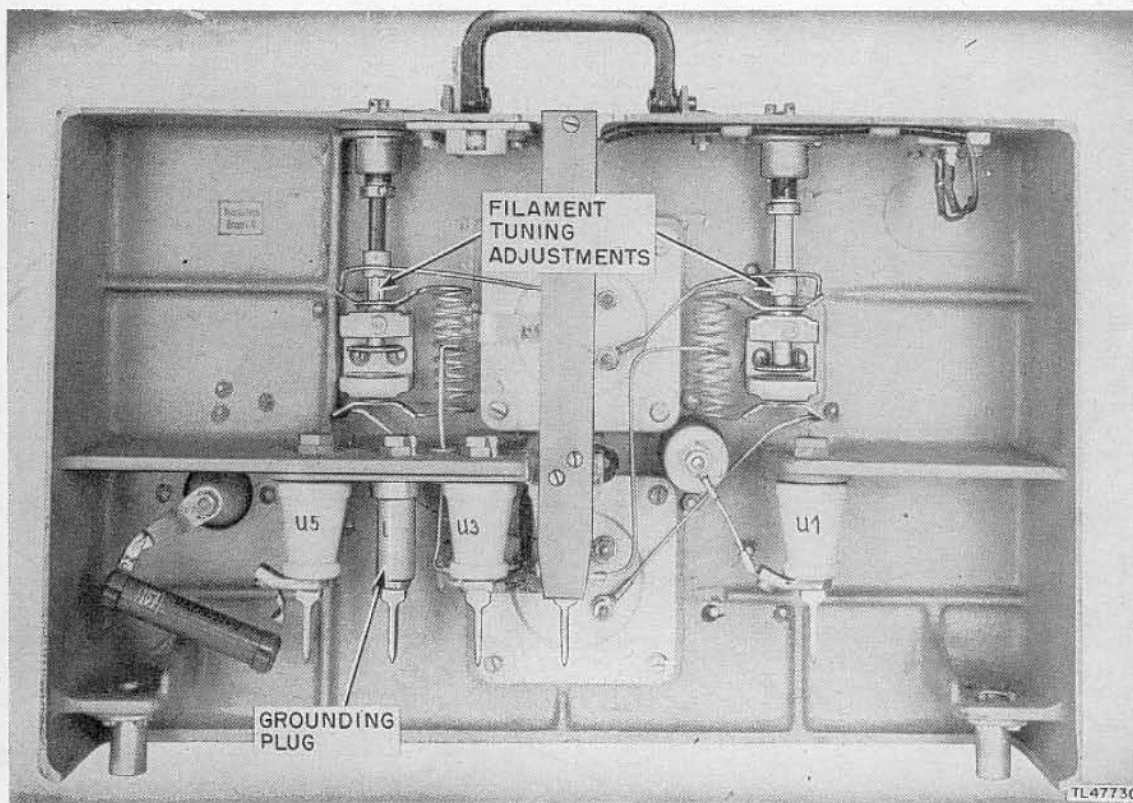


Figure 17. Freya transmitter (T 106).



① Top view.



② Bottom view.

Figure 18. Freya transmitter r-f unit (GTU 100).

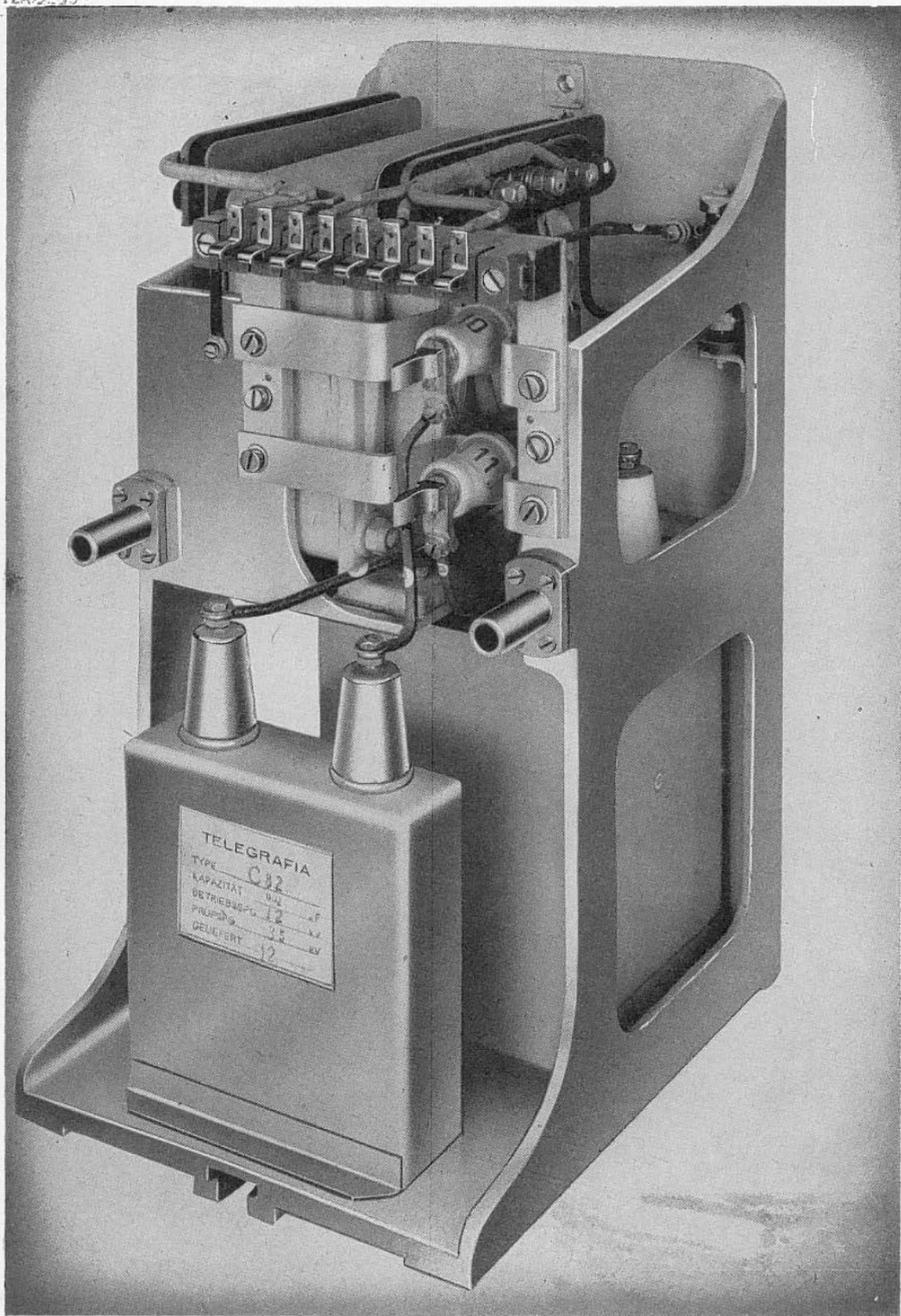


Figure 19. Freya transmitter filament transformer unit (TN 100)—rear view.

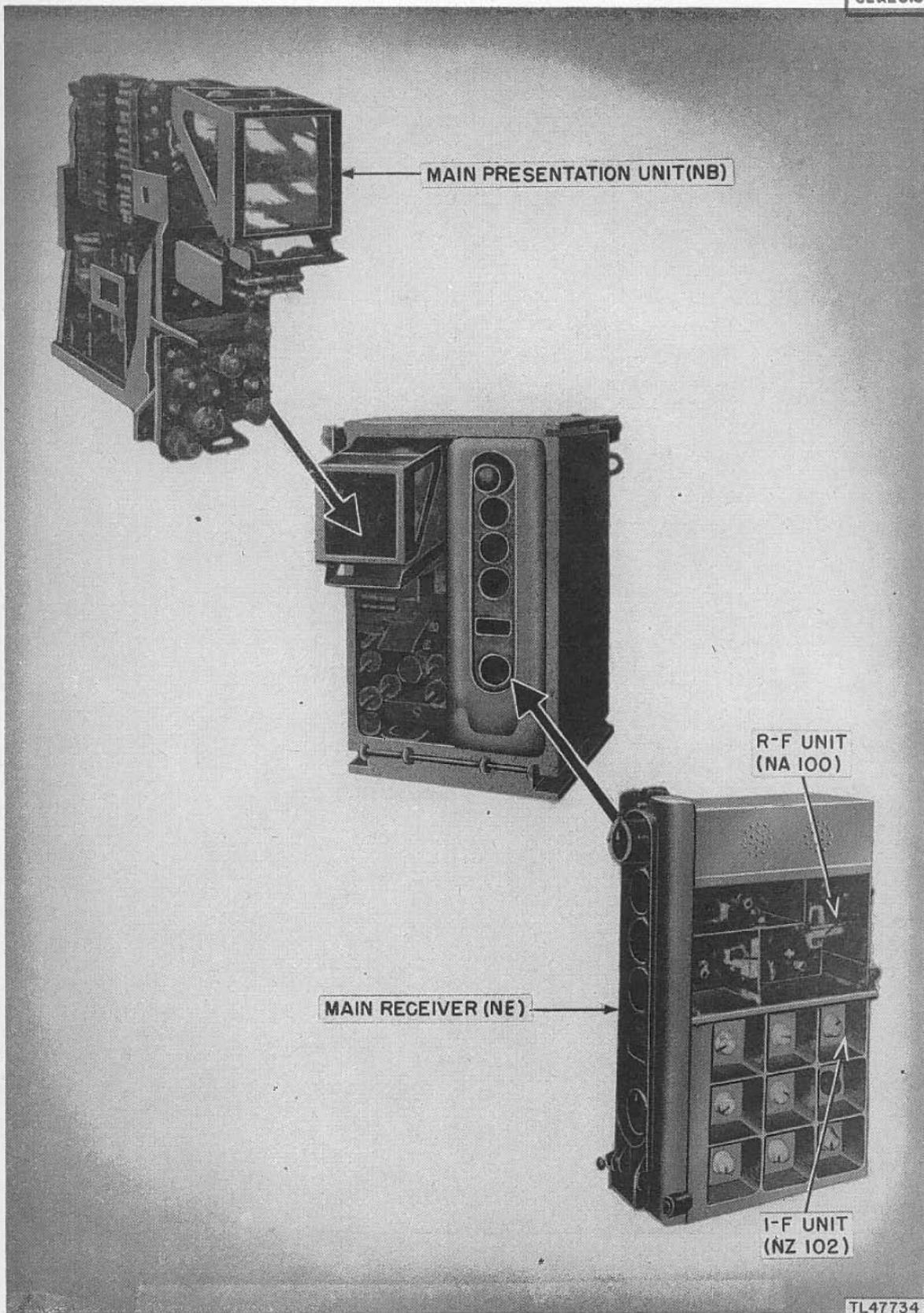
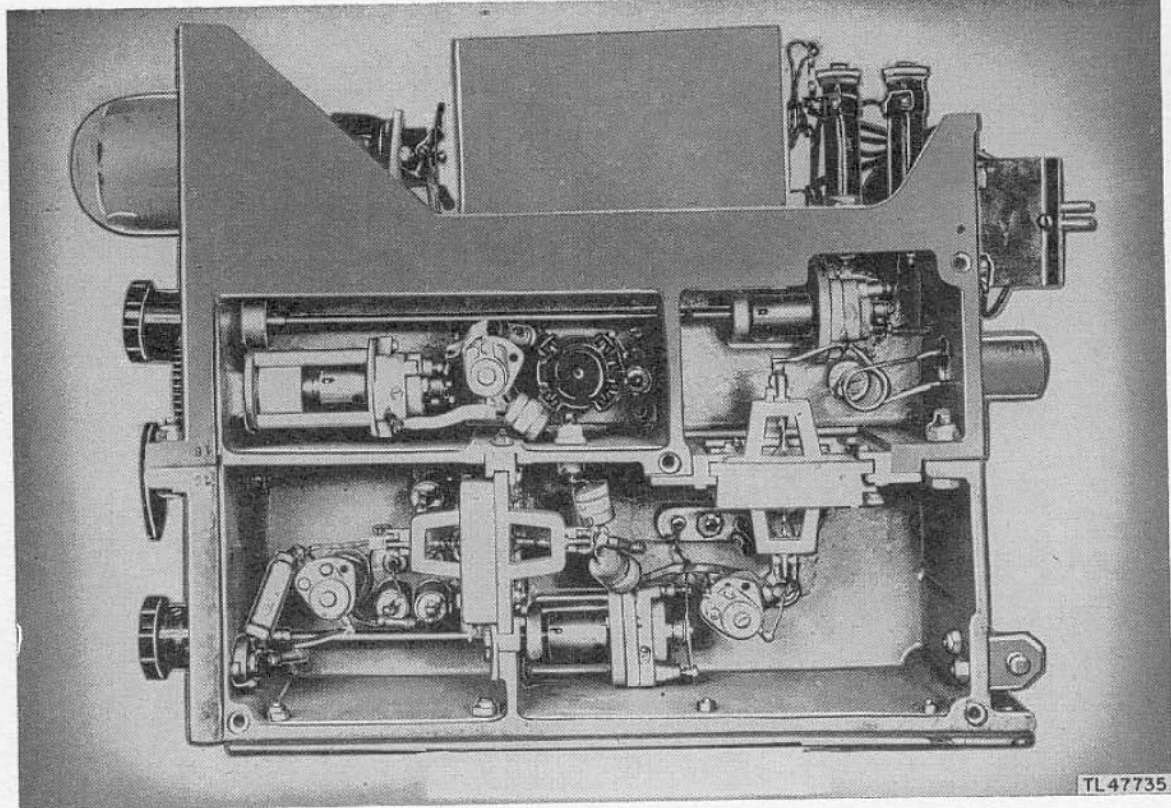
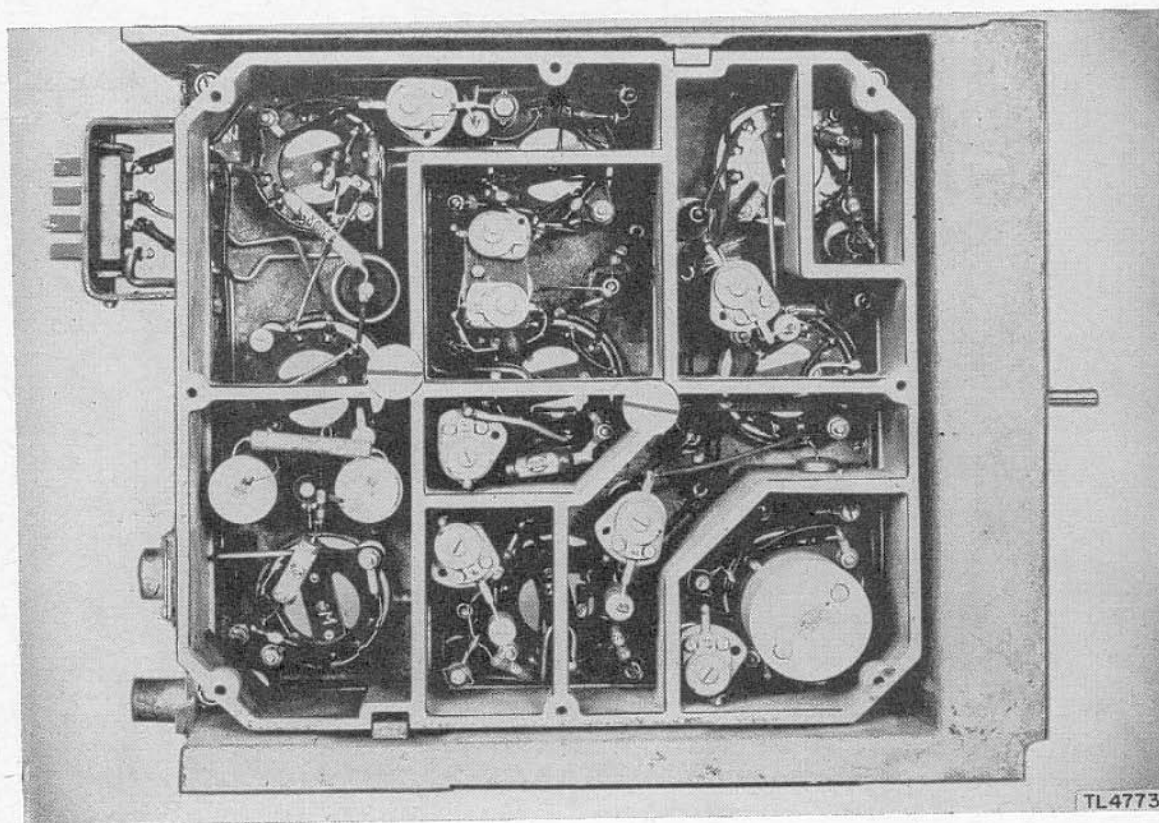


Figure 20. Freya main receiver and presentation unit (N 105).



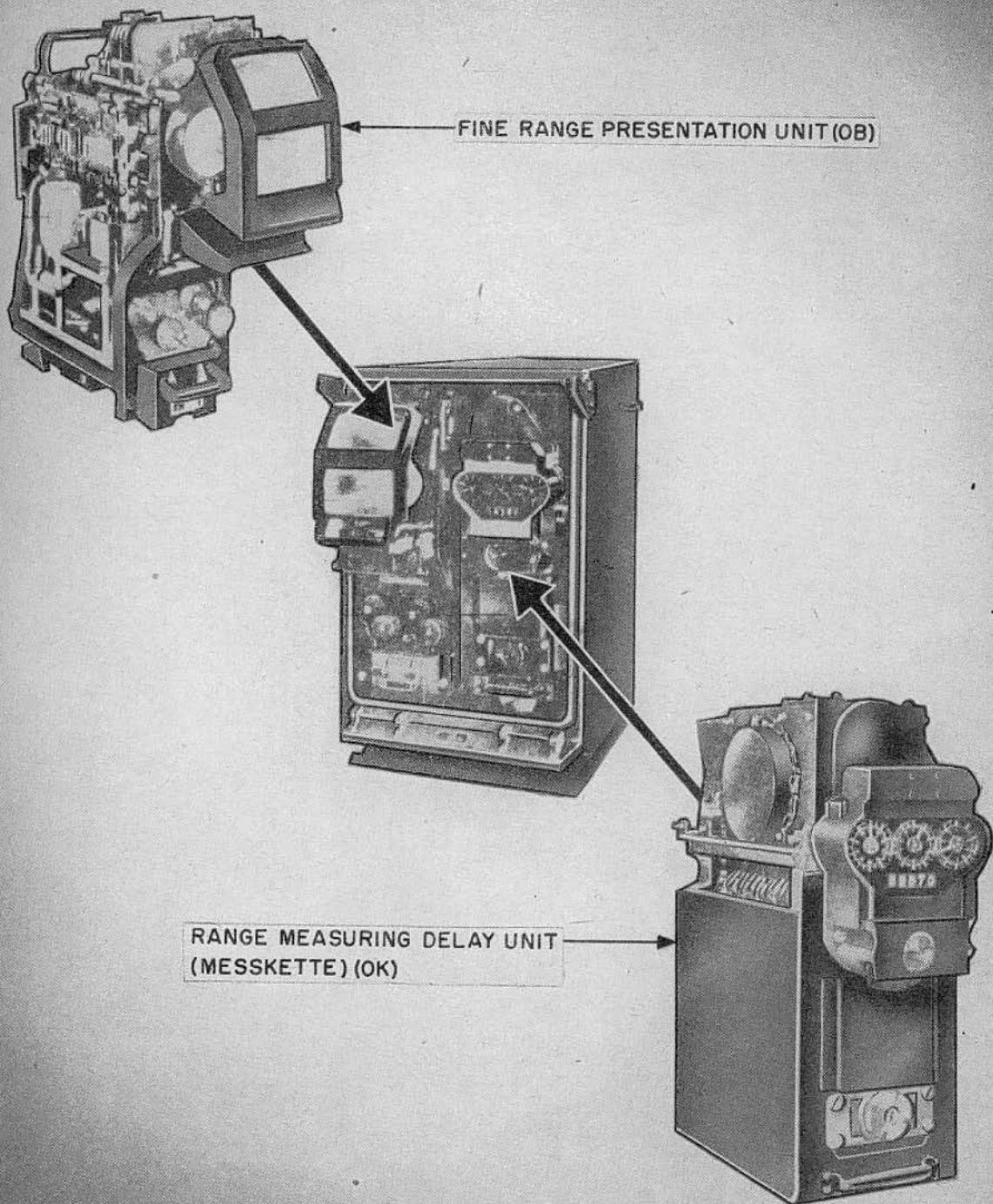
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Figure 21. Freya receiver r-f unit (NA 100).



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Figure 22. Freya receiver i-f unit (type NZ 102).



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Figure 23. Freya fine ranging and presentation unit (0 111).

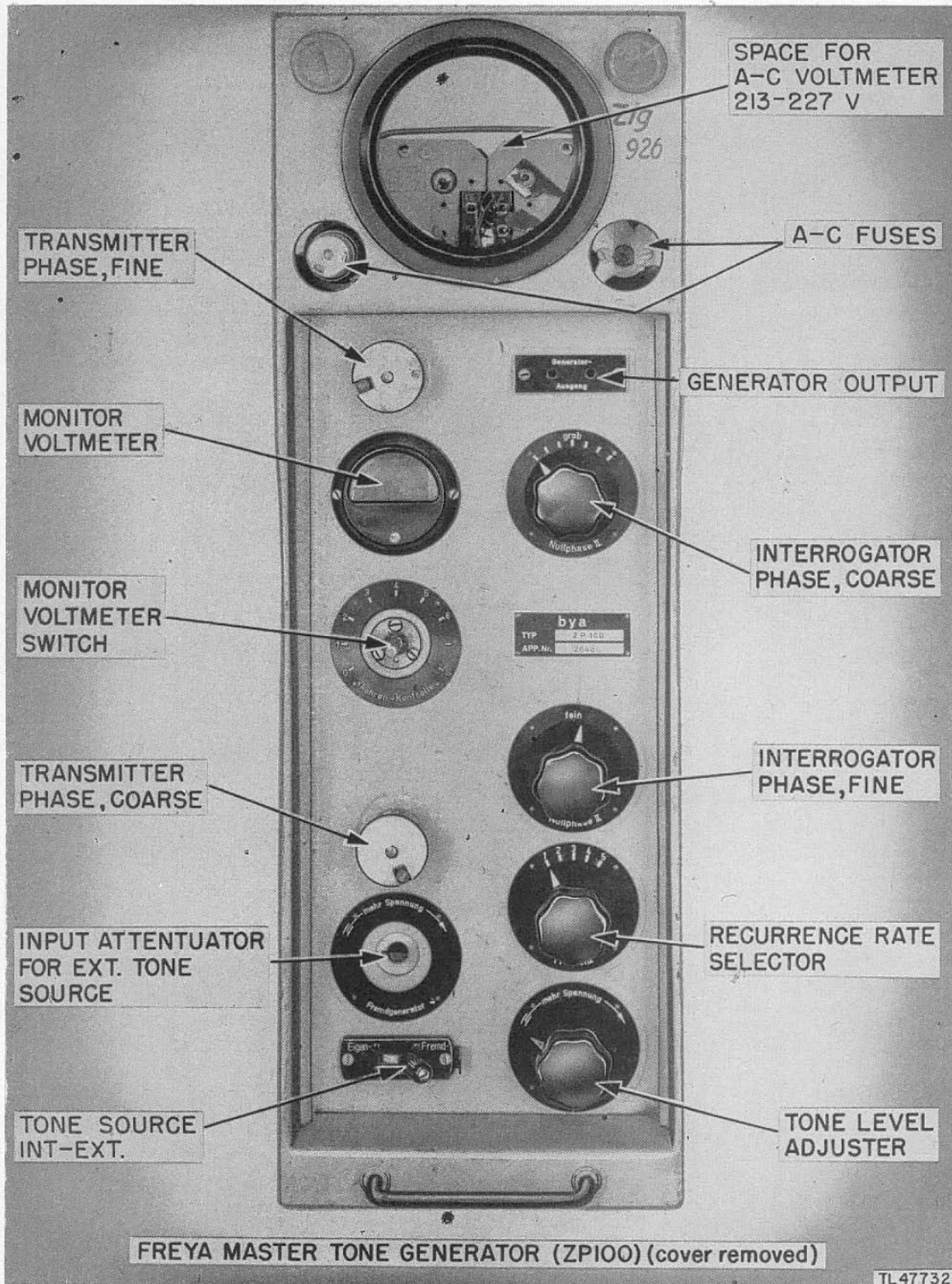


Figure 24. Freya master tone generator (ZP 100)—cover removed.

FREYA (POLE TYPE) EW RADAR

The Pole type Freya is a newer design than the Limber type. Its functions, performance, and radio characteristics are much the same, but its form and mechanical design are entirely new. The most obvious difference is in its mechanical mounting; it is assembled from a larger number of smaller components to render it suitable for air transport (it is known that five Ju 52's are required to transport a complete station). It is not fitted with limbers for use as a mobile set, but may be transported in three big trucks.

This Freya usually has IFF antennas and gives azimuth readings that are accurate to a fraction of a degree. Beam width of the transmitter is 40° and of the receiver, 48° , from zero to zero. IFF receiver frequency is 155

plus or minus 5 mc (approximately). IFF interrogator frequency (when Freya frequency differs from 125 mc) is 125 mc, 500 pulses per second, with peak power approximately 0.5 to 1.0 kw. The IFF presentation consists of parallel traces on tubes in presentation units.

Characteristics of the Pole type Freya are similar to those for the Limber type, with the following differences:

RANGE (miles): About 120.

ANTENNA: Antennas mounted on heavy pole instead of the framework used with the Limber type. IFF array consists of full-wave dipoles.

TYPE OF PRESENTATION: Three units all with 10-cm double-beam CRT's.

TOTAL WEIGHT: 5 tons.

HOARDING (MAMMUT) EW RADAR

Employed for long-range early-warning of enemy aircraft on coastal areas in northwestern Europe, the Hoarding or Mammut radar was manufactured by Gema (1942). This equipment is contained in a concrete building, completely or partly buried, surmounted by four upright girders with cross girders carrying the antenna arrays. Scanning is electrical by phase control, covering a sector about 120° wide, front or back, with gaps at the side. Beam width is approximately 10° from zero to zero. It is equipped with IFF.

This is believed to be an experimental model used in limited areas and never put into production.

A similar equipment, known as "Small Hoarding," makes use of three concrete buildings in line for foundations, with the two outside chambers somewhat larger than the middle one. It is believed that it may be used for coast watching, since the sites where it has been noted are closely associated with coast-watching duties. Three vertical girders spring from the buildings and carry crossmembers supporting the reflector frames. At the top of the uprights there is a curved horizontal rail that is prob-

ably used for a running block and tackle to hoist the antenna arrays into position.

Characteristics of the Hoarding are as follows:

RANGE (miles): 180 (20,000-foot target);
125 (3,000-foot target).

FREQUENCY RANGE (mc): 116 to 146.

PULSE RECURRENCE FREQUENCY (cps):
Believed to be 490 to 510.

PULSE LENGTH: 2 to 3.5 microseconds.

ANTENNA: Fixed broadside array, vertically polarized, about 100 feet by 36 feet. Full-wave vertical dipoles. Array can be single-faced or both forward- and backward-looking. Possibly common T&R. Arrays are like Freya except larger.

TYPE OF PRESENTATION: Similar to Freya.

DATA OBTAINED: Range and azimuth.

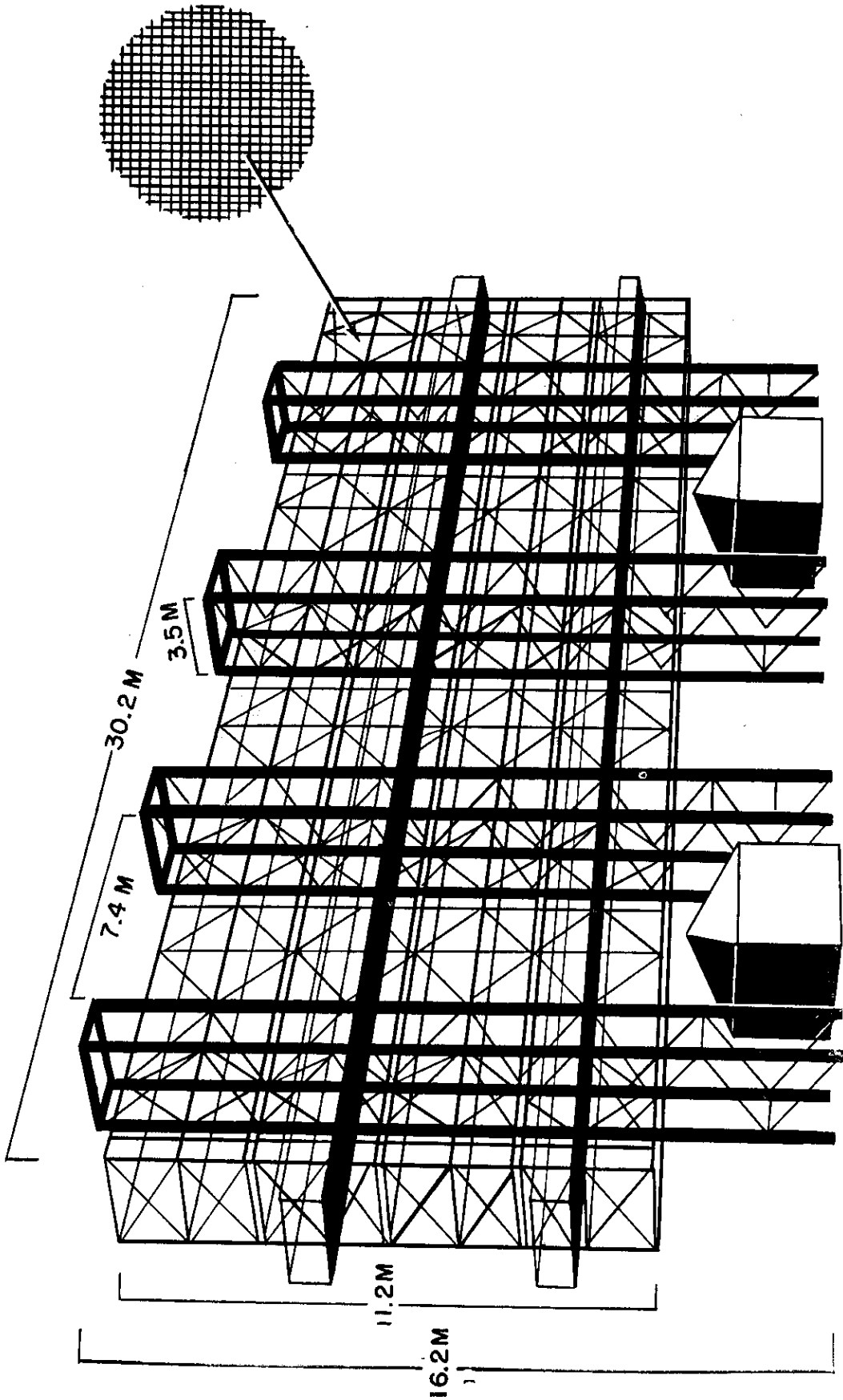
POWER SOURCE: Power lines; stand-by motor generator sets.

SIMILAR SETS: Freya; Chimney (Wassermann).

POWER OUTPUT: 20 kw (peak).

TUBES: Similar to Freya.

TOTAL WEIGHT: No information.



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Figure 27. Hoarding.

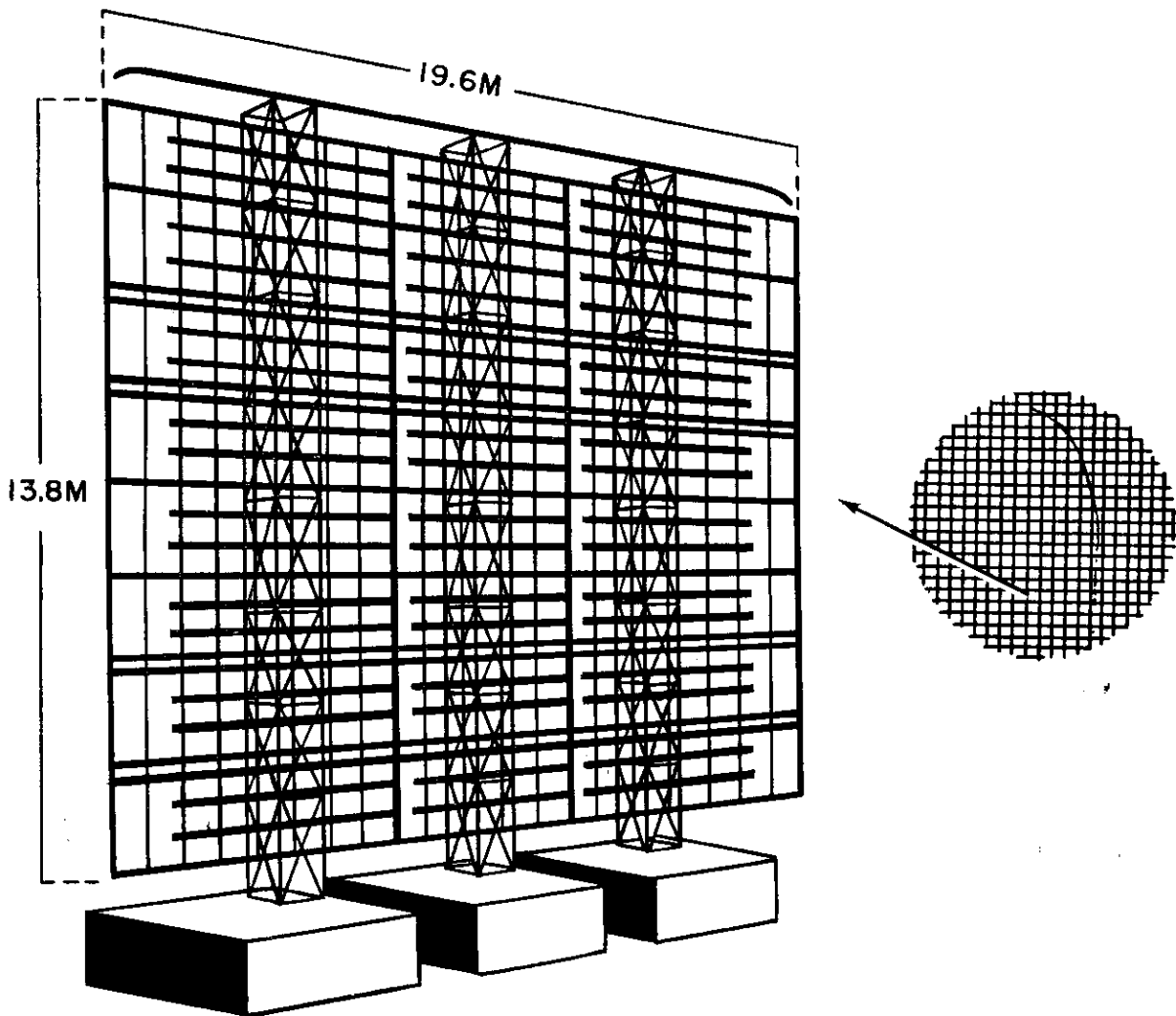


Figure 28. Small Hoarding.

TL47742

CHIMNEY (CYLINDER TYPE) (WASSERMANN) LONG-RANGE EW RADAR

The Chimney or Wassermann equipments, of which at least two versions are in operational use (the cylinder type and the girder type), are used for long-range aircraft reporting, measuring range and azimuth, occasionally for long-range interception, and possibly for long-range height-finding. The original model was erected in Norway to intercept courier planes (at long ranges) operating between Stockholm and London.

The cylinder type, most commonly used in northern Europe, is a permanent structure. The antenna array is hung on a rotatable hollow steel tower mounted on a partly buried concrete building. The cylinder is topped by a crane arm with block and tackle for hoisting the antenna array into position. IFF, with which the cylinder type is sometimes equipped, is an additional 23-foot extension to the top of the array.

Scanning with the large Chimney is done by mechanical rotation (horizontal) and possible phase control (vertical). Beam width is estimated at 20° and 14°, zero to zero, with common T&R and no "split."

Manufactured by Gema, the cylinder-type Chimney was introduced into service in 1942; approximately 25 were in service by the end of 1943.

Characteristics of the cylinder-type Chimney are as follows:

RANGE (miles): 180.

FREQUENCY RANGE (mc): 116 to 146;
120 to 150 also reported.

PULSE RECURRENCE FREQUENCY (cps):
490 to 510.

PULSE LENGTH: 2.5 microseconds.

ANTENNA: Broadside array 98 feet high and 44 to 62 feet wide, supported on tubular mast 131 feet high and 8 inches in diameter. Array consists of vertically polarized full-wave dipoles backed by netting reflector. Common T&R.

POWER SOURCE: Power lines, also stand-by (portable) gas engine motor-generator sets.

SIMILAR SETS: Freyas and girder-type Wassermann.

POWER OUTPUT: 20 kw (peak).

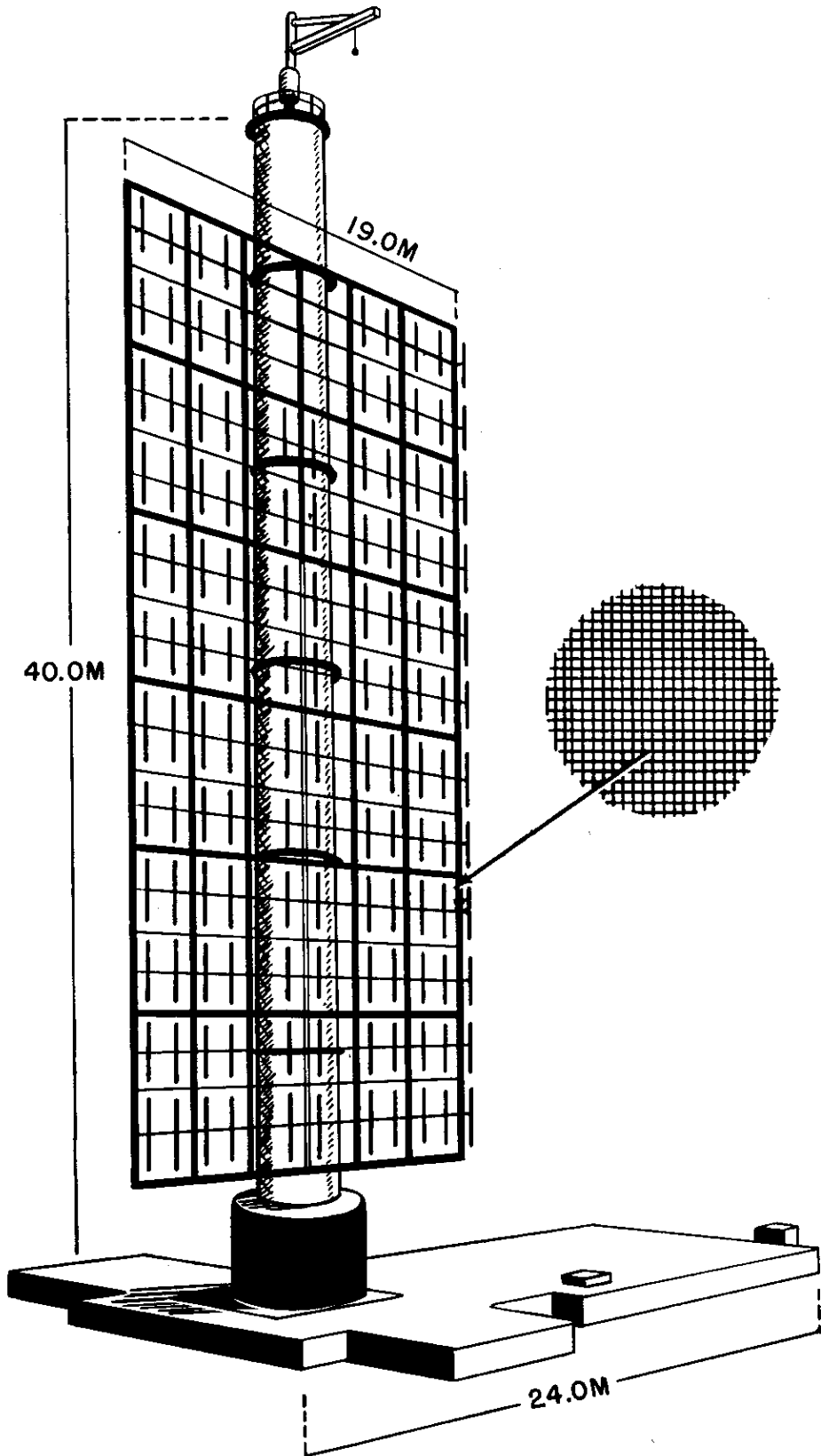


Figure 29. Cylinder Chimney.

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CHIMNEY (GIRDER TYPE) (WASSERMANN L) LONG-RANGE EW RADAR

The small, girder-type Chimney or Wassermann L was commonly used in the Mediterranean area for long-range aircraft reporting. The main structure is a triangular section girder-work mast of light alloy, rising out of a short steel column the lower end of which rests in a socket on the ground. It is kept upright by several steel guy wires secured to the top. The cabin is built around the steel column and houses the radar equipment, turning gear, and operators.

A variation of this equipment, seen on a very few occasions in the Mediterranean area, is the so-called "box" type, distinguished by a square-section box girder supporting the aerial array. This girder is 16 feet square and nearly 120 feet high; about half-way up the girder is mounted a cubical cabin with sides about 12 feet long. The girder is mounted on a short stub on which it rotates; at the upper end of the girder, four corner pieces are brought together to form a cone 26 feet high, above which there is a 16-foot mast. Guys keep the equipment upright.

No details of the performance of the Wassermann L sets found in the Mediterranean area are available, but it is known to be superior to Freya performance at long range. The accuracy of azimuth determination is not known. Scanning is by electrical rotation, with alternative hand drive for the horizontal plane. Low-cover, high-cover change-over is accomplished by a motor-driven phasing unit which changes the beam elevation from horizontal to plus

$2\frac{1}{2}^{\circ}$ to provide high cover. There is no intermediate position. Beam width is 40° from zero to zero. Most of the Wassermann sets of the girder type that have been found have been sited at altitudes of 200 feet.

Manufactured by Gema, the Wassermann L was introduced into service in 1942; by the end of 1943, there were an estimated 20 in service.

The characteristics of the girder-type Chimney are as follows:

RANGE (miles) : 186 (maximum) ; 65 (20,000-foot target).

FREQUENCY RANGE (mc) : 120 to 150.

PULSE RECURRENCE FREQUENCY (cps) : 500.

PULSE LENGTH : 2 to 3 microseconds.

ANTENNA : Broadside rotating array, vertically polarized, 98 feet high and 20 feet wide, divided into two stacks of four sections, each having three rows of three full-wave dipoles. Array is supported on rotating triangular trellis mast built from light steel girders. It is similar to that of cylinder-type Chimney.

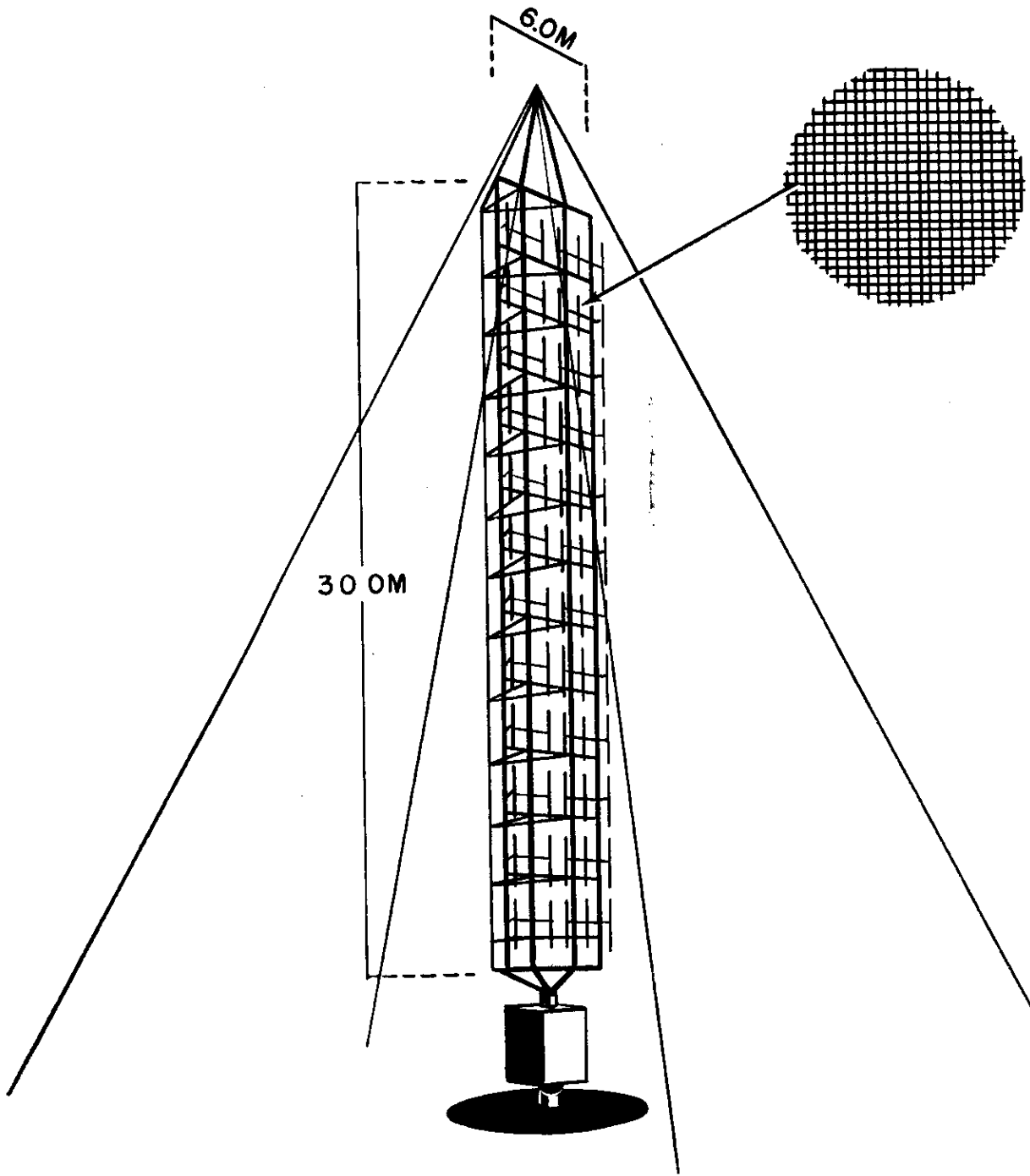
POWER SOURCE : Power lines or stand-by motor-generator sets.

SIMILAR SETS : Other Wassermanns.

POWER OUTPUT : 20 kw (peak).

TRANSPORTATION : Although this is not a fixed installation, there is only vague information on how it is moved. Probably it is broken into sections and moved by truck.

DATA OBTAINED : Range and azimuth.



TL47743

Figure 30. Girders Chimney.

COASTWATCHER (SEETAKT) RADAR (EW TYPE VS. SHIPS)

The Coastwatcher, or Seetakt, as its name implies, is a Naval set used for ship detection, although it can be used also for coastal gun-laying. There is also evidence that Seetakt stations are being used to supplement the aircraft reporting chain. A fixed-station set, its mounting is normally similar to the Limber-type Freya; like the Freya, the entire set is rotated in azimuth in searching for targets.

The Seetakt has an effective beamwidth of 10°. It is normally sited on high ground in a circular emplacement with a square extension on the landward side. Its performance against shipping depends to a great extent on the elevation of the site and on the size of the surface vessel, large vessels being detected at 32 miles from an elevation of 500 feet and small vessels at 19 miles from the same site. Its performance against low-flying aircraft should be almost equivalent to that of the Giant Würzburg. For aircraft tracking between 1,000 and 10,000 feet, performance is similar to that of a Freya; at 20,000 feet, there would be a weakness in cover due to limitation of its radiation to low angles of elevation.

The Seetakt transmitter, in weatherproof case, is mounted adjacent to the antenna that it serves. It is in two sections, one above the other, and is fed from the main power pack of the station. A closed-circuit air cooler (Kühlergerät) is mounted on top of the case. The oscillator unit TU 106 is in the upper portion of the case; the lower compartment contains the modulator unit TS 103, the filament transformer unit TN 103 (Netzteil), both removable, the filament rheostat 182, and the EHT bleeder chain 176-181.

The transmitter is remarkable because of its simplicity of operation and absence of adjustments, but the output is very low compared with American and British standards. The modulator, producing the final modulating pulse from the master sine wave in only two

stages, is especially worthy of notice, but the form of the output pulse of this modulation is not ideal, and the r-f pulse controlled by it is only 15 kw.

The only tuning adjustment in the entire transmitter is that of the tuning loop in the oscillator chassis, and this appears to be merely to keep it to the preset frequency after a change of tubes.

Although there are many points of similarity between this and the Freya transmitter, especially as regards the modulator and the Netzteil units, there is no interchangeability of parts between the two equipments.

The Seetakt receiver is similar to the Freya receiver. In the Seetakt receiver, the signal frequency of 375 mc is converted to 15 mc without prior amplification, but the subsequent stages are exactly similar to those of the Freya receiver. The entire output is plugged into the display unit housing, connections being made automatically between fixed sockets on the latter and plugs at the rear of the receiver.

A variant of the Seetakt is the so-called "large" Coastwatcher, which consists of a rotating cabin surmounted by a tall square girder structure to which the aerial frames are attached. The aerial system may look something like that indicated in the pictorial view.

Manufactured by Gema, the Seetakt was introduced into service in 1939.

The characteristics of the Coastwatcher are as follows:

RANGE (miles): 30, against ships, depending upon elevation of set.

FREQUENCY RANGE (mc): 350 to 390 (a spot frequency 375).

PULSE RECURRENCE FREQUENCY (cps): 500.

PULSE LENGTH: 2 to 3 microseconds.

ANTENNA: One Freya frame supports transmitting and receiving arrays, each of which

consists of a horizontal bank of 16 full-wave vertical dipoles backed by wire-netting reflector and rotatable about a vertical axis. Vertical polarization. A larger array is used in some installations.

POWER SOURCE: Power lines, also stand-by motor-generator sets.

SIMILAR SETS: Freya (Limber type); large Coastwatcher.

POWER OUTPUT: 15 kw.

TYPE OF PRESENTATION: General obser-

vation tube and high-speed trace tube for precision ranging. Precision measurement is by calibrated phase-shifter working on the sinusoidal deflector voltage of the high-speed trace.

DATA OBTAINED: Range and azimuth.

ACCURACY: Of range, better than 1 mile; of azimuth, 0.2° .

TUBES (type and number): Transmitter, two LS 50 oscillator tubes.

TOTAL WEIGHT: 6.87 tons.

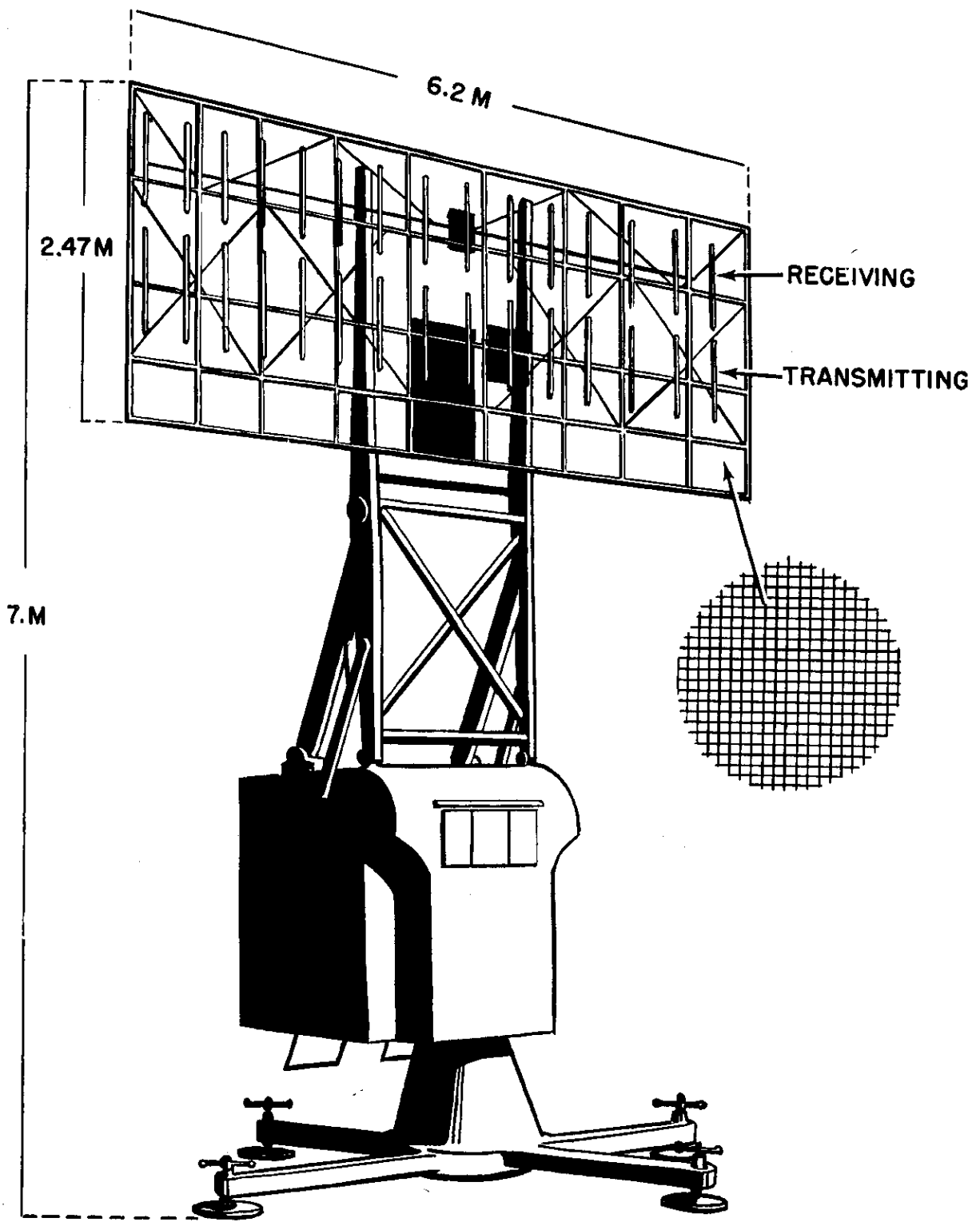


Figure 31. Coastwatcher.

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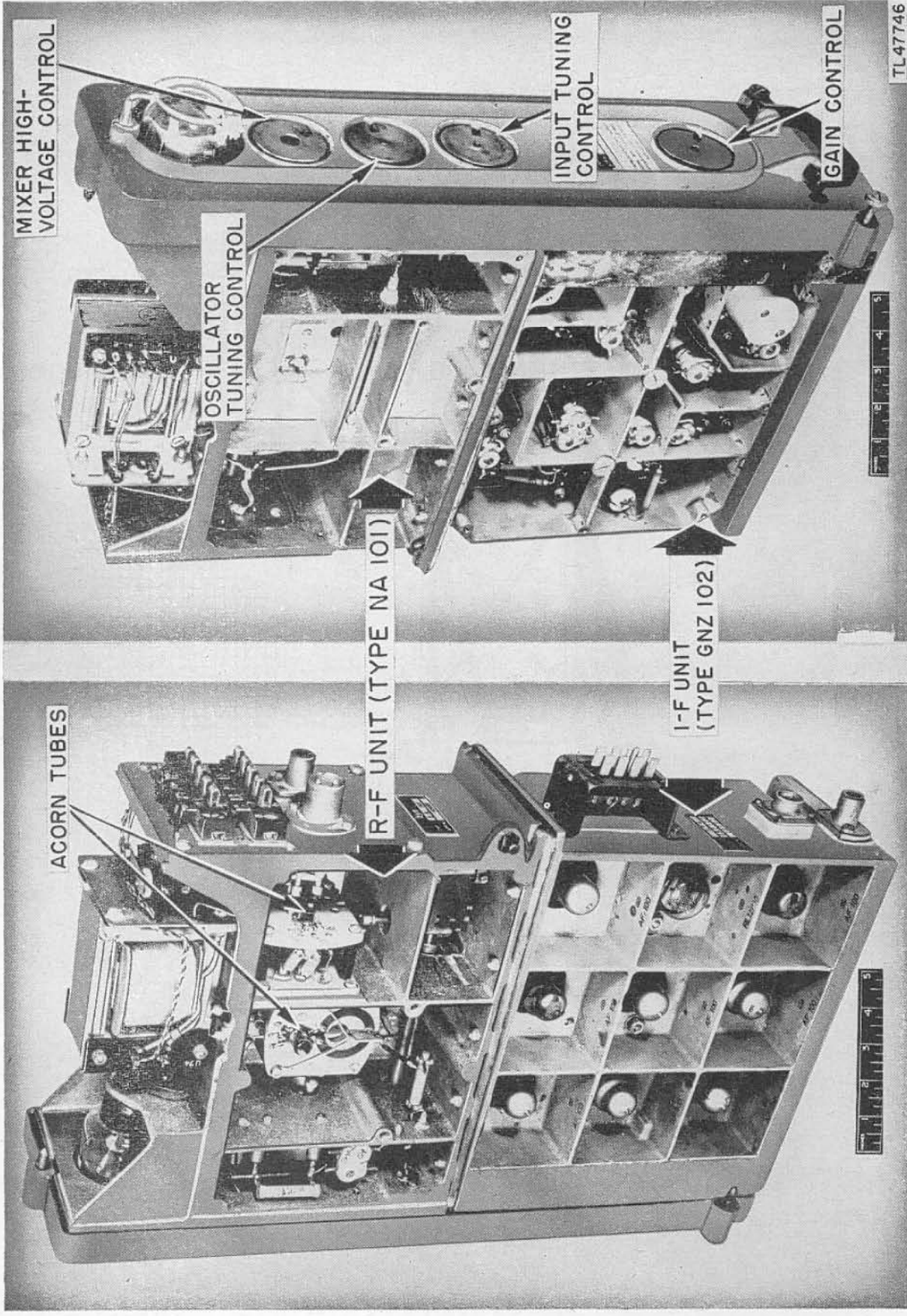


Figure 32. Coastwatcher receiver (side covers removed).

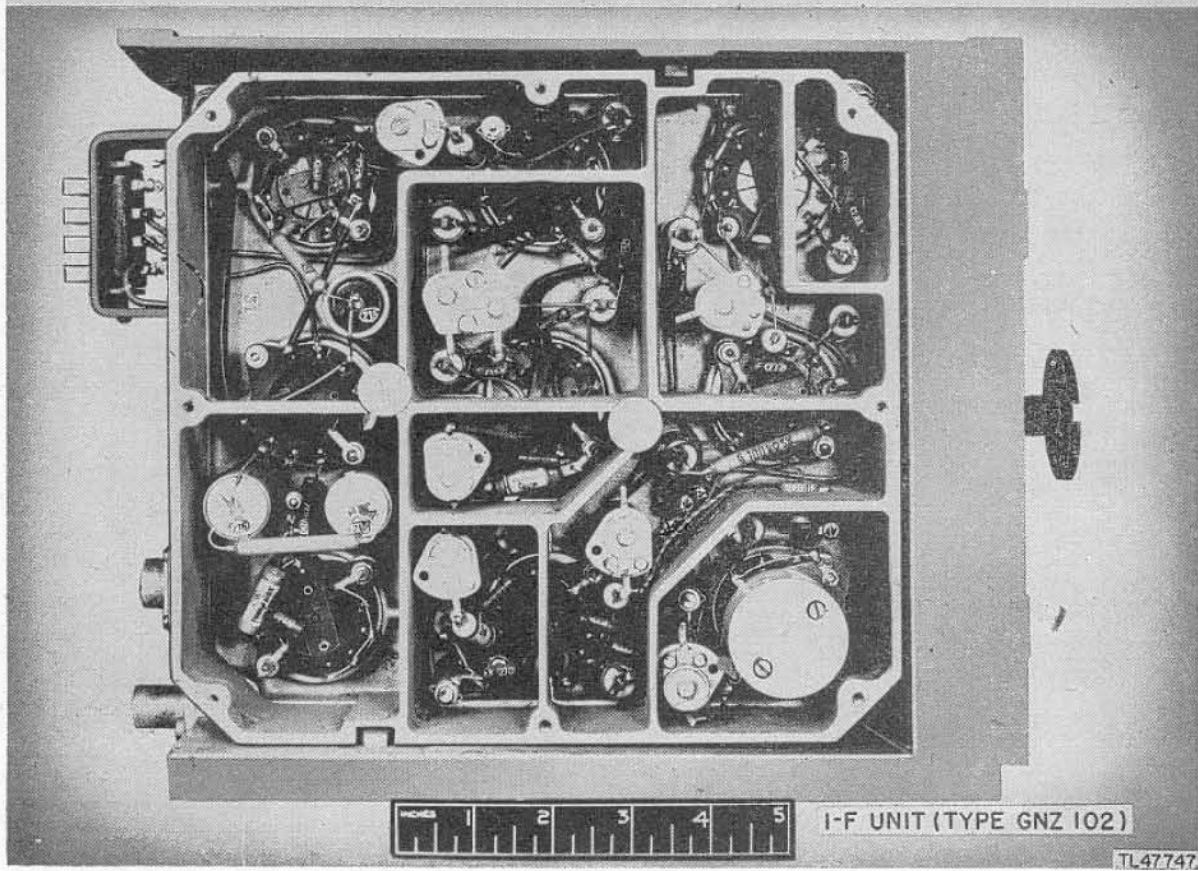
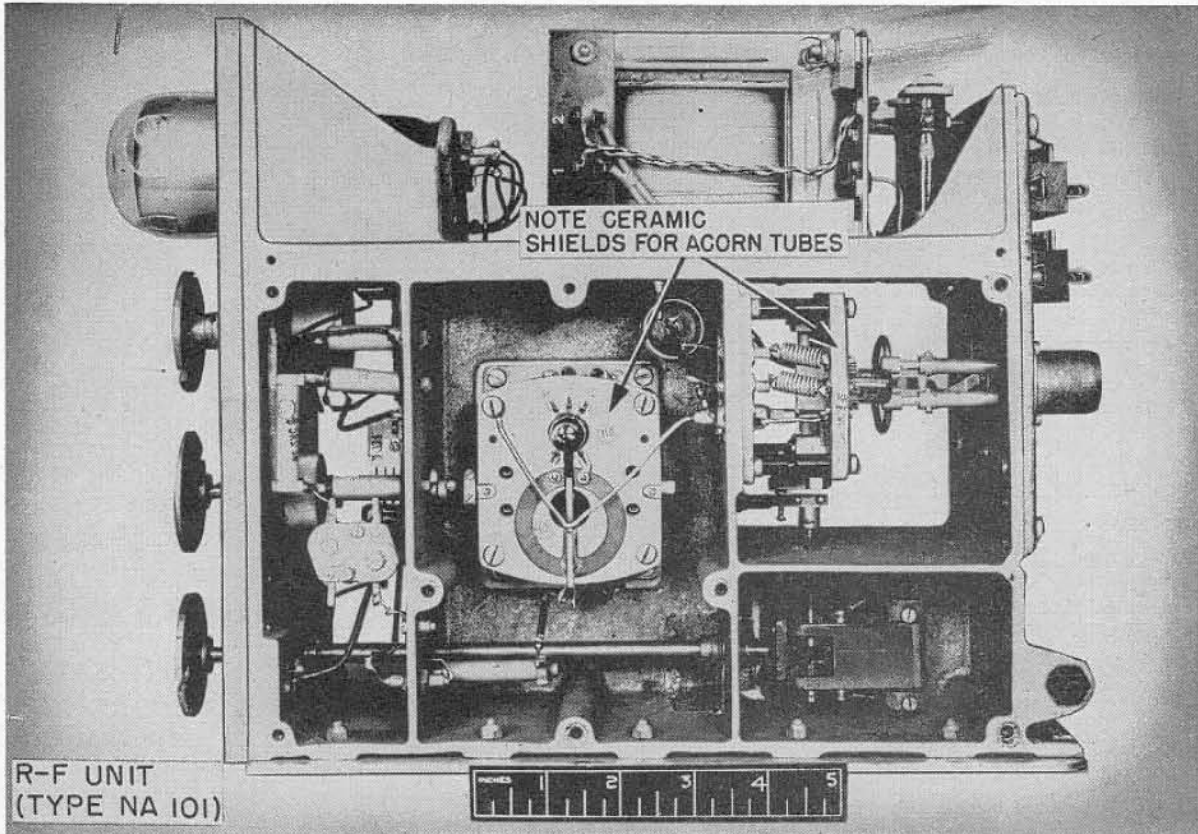
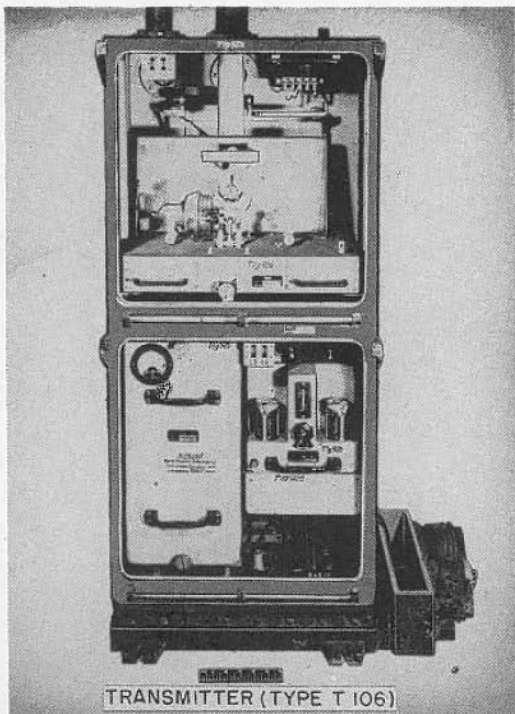
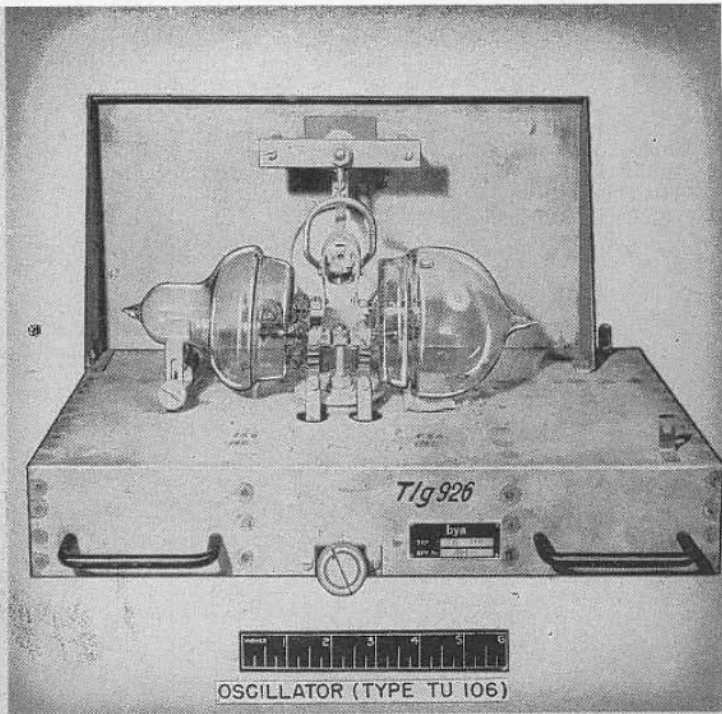


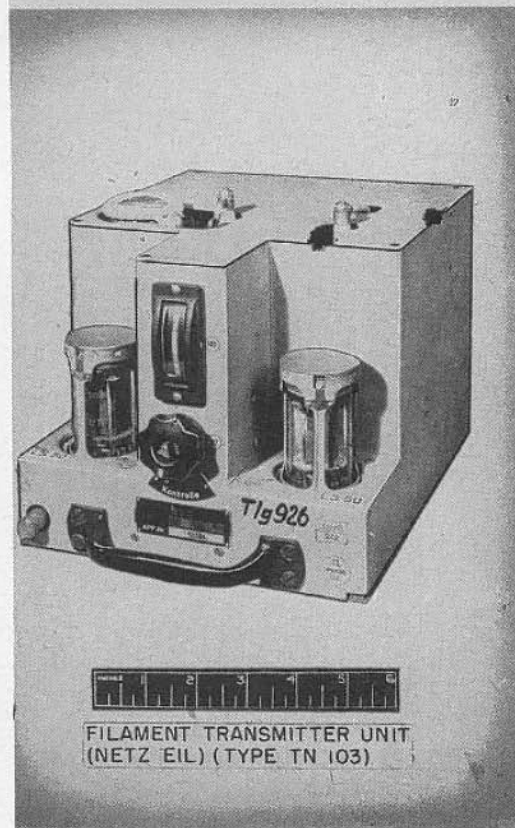
Figure 33. Coastwatcher receiver.



TRANSMITTER (TYPE T 106)



OSCILLATOR (TYPE TU 106)

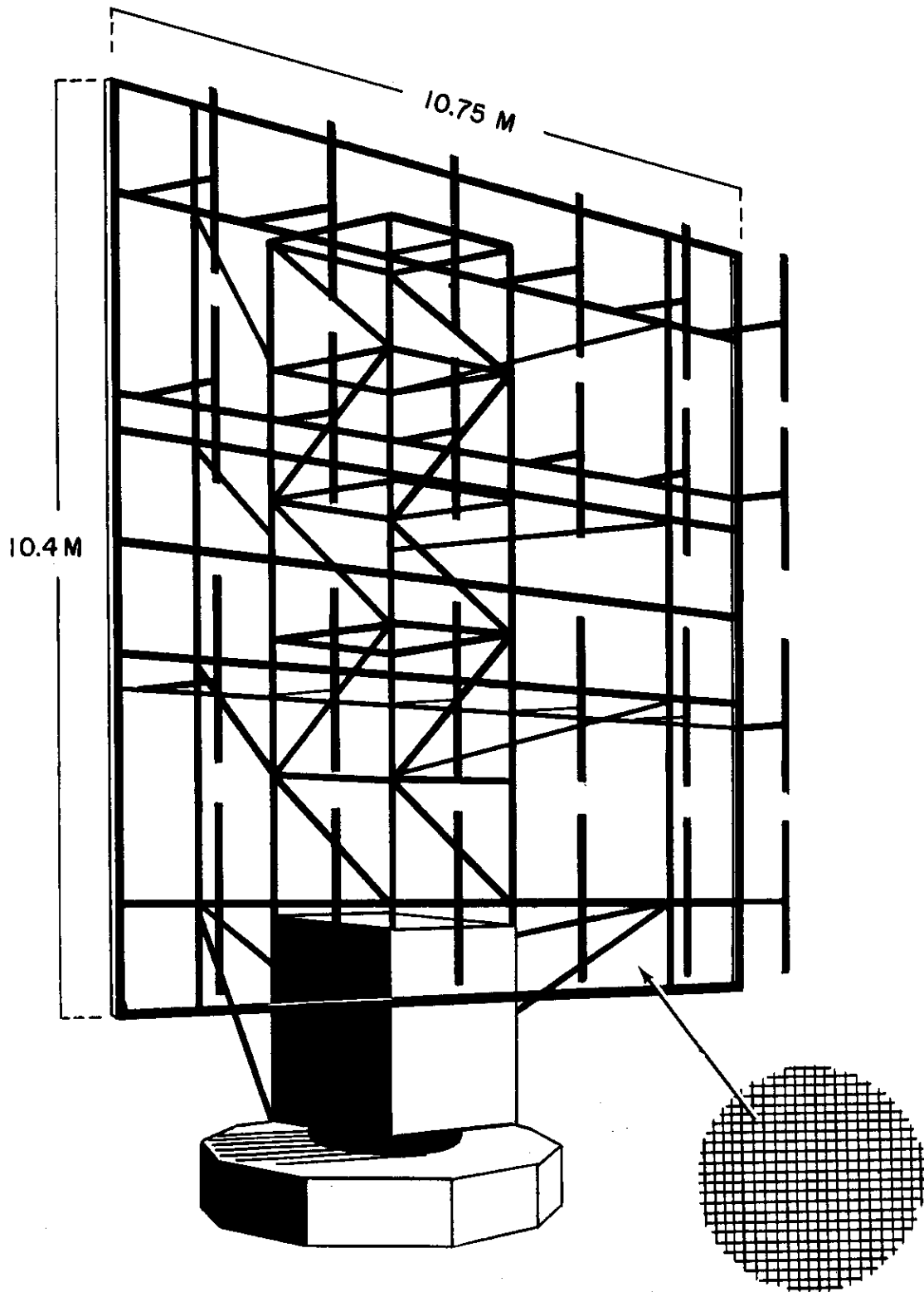


FILAMENT TRANSMITTER UNIT
(NETZ EIL) (TYPE TN 103)



MODULATOR (TYPE TS 103)

Figure 34. Coastwatcher.



TL47749

Figure 35. Large Coastwatcher.

FMG 39L AND 40L (WÜRZBURG) GL RADAR (NOT STANDARD)

This equipment was designed by Lorenz, but not standardized, as an early Flak, gun-laying set. A few are in use on coastal sites for aircraft reporting, a few were given to the Navy for coast-watching duties, and about 10 were sold to the Italians.

These types, FMG 39L and 40L, have been described as consisting of two bowls, one for reception and one for transmission, mounted on a movable arm on top of a cabin containing the rest of the equipment. The lower bowl is the receiver. Display comprises one CRT with two circular traces, one for bearing and the other for elevation. In operation, the bowls are moved until maximum pip is obtained on each trace; readings of elevation and bearings are indicated mechanically in accordance with the position of the bowls. The pips appear on the periphery of the traces immediately opposite each other. As the range of the objective increases, the pips move in unison in a clockwise direction around the tube.

To obtain range, a plotting cursor from the center of the tube is laid over the center of the pips, and is extended to a celluloid scale calibrated in km fitted around the outside of the tube.

The equipment is manned by three operators accommodated inside the cabin.

The characteristics of the Lorenz Würzburg are as follows:

RANGE (miles): 15 to 22.

FREQUENCY RANGE (mc): 560 to 580.

PULSE RECURRENCE FREQUENCY (cps):
5,000; reduced to 3,000 on later models.

PULSE LENGTH: 2 microseconds.

ANTENNA: Two 10-foot parabolic mirrors of wire mesh, one for transmitting and the other (the upper one) for receiving; focal length 29.5 inches. Horizontal polarization.

POWER SOURCE: Gasoline-engine driven motor-generator sets or power lines.

SIMILAR SETS: Würzburgs manufactured by Telefunken about the same time.

TRANSPORTATION: Mounted on four-wheel trailer with fixed cabin.

TYPE OF PRESENTATION: Two concentric circular timebases on tube, the outer indicating azimuth and the inner indicating elevation.

DATA OBTAINED: Elevation and azimuth (range is scaled).

ACCURACY: Of range, 55 yd; of azimuth, 1°; of elevation, 6°.

FMG 39T (A) (WÜRZBURG) GL RADAR

FMG 39T (A), (C), and (D) are small (Bowl Fire) types of Würzburg. All can perform all duties involving measurement of small ranges, such as the detection of nearby aircraft and shipping, the control of Flak, and, in some instances, the control of searchlights.

FMG 39T (A) is the basic Würzburg design, manufactured by Telefunken and introduced into the service in 1940. This type is used in coastal and inland sites in northwest Europe and the Mediterranean area, principally for gun-laying; it can also be used for short-range early warning of aircraft and for height-finding in aircraft reporting. Würzburgs and Freyas are frequently sited in the same neighborhood, the Freya to give early, long-range warning of the approach of aircraft and the Würzburg to obtain height measurements and to follow at close range.

This type has no lobe switching; it uses only one CRT, azimuth and elevation being determined by maximum pip amplitude. The transmitting tube is a triode with approximately 8-kw peak power. The i-f amplifier has four stages at 25 mc, and five stages at 6 mc, the i-f bandwidth being 0.5 mc (-6 db). The local oscillator consists of push-pull triodes at 146.2 mc and quadrupler tube feeding capacity-resonator harmonic selector.

Most of the models are equipped with IFF receiving antennas (two dipoles with D/F facilities) at the sides of the paraboloid, operating on a frequency of approximately 155 mc. Although IFF is aural, the equipment has an auxiliary visual signal strength meter. It allows D/F on a minimum.

The apparatus consists of a small antenna with parabolic reflector, transmitter and receiver in a small hut, mounted on a trailer that can be folded back and held in position by bars. It is so delicately balanced that a spirit level or plumb line is a necessary part of the equipment. The unit is of light alloy; it is

extremely simple and robust; construction and workmanship are good. In general, ease of operation has been sacrificed for simplicity, since the paraboloid has to be tilted by hand.

The hut (or "cupboard") and reflector can be rotated horizontally through 360° and the antenna and reflector can be tilted in a vertical plane from 15° below to about 75° above the horizontal. It has a narrow circular field of view, about 14°, and has to be forewarned of the approach and approximate position of the target. This may be done by a controller or by a neighboring Freya. After receiving the warning, the Würzburg is turned in the direction of the target, which it may perceive at a distance of from 25 to 30 miles.

All types of Würzburg can measure height by calculating the range of the target and the angle of elevation of the reflector required to produce the maximum response at the receiver. Ranges are accurate to less than 1 mile and elevation to less than 1°. Aircraft can be detected at all but very low altitudes.

The characteristics of the FMG 39T (A) are as follows:

RANGE (miles): Normal, from 10 to 25; maximum, from 30 to 40. Minimum angle for accurate height-finding is from 5° to 10° above the optical horizon for inland sites.

FREQUENCY RANGE (mc): 520 to 590; 500 to 600 also reported.

PULSE RECURRENCE FREQUENCY (cps): 3,750, increased to 5,000 when IFF is used.

PULSE LENGTH: 2 microseconds; 1.5 microseconds when IFF is used.

ANTENNA: Sheet-metal paraboloid 10.1 feet in diameter, focal length 36.3", with fixed tubular half-wave dipole and sheet-metal front reflector: Common T&R. Horizontal beamwidth 24°, vertical beamwidth 35° (estimated figures). Vertical polarization.

POWER SOURCE: Power lines through rotary

converter; for standby a gasoline-driven generator. 90 to 380 volts, 40 to 60 cycles ac. SIMILAR SETS: Other Würzburgs: types FMG 39T (C) and (D), both small types, and FMG 39T Riese (Giant).

POWER INPUT REQUIRED: 3 kw.

POWER OUTPUT: 7 to 11 kw (peak).

TUBES (type and number): 75 tubes in transmitter-receiver unit FuSE 62 as follows: one LS 80, twelve LS 50, twelve LS 30, four LD 2, thirty-four RV 12, one LV 1, two LG 1, one LG 2, one LB 13/40, one LB 7/15, four neon lights TE 4, one quartz crystal OEK 1, and one stabilizer STV 150/15.

TRANSPORTATION: In light, four-wheel trailer with outriggers.

TYPE OF PRESENTATION: One CRT ap-

proximately 4" in diameter, with circular timebase.

DATA OBTAINED: Range, azimuth, and elevation.

ACCURACY: Of range, 137.5 yd; of azimuth, 1.8°; of elevation, 2°.

PRINCIPAL COMPONENTS

	DIMENSIONS			WEIGHT
	<i>Height</i> (in.)	<i>Width</i> (in.)	<i>Depth</i> (in.)	
Transmitter-receiver box	24½	10½	6¼	
Receiver i-f amplifier box	6½	7	12½	
Impulse generator	13	12¾	6¾	

Total weight of set..... 2.3 tons
(Dimensions are of the equipment captured in the Bruneval raid.)

FMG 39T (C) (WÜRZBURG) GL RADAR

Type FMG 39T (C) is a modification of the basic Würzburg design. It has a rotating dipole with synchronous antenna and indicator switching. Three CRT's are used: one large one with circular timebase for range measurement, and two smaller ones (azimuth and elevation tubes). Minimum angle of elevation for cover is 5° and for height-finding is 10° above the optical horizon for inland sites. A hand-rotated circular scale, calibrated from 2 to 16 km, is also provided. Setting the pointer of this scale to the same range as that indicated in the range tube brings the correct echoes into the smaller tubes for aiming.

There is also a push button by means of which the operator can change the pulse repetition frequency from 3,750 to 5,000 cps in order to enable the aircraft IFF to function.

Type FMG 39T (C) is used at most Seetakt sites in northwest Europe. It is used mainly for Flak control, for searchlight control (via the plotting instrument "Malsi"), height-finding for aircraft reporting, or as stand-by in interception control.

This set was introduced into service in 1941.

The characteristics of this equipment are as follows:

RANGE (miles): From 1 to 25.

FREQUENCY RANGE (mc): "A" band, 550 to 580; "B" band, 470 to 490; intermediate band, 545 to 555; 520 to 590 also reported.

PULSE RECURRENCE FREQUENCY (cps): 3,750 increased to 5,000 when used with IFF.

PULSE LENGTH: 1 to 2 microseconds.

ANTENNA: Sheet-metal paraboloid 10.1 feet

in diameter, with wide-band dipole of sheet-metal blades; blade-fixing holes slotted for adjustment at approximately 21.2 inches or 25.2 inches working. Alternative narrow-band dipole on some specimens. Front reflector is 3.2-inch strip of sprayed metal on bakelite disk, 3.1 inch in front of dipole. Common T&R.

POWER SOURCE: 90 to 380 volts, 40 to 60 cycles a-c from power lines or standby motor-generator set or both.

SIMILAR SETS: Würzburg: FMG 39T (A) and (D) and FMG 39T Riese (Giant).

POWER INPUT REQUIRED: 3.3 kw.

POWER OUTPUT: 7 to 11 kw (peak).

TUBES (type and number): 75 tubes in transmitter-receiver unit FuSE 62 as follows: One LS 80, twelve LS 50, twelve LS 20, four LD 2, thirty-four RV 12, one LV 1, two LG 1, one LG 2, one LB 13/40, one LB 7/15, four neon lights TE 4, one quartz crystal OEK 1, and one stabilizer STV 150/15.

TRANSPORTATION: Mobile; it can be carried in truck or trailer.

TYPE OF PRESENTATION: Three CRT's: one large, with circular timebase for range measurement and two smaller ones, elevation and azimuth tubes.

DATA OBTAINED: Range, elevation, and azimuth.

ACCURACY: Of range, 137.5 yd; of azimuth, 0.2° ; of elevation, 0.2° (estimated).

	<i>Height</i>	<i>Width</i>	<i>Length</i>
Over-all dimensions of set:	102 in.	120 in.	211 in.