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INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

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1. Attached is a [redacted] Polish military manual authorized for use in the Polish Armed Forces on 26 February 1962 by Colonel Edward Holynski, Chief of the Signals Corps. The Polish classification of the document is SECRET. The R-401, which is of Soviet production, is currently being introduced into the Polish Armed Forces. 50X1-HUM

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INFORMATION REPORT INFORMATION REPORT

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POLAND/U.S.S.R.
AIR/MILITARY

MINISTRY OF NATIONAL DEFENSE

SECRET

SIGNALS MANUAL

THE R-401 RADIO RELAY STATION

PUBLICATION OF THE MINISTRY OF NATIONAL DEFENCE

1962

Warsaw, 26th February 1962.

ORDER No. 022/Laczn.

I approve and introduce for use the " Signals Manual - The R-401 Radio Relay Station".

CHIEF OF THE CORPS OF SIGNALS

Colonel Edward HOLYNSKI

SECRET

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SOME ABBREVIATIONS

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1.	APCz	Automatyczne podstrajanie czestotliwosci. Automatic frequency control (AFC).
2.	Dz	Dzwonek. Bell.
3.	FMCz	Filtr malej czestotliwosci. Low frequency filter.
4.	FP	Filtr pasmowy. Band pass filter.
5.	FTg	Filtr telegraficzny. Telegraph filter.
6.	GZA	Generator zewu akustycznego. Audio calling signal generator.
7.	MKT	Mikrotelefon. Microtelephone, telephone handset.
8.	N	Neper, (1 Neper = 8.686 decibels).
9.	OZA	Odbiornik zewu akustycznego. Audio calling signal receiver.
10.	P	Przekaznik. Relay.
11.	PN	Przekaznik nadawczy. Transmitting relay.
12.	PO	Przekaznik odbiorczy. Receiving relay.
13.	TrR	Transformator roznicowy. Differential transformer. (Hybrid coil).
14.	URW	Uklad rozmowniczo wywolawczy. "Talk - call" unit.
15.	UR	Uklad rozwidleniowy. Hybrid junction unit.
16.	WPCz	Wzmacniacz posredniej czestotliwosci. Intermediate frequency amplifier.
17.	WWCz	Wzmacniacz wysokiej czestotliwosci. High frequency amplifier.
18.	WMCz	Wzmacniacz malej czestotliwosci. Low frequency amplifier.
19.	ZZ	Zmiennik zewu. Calling signal converter.
20.	TF	Telefon(iczny). Telephone(-ic).
21.	TG	Telegraf(iczny). Telegraph(-ic).

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CHAPTER I

FUNDAMENTALS OF MULTI-CHANNEL COMMUNICATION WITH FREQUENCY DIVISION MULTIPLEXING

1. Communication by means of a radio-relay is a novel method of providing communication by radio, which differs substantially due to its features and possibilities from the previously used methods. The design of the radio-relay equipment permits the use of the radio-relay channels in connection with wire communication channels. Due to this possibility, a complex communication system can be set up, where the same terminal equipment is used for both wire and radio links. With such a system a subscriber, whose telephone set is connected to the exchange, can talk through the wire links, or through the radio links, or through mixed wire and radio links. Therefore the application of the radio-relay raises the quality of the radio communication up to the level of a good quality wire communication, at the same time preserving the fundamental advantage of radio communication, namely good manoeuverability.

2. To obtain a more efficient use of the wire lines for long distance communication, wide use is made of multiplexing (multi-channeling). This means a simultaneous transmission of many conversations along a common path. The multiplexing of radio links for the simultaneous transmission of several conversations is widely applied in the radio-relay communication. The principles of multi-channel communication by means of the radio-relay with frequency division multiplexing will now be examined, taking as an example the radio-relay station R-401.

3. The frequency band transmitted by the R-401 radio-relay station is contained within the limits of 300 to 15000 c/s. Within this band there are located two telephone channels, and two telegraph channels. The first telephone channel is the natural voice frequency channel. The second telephone channel - the carrier frequency channel - is an ultrasonic frequency channel, operating on the principle of the suppressed-carrier

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transmission. Both telegraph channels are also ultrasonic. In these channels, the telegraph pulses are transmitted with the aid of frequency modulated oscillations.

4. The suppressed-carrier transmission method of telephone conversations consists of shifting the natural voice frequency band into the range of higher frequencies, and then transmitting it through the radio-relay link. This is accomplished by special processes taking place on the transmitting side. On the receiving side, the frequency band is submitted to a reverse process, resulting in the recovery of the original voice frequency band of the telephone signal.

5. The process of shifting the voice frequency band into the higher frequency range on the transmitting side is known as modulation, and the reverse process on the receiving side is known as de-modulation.

6. It is known that the telephone speech is sufficiently intelligible even when the audio frequency band is reduced to a band contained within the limits of 400-2500 c/s. An example of the relative amplitudes of sinusoidal components of the telephone conversation frequency band is given in Figure 1 a.

7. When the oscillations of a special oscillator (the sub-carrier frequency oscillator) are modulated with a signal of the above frequency band, the amplitude modulated oscillations frequency spectrum will contain the following frequencies: sub-carrier frequency (the oscillator frequency), and two side-bands (Figure 1 b).

8. The width of each side band equals the width of the modulating signal band, and the particular frequencies are the sum of, or difference between the oscillator frequency and the frequencies of the modulating signal. For example the sub-carrier frequency of the R-401 radio-relay station is f_{pn} = 7400 c/s. Hence the lower side band contains frequencies lying between 4900 and 7000 c/s (from f_{pn} - 2500 c/s to f_{pn}-400 c/s), and the upper side-band contains frequencies lying between 7800 and 9900 c/s (from f_{pn} + 400 to f_{pn} + 2500 c/s). [redacted] 50X1

9. From Figure 1 b it follows that the distribution of amplitudes in the upper side-band corresponds exactly to the amplitudes distribution within the natural band of the telephone speech. In the lower side-band the higher frequency components correspond to the lower frequency components of the natural band, and vice-versa - the lower frequency components of the lower side-band correspond to the higher frequency components of the natural band. In other words, the distribution of the component oscillations amplitudes within the lower side-band is in inverse ratio to the distribution in the natural band.

10. Frequently, to make the best use of the frequency band which can be transmitted by the radio-relay, only one of the side-bands is used for the transmission of speech. In the R-401 radio-relay only the lower side-band is transmitted. The sub-carrier frequency serves here only for the purpose of producing the amplitude modulated oscillations. The sub-carrier frequency oscillations, together with the upper side-band components are subsequently attenuated by a filter. The telephony system based on the principle of the single side-band, suppressed-carrier transmission presents the advantage that the frequency band width, required for the transmission of the speech signal, is equal to the signal band width only.

11. The frequency band transmitted by the R-401 radio-relay station is shown in Figure 2.

12. The block diagram shown in Figure 3 explains the principle of frequency division multiplexing in the radio-relay link.

13. The signal from the subscriber's microphone in the first telephone channel, passes through the amplitude limiter OA, and is applied to the low frequency filter FMCz. Through this filter pass only frequencies below 2500 c/s. This eliminates the possibility of interference in the remaining channels during the operation of the first telephone channel.

14. The signal from the microphone of the second telephone channel, after passing through the amplitude limiter OA, is applied to the modulator.

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At the output of the modulator is a band-pass filter FP_1, which transmits only the lower side-band frequencies (4900-7000 c/s) and substantially attenuates all the other frequencies, eliminating the possibility of interference in the other channels. From the output of the filters FMCz and FP_1 signals of both telephone channels are applied to the input of the modulation amplifier of the radio-relay transmitter.

15. The amplitude limiters OA at the input of each telephone channel limit the level of the incoming signal to a definite value in order to prevent the overloading of the following channels, and to reduce the possibility of cross-talk between the channels. As the limiters are non-linear elements, they cause signal distortions in the telephone channels. However, it turns out in practice that the non-linear distortions caused by the limiters affect much less the quality of communication, than cross-talk between the channels in the absence of limiters. On the block diagram a dotted line is drawn around the second telephone channel elements which in the carrier telephony equipment are known as the transmitter.

16. The block diagram explaining the principle of separation of particular channels on the receiving side, is shown in Figure 4.

17. The low frequency filter $FMCz_1$, located at the input of the first telephone channel, transmits to the subscriber, from the whole frequency band of the received signal (Figure 2), only the first channel frequencies (natural voice frequency band). It does not pass frequencies of the remaining channels.

18. The band-pass filter FP_1, located at the input of the second telephone channel, transmits from the whole frequency band received, only frequencies corresponding to the lower side-band of this channel, i.e. only the band 4900-7000 c/s. Signals of the pass band frequency enter the demodulator (Dem.), where they are transformed into the natural telephone speech frequency band. The demodulator consists here of a cuproxide rectifier, which is a non-linear element. [redacted]

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19. When to the non-linear element is applied a signal containing lower side-band frequencies (f_b), and a sub-carrier frequency f_{pn} = 7400 c/s, generated by a local oscillator, then at the output of this element there appear, beside the fundamental frequencies, also their harmonics, and the combined frequencies of f_b and f_{pn} (Figure 5). The frequency components, which are the difference of $f_{pn} - f_b$, correspond to the voice frequency band transmitted by the second telephone channel. The low frequency band filter (low pass filter) $FMCz_2$ at the output of the demodulator attenuates all the higher frequencies beyond the voice frequency band transmitted through the second telephone channel. From the output of this filter, the signal containing voice frequencies, after being amplified by the amplifier W, is sent to the subscriber. On the block diagram a dotted line is drawn around the part of the circuit which in the carrier telephony system is known as the receiver.

20. In Figure 6 is shown a simplified block diagram of the second telephone channel of the R-401 station. For the transition from the four-terminal multiplex system into the two-terminal subscriber's line is used a differential transformer /hybrid coil/. The principle of its operation is as follows.

21. The currents of the natural voice frequency band from the demodulator flow through the primary winding of the differential transformer TrR into the subscriber's line, and simultaneously into the balancing network Rn. The balancing network is so designed that its impedance is equal to the input impedance of the subscriber's line. Therefore currents through the balancing network and through the subscriber's line are equal. As these currents flow through the primary winding in opposite directions, the resultant magnetic flux in the core of the differential transformer TrR is zero. In consequence, no electromotive force is induced in the secondary winding of the transformer, which is connected to the modulator input, and the telephone signals directed to the subscriber do not enter into one's own transmitter input. On the other hand, currents from the

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subscriber microphone flow in the same direction through both halves of the differential transformer primary winding. An EMF is therefore induced in the secondary winding, which is then applied to the input of the modulator.

22. The above multiplexing method is used in the R-401 station.

23. We will now examine the principle of telegraphy with the aid of the frequency modulated oscillations, as used in both telegraph channels of the R-401 station. The positive telegraph pulses arriving from the line develop alternating current signals of a frequency f_1, and the negative pulses, or zero current pulses develop signals of a frequency f_2. Conversion of the d.c. pulses into the a.c. signals is done with the aid of the transmitting relay which controls the generator oscillations. At the instant of the transition of the transmitting relay arm from one contact to the other, the generator frequency has an average value of $f_o = \frac{f_1+f_2}{2}$.

24. During the transmission of positive telegraph pulses, the frequency f_o is increased by the amount Δf_t, and during the transmission of the negative or zero current pulses, the frequency drops by the same amount. The amount of the frequency increase Δf_t is known as the frequency deviation of the generator. In this manner, by changing the frequency of the generator oscillations, the telegraph signals can be transmitted, without interrupting the oscillations of the generator.

25. The width of the telegraph channel frequency band with frequency modulated oscillations depends upon the coefficient of modulation (modulation index) m_f which is expressed as the ratio:

$$m_f = \frac{\Delta f_t}{F} = \frac{2 \Delta f_t}{v}$$

where: F = fundamental telegraph signalling frequency, equal to one half of the telegraph signalling speed expressed in bauds.

26. In the R-401 station the frequency deviation of both telegraph channels is the same, and equals $\Delta f_t = 300$ c/s. As the frequency deviation is always constant, the frequency band width is determined by the highest telegraph signalling speed which, for the telegraph channels of the

R-401 station, equals 50 bauds. At this signalling speed, the frequency band occupied by each telegraph channel is 800 c/s.

27. The block diagram of the circuit converting the d.c. telegraph signal pulses into frequency modulated oscillations is shown in Figure 3. Pulses from the telegraph transmitters connected to the inputs of the channels, activate the transmitting relays PN, which in turn control the oscillation frequency of the generator G_1 or G_2.

28. The frequency modulated oscillations pass from the generator through the band-pass filter FP_2 (or FP_3 of the second channel) into the input of the modulator amplifier of the transmitter.

29. The spectrum of the telegraph and telephone frequency channels, and their position within the frequency band transmitted by the R-401 station, is shown in Figure 2. The frequency bands of the individual channels of the station are so distributed along the frequency spectrum as to minimise the possibility of cross-talk between the channels.

30. The block diagram of the frequency modulated telegraph signal receiving circuit is shown in Figure 4. The frequency modulated oscillations arriving from the receiver, pass through the filter FP_2 (or FP_3), their amplitude is limited, and they are then amplified. The purpose of the amplitude limiter was discussed above.

31. The amplitude limited and amplified frequency modulated oscillations corresponding to the telegraph signals, are applied to the frequency detector /discriminator/ D, composed of two resonant circuits connected in series. The resonant frequency of one circuit equals $f_o + f_t$, and the resonant frequency of the second circuit equals $f_o - f_t$. With the aid of this detector the frequency modulated oscillations are converted into amplitude modulated oscillations. They are then rectified by the cuproxide rectifiers Pr. The rectified currents flow through the windings of the polarised receiving relay PO whose arm reproduces the d.c. telegraph signal pulses, which are then transmitted through the line to the telegraph receivers.

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CHAPTER II

DESCRIPTION OF THE STATION EQUIPMENT

1. Purpose of the Station and basic Tactical and Technical Data

32. The R-401 radio-relay station serves primarily for the maintenance of communication between command posts, and as a branch link from large, multi-channel radio-relay stations. In addition, the station can be used as an intermediate station for the wire lines, and also for other purposes.

Equipment of the station

33. The equipment of the R-401 radio-relay station is located in a special body of the GAZ-63 truck (Figure 7). The weight of the truck, including the body, the equipment, the accessories and fuel, is 5400 kgs.

34. Each radio-relay station is equipped with two identical half-sets. Each half-set is composed of the following basic assemblies: the transmitter-receiver unit (Block 1), the multiplexing unit (Block 2), the rectifier unit (Block 3), the line panel, the battery charging panel, the petrol-driven generator for battery charging, six storage batteries 5 NKN-45, the aerial, the mast with guy-ropes, and two coaxial aerial cables /feeders/. In addition, the station outfit also includes: an instrument for the adjustment of channels and telegraph relays, a mains supply attachment, a telephone instrument TAI-43, spare parts, and auxiliary equipment.

35. The blocks 1, 2 and 3 of each half-set are fixed in a metal rack (Figure 8). The racks are attached to the table and to the rear wall of the truck body with the aid of shock absorbers. The lay-out of the equipment in the truck is shown in Figure 9.

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36. The design of the equipment and the wiring of the station makes possible speedy dismantling of the equipment and removing it for operation outside the truck, and also its speedy replacement in the truck. The removable equipment consists of: the transmitter-receiver unit, the multiplexing unit, two storage batteries 5 NKN-45, the aerial in its packing, a mast hoist, a set of guy-ropes in their packing, the mast components in their packing, the line panel, a telephone hand set, and connecting cables in their packing. When removing the equipment, the units 1 and 2, and the line panel should be placed in a special cover. The weight of the removable equipment (Figure 10) is about 200 kgs.

Basic Equipment Data - Range of Communication

37. In a moderately undulating, afforested and flat terrain, the range of communication between two stations is up to 45 kms. With two more relay (intermediate) stations it is possible to communicate over a range of 120 kms. In a flat open terrain the range between the stations can be increased.

38. It should be borne in mind that when using intermediate (retransmission) stations, each retransmitting section extending the radio-relay route causes an increase of the noise in individual channels. Therefore, in order to ensure normal conditions of operation of the radio-relay, it is necessary to increase the received signal levels at the individual stations. This can be obtained by reducing the distance between the stations, as compared with the distance between two terminal stations (without any relay stations). This explains the fact that with two relay stations the range of communication is less than treble the range between two terminal stations.

Frequency range

39. The station operates in the metric wave range (4.55 - 4.29 m.),

at frequencies from 66 to 69.975 Mc/s. This range is subdivided into 54 fixed operating wavelengths, at 75kc. intervals. Operating wave No. 1 corresponds to the frequency of 66 Mc/s.

40. The tuning assembly (of the transmitter and of the receiver), which has a scale and a pointer, serves for tuning the station and for setting it to any desired operating wavelength.

Types (modes) of Operation

41. The station provides the means for simultaneous duplex operation with two telephone channels, and two telegraph channels.

42. The output of each telephone channel can be connected to a two-wire (single pair) or to a four-wire (double pair) line. In other words, the transmission and the reception in each channel can be carried out either through a common circuit, or through two separate circuits. In both cases, in each telephone channel, the magneto calling signals can pass over in both directions. There is also provision for a secondary multiplexing (re-multiplexing) of the telephone channels by the telegraph channels with the aid of the carrier telegraphy equipment type P-313. As the second telephone channel is a carrier channel, its multiplexing with the aid of the P-313 equipment results in a slightly inferior communication, as compared with the first telephone channel. The telephone channels can also be used for the transmission of fixed images with the aid of tele-photography equipment.

43. The telegraph channels can work with uni-directional pulses of the telegraph set ST-35, as well as with the bi-directional pulses of the Baudot telegraph system. With the aid of the differential line transformers, supplied with the station, it is possible to operate the telegraph communication through two-wire lines connected to the telephone channels.

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44. The multiplexing equipment of the station permits an external multiplexing of the radio-line with the aid of the carrier telephony sets P-310 and P-312. When the external multiplexing sets are being used, the second telephone channel and both telegraph channels are switched off. The first telephone channel operates as usual.

45. When the station operates with its own multiplexing equipment, any channel can be extracted from the intermediate station. The relaying /re-transmission/ of the remaining channels is carried out on low frequencies (natural or carrier frequencies). During external multiplexing operation with the aid of the sets P-310 and P-312, only the first telephone channel can be extracted from the intermediate /repeater/ station.

46. The station telephone channel outputs can be connected to the telephone channels of the wire or radio-relay systems.

Characteristics (specifications) of the channels

47. The basic characteristic values of a telephone channel are: the rated input and output levels, the intelligible cross-talk level (from other channels), the magnitude of the non-linear distortions and frequency /linear/ distortions, and the noise level at the channel output.

48. The noise level in the radio-relay telephone channel depends upon the high frequency signal levels received by each station, and upon the number of stations in any given link.

49. At the above given ranges between the stations, the psophometric noise level in the telephone channels, including the cross-talk level, does not exceed 5 mV.

50. With a two-wire input to the telephone channels, and at the input level of - 1 N /nepers/, the absolute cross-talk level over one repeater section does not exceed - 7 N. With three repeater sections there is practically no cross-talk. The operation of the telegraph channels

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(both own channels and the channels obtained as a result of the secondary multiplexing with the aid of the P-313 unit), does not in practice cause an interference in the telephone channels.

51. Each telephone channel transmits a speech frequency band from 400 to 2500 c/s, with an attenuation of the extreme frequencies of this band not exceeding 0.4 N.

52. The non-linear distortion coefficient of the telephone channels with two-wire input, and an input level of - 1 N, does not exceed 10% for one repeater section.

53. The non-linear distortion coefficient of the first telephone channel with a four-wire input (4TC), and an input level of - 0.4N does not exceed 4% for one repeater section.

54. The input and output impedence of the radio-relay telephone channels is 600 ohms. The rated levels of the telephone channels, measured at a frequency of 800 c/s, are as follows:

- for a two-wire input: input level - 1.0 N, (285 mV);
  output level - 2.0 N, (105 mV);
- for a four-wire input with a magneto calling signal repeater (4TF): the input and the output levels are - 1.4 N (190 mV);
- for a four-wire input without a magneto calling signal repeater: the input and the output levels are - 0.4 N, (519 mV).

55. At the rated supply voltages it is possible to adjust the attenuation of the telephone channels with the aid of the measuring instruments, with an accuracy of ± 0.2 N.

56. The quality of the telegraph channels can essentially be determined by two parameters - the maximum telegraph signalling speed, and the coefficient of the telegraph signals distortions. The telegraph channels of the R-401 station make it possible to telegraph speed at a rate of 50 bauds. At this speed, the distortions of the telegraph signals

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for a link consisting of two intermediate repeater stations and two terminal stations, do not exceed 10%.

57. The lack of constancy of the frequency response from 3.5 to 15 kc/s., with external multiplexing does not exceed, for one repeater section, the limits of + 0.2 to - 0.5 N, in respect of the reference level at 9 kc/s. The rated levels of the channel with external multiplexing are: input level - + 0.4 N; output level - not less than - 2 N. The input and the output impedances of this channel are 1000 ohms.

The transmitter output power

58. The output power of the transmitter at rated power supply voltages, and average values of the output stage valve parameters, is not less than 2 W. With the batteries voltage drop to 11 V, or with the mains voltage drop of 10%, the transmitter output power should be not less than 1.3 W.

Receiver sensitivity

59. The receiver sensitivity of the station for both telephone channels, at a frequency deviation of 6 kc/s, at the rated output level, and a signal-to-noise ratio of 20 at the telephone channel output, should be not less than 2 microvolts. With the power supply voltages fluctuating within the limits of ± 10% the receiver sensitivity remains practically constant.

Receiver selectivity

60. The image signal attenuation is not less than 10 N for the first intermediate frequency, and not less than 11 N for the second intermediate frequency.

61. The attenuation of the intermediate frequency signals is not less than 11.5 N.

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62. When the receiver is de-tuned from 75 kc/s to 300 kc/s, the sensitivity drops not less than 9.2 N. When the receiver is de-tuned over 300 kc/s, the sensitivity drops not less than 11.5 N. The band-pass width of the receiver at the level of 0.5 is 48 kc/s.

Frequency stability of the receiver and the transmitter

63. The frequency stability of the transmitter and the receiver ensures the establishing of the communication without searching for the correspondent, and also the maintenance of communication without the necessity of manual re-tuning.

64. The cumulative error of the scale calibration and the tuning of the transmitter and receiver to the operating frequency does not exceed ± 6 kc/s. When the valves of the master oscillator, or the modulator in the transmitter, or the valves of the heterodyne oscillator, or the automatic frequency control stage in the receiver, have been changed - it is necessary to re-calibrate the equipment, with the aid of the quartz calibrator of the station.

65. The correction of the receiver and transmitter calibration should be repeated periodically during the technical inspections of the station.

66. After the switching on of the transmitter and receiver, during the warming up period of the valves and circuit elements of the transmitter master oscillator, and the receiver first heterodyne oscillator, their frequency is changing. About 15 minutes after the switching on, the frequency of the transmitter and of the heterodyne oscillator of the receiver become stabilized, and do not vary any more. The de-tuning of the transmitter and of the heterodyne oscillator of the receiver one minute after switching on does not exceed 3 kc/s.

67. When the power supply voltages fluctuate within the limits of ± 10% from the rated value, the frequency fluctuations of the transmitter and of the first heterodyne oscillator do not exceed 3.5 kc/s.

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68. The thermal frequency factor (TWCz) of the transmitter and of the first heterodyne oscillator of the receiver does not exceed $\pm 4 \times 10^{-6}$.

69. After communication has been established, the automatic frequency control circuit of the receiver should be switched on. This reduces the receiver de-tuning, in respect of the opposite station transmitter, almost six times, if de-tuning does not exceed one half of the receiver band-pass width ($\pm$ 25 kc/s).

The Aerial and Mast Equipment

70. For the transmission and reception of high frequency signals, the R-401 station uses two separate "Yagi" type aerials with mutually perpendicular polarization, assembled as a single cruciform unit. The horizontal and the vertical aerials, which form one unit, are installed on top of a collapsible mast 14.5 m. high.

71. The beam width angle of the horizontal radiation pattern main lobe, measured between two half-power points is:

- for the vertical aerial - about 75° (Figure 73);
- for the horizontal aerial - about 55° (Figure 74).

The directional gain of the aerial in respect of a half-wave dipole is not less than 6 db. The reciprocal attenuation between the horizontal and the vertical aerials is not less than 38 db.

72. Aerials are connected to the receiver and the transmitter by co-axial feeders type RK-1, 25 m. long.

Power Supply

73. The station can be powered from storage batteries, or from 127/220 V a.c. mains. Each half-set is equipped with three groups of storage batteries, consisting of two batteries each, type 5 NKN-45.

74. One group of storage batteries can supply continuously one half-set for 8 hours.

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75. Power drawn by one half-set from storage batteries is:

- during operation of the whole half-set - not more than 75 W;
- during stand-by duty (only receiver is energised) - not more than 35 W.

76. Power drawn by one half-set from the mains is:

- during operation of the whole half-set - not more than 150 W;
- during stand-by duty - not more than 65 W.

77. During operation of both half-sets at maximum load (calling, scale lighting, truck indoor lighting) the total power drawn by the station from a.c. mains is not more than 340 W.

78. Fluctuations of the supply voltages within ± 10% of the rated value do not affect the normal operation of the station. The storage batteries are charged by means of a mobile petrol-driven generator, type PES-0.75.

79. The anode and screen grid circuits of the valves, and the line circuits of the Baudot telegraph sets, are supplied from:

- a vibrator converter, when using the battery power supply;
- rectifiers, when using the a.c. mains supply.

<u>Deployment and dismantling of the Station</u>

80. The time required for the deployment and for dismantling of one intermediate station (erection and dismantling of two aerial and mast assemblies) by operating personnel consisting of 5 men, does not exceed one hour.

81. The design of the aerial and mast equipment permits the deployment of the station on relatively small sites, and also at night.

<u>Other data of the Station</u>

82. (1) The dimensions of the truck and body:

- length 5550 mm. /?/
- width 2240 mm. /?/ /indistinct copy/
- height 2990 mm. /?/

/ (2)

(2) Total petrol supply for the truck:

- petrol tank under the seat - 90 litres;
- petrol tank under the body - 105 litres;

(3) The total number of radio valves in one half-set is 30. Of this:

- in the transmitter: 6 valves (5 type 12ZIb, and one type 4PIb);
- in the receiver: 16 valves (12ZIb);
- in the multiplexing unit: 8 valves (12ZIb).

2. Modes of Operation of the Station

83. The R-401 station can operate in three alternative ways: as a terminal station, as an intermediate /repeater/ station, and as a main repeater station. In addition, any half-set can operate on stand-by duty (only the receiver operates).

Operation as a terminal station

84. A block diagram of the station operating as a terminal station is shown in Figure 12.

85. The subscriber's telephones in the telephone channels are connected through wire lines to the hybrid junction unit UR. The first channel subscriber signal passes through the hybrid junction unit UR, through the amplitude limiter OA, through the low frequency filter of the pass band 0.4 to 2.5 kc/s, and is applied to the modulation amplifier of the radio-relay transmitter (Block 1). Signals from this channel are applied to the input of the modulation amplifier without frequency conversion.

86. The second channel subscriber's signal passes through the hybrid junction unit to the input of the multiplexing unit transmitter, where the input signal frequencies are converted into higher frequencies. After frequency conversion, and after passing through the 4.9 to 7.0 kc/s band-pass filter, the signal, which now contains only the lower side-band

frequencies, is applied to the input of the modulation amplifier of the radio-relay transmitter.

87. The d.c. telegraph pulses, from the telegraph instruments connected to the telegraph channels of the station, are applied to the transmitting relay PN control the frequency of oscillations of the generator G_2 in the first channel, and of the generator G_3 in the second channel respectively. When the applied telegraph pulses are negative (or no-current pulses), the frequency of the generator G_2 oscillations in the first telegraph channel is 8.5 kc/s. When the pulses are positive (or current pulses), the oscillation frequency is 9.1 kc/s. The second telegraph channel generator G_3 generates oscillations of the frequency 12.2 and 12.8. kc/s respectively.

88. The frequency of oscillations of the generators G_2 and G_3 are in this way modulated during the operation of the telegraph instruments.

89. The frequency modulated oscillations pass through the 8.4 to 9.2 kc/s band-pass filter in the first channel, and through the 12.1 to 12.9 kc/s band-pass filter in the second channel, into the input of the modulation amplifier of the transmitter.

90. The signals of particular channels, shown in Figure 2, after being amplified to a suitable level in the modulation amplifier, modulate the high frequency oscillations of the master oscillator in the transmitter. After further amplification, these oscillations are applied to the transmitting aerial through a coaxial line.

91. The high frequency signals received from the other station are fed through the coaxial line into the input of the receiver (Block 1). In the receiver they are amplified and then submitted to a conversion process in order to re-create the signals modulating the radio-relay transmitter frequency of the frequency spectrum shown in Figure 2. After

/ the conversion, ...

the conversion, the signal passes from the output of the receiver into a system of filters (Block 2) which distribute the component frequency bands into particular channels.

90. The signal containing the natural speech frequency band of the first telephone channel, after passing through the low frequency 0.4 to 2.5 kc/s band-pass filter, through the amplifier W, and through the hybrid junction unit UR, is sent to the subscriber.

93. The second telephone channel frequency band, separated by the 4.9 to 7.0 kc/s band-pass filter, is applied to the receiver of the multiplexing unit, where it is converted into the original telephone speech frequency band. After the conversion, the signal passes through the low-pass filter, through the hybrid junction unit UR, and then is sent to the subscriber.

94. In order to carry out a telephone conversation from own station, with the other radio-relay station or with a telephone exchange, use is made of the talk-call unit. This unit can be connected to the appropriate telephone channel.

95. The frequency modulated signals of the first telegraph channel, after passing through the 8.4 to 9.2. kc/s band-pass filter for the first telegraph channel, or after passing through the 12.1 to 12.9 kc/s band-pass filter for the second telegraph channel, enter the appropriate telegraph signal receiver, where they are converted into d.c. pulses. These pulses pass through the windings of the polarised receiving relays PO. The arms of the receiving relays reproduce the d.c. pulses, and transmit these pulses through the line to the receiving telegraph instruments.

96. With external multiplexing with the aid of the carrier telephony sets P-310 and P-312, the R-401 station can operate only as a terminal station in a four-wire system, i.e., with the separation of directions of transmitting and receiving. In this case, the station should be connected

as a terminal station with external multiplexing.

97. The block diagram of the external multiplexing equipment connections is shown in Figure 13. This figure shows that in this case the first telephone channel operation is similar to the operation with internal multiplexing equipment. On the transmitting side, the external multiplexing equipment is connected to the input of the radio-relay transmitter modulation amplifier through a wide-band transformer Tr_6, and on the receiving side, it is connected with the output of the receiver through the wide-band transformer Tr_7 (Block 1).

Operation as an intermediate (repeater)sstation

98. The block diagram of the station when operating as intermediate station (repeater station) is shown in Figure 14. In this case all the channels of the station are connected for re-transmission (repeater) operation.

99. As the station must re-transmit signals simultaneously in both directions, both half-sets must operate. The receivers and the transmitters of both half-sets are operating simultaneously, and in addition both telephone channels are switched on for reception, so that the calling signals can be received, and it is possible to check (monitor) the telephone channels for quality of communication. The telegraph channels are connected for re-transmission, but their power supply sources are not switched on.

100. For the re-transmission of channels a four-wire system is used. From the receiver output of one half-set, signals of all the channels are applied to the transmitter input of the second half-set through the filters of the respective channels. When a calling signal comes in through an telephone channel, the intermediate station operator switches this channel to the terminal station operation, and connects the "talk-call" unit URW, which allows him to carry out the conversation.

/ 101.

101. The block diagram of an intermediate station with external multiplexing using the carrier telephony sets P-310 and P-312, is shown in Figure 15. For re-transmission of a channel with external multiplexing, the second telephone channel and both telegraph channels of each half-set are disconnected. There is no change in the re-transmission of the first telephone channel, as shown in the diagram in Figure 14. For channel re-transmission with external multiplexing a four-wire system is used. In each half-set, the signals of this channel pass through a wide-band transformer.

Operation as a main repeater station

102. An intermediate (repeater) station is called the main repeater station when some of the channels are extracted for local use. In this case the extracted telephone and telegraph channels are reconnected at the intermediate station for terminal operation. (In Figure 14 these connections are shown with broken lines). Telephone and telegraph channels which are not extracted, operate in the re-transmission system. (In Figure 14 connections for this case are shown with a continuous line). The "talk-call" unit of each half-set of the main repeater station permits conversation through the extracted channel, and also monitoring of the re-transmission channels.

Station connected for stand-by reception

103. In addition to the modes of operation described above, any half-set of the terminal or intermediate station can be connected for reception only. In this case only the receiver of the radio-relay and both telephone channels are in operation, so that it is possible to receive the calling signal from the distant station.

104. When an audio frequency signal (800 c/s) is received, the receiver of the audio calling signal OZA in one of the telephone channels will

come into operation and will energise the bell. On hearing the bell, the operator switches on the half-set (switches on his transmitter), and answers the call of the distant station.

3. Transceiver Unit

105. In the transceiver unit (Block 1) are located the following basic elements: the radio transmitter, the radio receiver, and the vibrator converters of the transmitter and the receiver. The description of each element is given below. The voltages and currents required for the supply of the particular circuits, and the operating data for the valves of the transceiver unit are given in Appendices 4 and 5.

The construction of the unit

106. The transceiver unit is assembled on a siluminum cast base, with the front panel attached to it with bolts.

107. The external view of this unit is shown in Figures 17, 18, 19 and 20.

108. The individual elements of the unit are assembled in separate partitions divided into several compartments. The design of the unit permits the rapid replacement of any of the transmitter and receiver valves.

109. The transceiver unit housing is made of duraluminium sheet. In the rear wall of the housing there are holes for the cable connectors, and on the side walls - holes giving access to the semi-variable capacitors /trimmers?/ serving for frequency correction /fine tuning/ of the transmitter and the receiver, and also to the potentiometers serving for the adjustment of the APCz /AFC/ circuit.

110. The size of the transceiver unit including the housing is: 370 × 215 × 415 mm. Weight of the unit: 26 kg.

/ The transmitter

The transmitter

111. The station transmitter is assembled in a separate frame. Access to all the elements of the transmitter is possible without removal of the frame from the chassis of the unit. The transmitter dial is fixed directly on the shaft of its tuning mechanism. The hairline of the scale is fixed to the front panel of Block 1.

112. On tuning the transmitter, the rotary motion of the dial is changed by means of a suitable threaded shaft into the progressive motion of the tuning elements.

113. Master oscillator tuning within the frequency range is obtained by varying the distributed capacity C_{35} of the oscillator grid circuit coil. This capacitance is varied by the movement of a ceramic core of high dielectric constant /permittivity/ inside the coil. Circuits of all the other stages are tuned inductively. Inductance of these circuits is varied by means of copper rings slid inside the coils. All the circuits are tuned simultaneously with the aid of a tuning mechanism driven by a knob.

114. The block diagram of the transmitter is shown in Figure 21. Each stage of the transmitter will be examined in turn.

Master oscillator

115. The master oscillator is an electron-coupled oscillator using the valve 12ZIL (L-3). The basic circuit of the master oscillator is shown in Figure 22.

116. The electron-coupled oscillator circuit makes it possible to obtain a relatively high degree of stability in a valve oscillator. The frequency of the generated osciallations is determined by the grid circuit $L_{11} - C_{35}$. This is a circuit of a high quality and of a high parameter constancy. Coil L_{11} (like all the coils in the transmitter circuits) is wound on a ceramic form, on which the individual windings have been made by the silver spraying method).

/ 117.

117. Coil L_{11} together with the coupling capacitor C_{34} is placed inside a screening cup, hermetically sealed against humidity. In order to reduce the effect of the valve upon the circuit frequency, the circuit is coupled with the grid by a small capacitance of C_{34} = 2 pF (wiring capacitance). The semi-variable capacitor C_{32} serves for transmitter frequency correction after a replacement of the master oscillator valve. The same capacitor is also used for frequency correction after a replacement of the frequency modulator valve.

118. In order to utilise the power of the high frequency oscillations, to the anode of the valve is connected another resonant circuit: L_6 – C_{23} – C_{24} located in a separate compartment of the frame. This circuit is coupled with the grid circuit through the electron stream within the master oscillator valve. The anode circuit is connected with the anode of the valve through two separating capacitors C_{22} and C_{25}, and the anode voltage is supplied through the choke L_{27}. This is a typical circuit for a shunt fed valve.

119. The cathode of the master osciallator is at a high frequency potential in respect to the ground, and therefore the cathode as well as the heater filament are de-coupled for the high frequencies with the aid of the chokes L_8, L_9 and L_{10}. Capacitors C_{28}, C_{29}, C_{30}, and C_{31} are the blocking capacitors. Resistor R_{18} gives automatic bias for the control grid of the valve, developed as a voltage drop due to the grid current.

120. Resistors R_{15} and R_{16} reduce the anode and the screen grid voltages respectively. The screen grid is grounded for the high frequency currents through the capacitor C_{26}.

121. Resistor R_{16} serves also for checking the master oscillator valve operation. The voltage drop developed across this resistor by the anode current, is applied through the resistor R_{17} and the switch W-3 to the terminals of the measuring instrument located on the front panel of the transceiver unit.

50X1-HUM

/ Separator ....

Separator /buffer amplifier/

122. The separator uses the valve 12ZIb (L-2), which is shunt fed (Figure 23). This stage serves for the amplification of the high frequency oscillations to the value required for the control of the power amplifier. This stage also makes the oscillator circuit independent of the effects of the changes in the load of the power amplifier, thus improving the generated frequency stability. The control grid bias of the valve L-2 is obtained as a voltage drop across the resistor R_{14} due to the grid currents.

123. The purpose of the other elements of this stage is identical with similar elements in the master oscillator.

Power amplifier

124. The power amplifier (the output stage of the transmitter) uses the valve 4-PIL (L-1), which is shunt fed (Figure 24). The anode circuit of this amplifier $L_1 - C_3$ is close coupled with the valve L-1. The semi-variable capacitor /trimmer/ C_5 /?/ serves for the fine adjustment of the circuit after a replacement of the power amplifier valve. Its shaft is brought up through the front panel of the transceiver unit (Figure 17).

125. The anode circuit is permanently coupled with the aerial through an auto-transformer. The output power of the transmitter can be checked with the aid of a crystal diode D-1, of type KD-2J-10, which is connected to the input of the aerial cable through capacitor C_1 = 1.5 pF. Current, rectified by the crystal diode, flows through the resistor R_1 and the switch W-2 to the measuring instrument located on the front panel of the transceiver unit. C_2 is a blocking capacitor.

126. The control grid bias for the power amplifier valve is obtained from two sources. From the voltage divider $R_8 - R_9$, through the resistor R_{10} and choke L_5, a permanent negative bias of about 8.5 V is applied to the grid. This bias limits the anode current of the valve in absence of

/ excitation....

excitation. When the excitation voltage is applied to the control grid, an automatic bias develops across the resistors R_{10} and R_8 due to the grid current. As a result, the combined control grid bias during the operation of the valve L-1, is about 19 V. The capacitors C_{10} and C_{11} are the blocking capacitors.

127. To the suppressor grid of the power amplifier valve is applied a small positive potential in respect of the cathode (about 9 V), through the resistor R_5. The suppressor grid is grounded for the high frequency currents through the capacitor C_{13}.

<u>Frequency modulator</u>

128. The frequency modulator uses the valve 12ZIb (L-4), connected as a diode [sic] (the suppressor and the screen grids are connected to the anode). The diagram of the frequency modulator is shown in Figure 25.

129. The anode current flows through the resistor $R_{[?]}$. From this resistor an automatic bias is applied to the control grid of the valve (through the resistor $R_{19[?]}$ and the choke $L_{12[?]}$). As a result, the control grid has a permanent negative bias of about 5 V in relation to the cathode.

130. Due to the negative potential of the grid, electrons emitted from the cathode form around it an electron cloud [space charge]. The capacitance between this cloud and the cathode, together with the electrostatic capacitance of the valve combine into a dynamic capacitance between the grid and the cathode of the valve. The magnitude of this capacitance depends upon the supply voltages of the valve.

131. When, in addition to the permanent negative voltage, a variable voltage is applied to the grid of the valve from the modulation amplifier through the capacitor C_{42} and the choke L_{12}, then - with the increase of the grid negative potential, the electron cloud will approach the cathode and the dynamic input capacity C_{wd} of the valve will be reduced (this capacitance

/ is indicated....

is indicated on the diagram by a broken line). Conversely, when the negative potential of the grid is reduced, the electron cloud will approach the grid, and the dynamic input capacity C_{wd} of the valve will increase. The control grid of the valve is connected through the capacitor C_{36} to the grid circuit $L_{11} - C_{35}$ which determines the oscillation frequency of the master oscillator (L-3).

132. When the grid-cathode capacitance varies with the modulating voltage, the combined capacitance of the master oscillator grid circuit also varies accordingly. As a result, the frequency of the master oscillator follows the variations of the modulating voltage or, in other words, the master oscillator is frequency modulated.

133. Transmitter modulation is tested in the following way: from the anode of the valve L-4 through the capacitor C_{48} and the resistor R_{33} the variable modulating voltage is applied to two cuproxide rectifiers D-2 and D-3. In series with the rectifiers, through the switch W-2, can be connected an indicating instrument, located on the front panel of the transceiver unit. The depth of the master oscillator frequency modulation is determined by the deflection of the instrument pointer.

134. The operation of the frequency modulator valve can be controlled with the aid of the same instrument. In order to check the operation of this valve, the instrument is connected to its anode through the resistor R_{21} (at an appropriate position of the switch W-3), and it then measures the voltage drop across the resistor R_{20} in the anode circuit of the valve.

<u>The modulation amplifier of the transmitter</u>

135. The modulation amplifier of the transmitter consists of a two-stage, wide-band (400 to 15000 kc/s), low frequency amplifier, which serves for the amplification of the signals from the multiplexing unit to the magnitude required for the proper operation of the transmitter frequency modulator. Both stages are designed as resistance-capacitance amplifiers using valves 12ZIb (Figure 26), connected as triodes. This amplifier is

/ characterised....

characterised by very low non-linear distortions.

136. The overall non-linear distortion factor of the whole transmitter does not exceed 1.5% at the modulating frequency of 6600 c/s and a frequency deviation up to 10 kc/s.

137. Grid bias for the modulation amplifier valves is obtained automatically as the result of the voltage drop across the resistors in the cathode circuit of each valve. Checking the operation of the amplifier valves is done similarly as in the preceding transmitter stages.

138. At the input of the amplifier there is a potentiometer for the adjustment of the modulating voltage, and therefore for setting the required value of the frequency deviation. The shaft of this potentiometer is brought up through the front panel of the transceiver unit (Figure 17).

The radio-relay receiver

139. The high frequency signals received by the aerial are applied to the superheterodyne receiver with double frequency conversion, and with an automatic frequency control circuit, (APCz). The block diagram of the receiver is shown in Figure 27.

140. The receiver is mounted in two solid frames, one of which contains the H.F. stages, and the other the I.F. and L.F. stages (Figures 19 and 20).

141. The frame containing the high frequency stages of the receiver is similar to the transmitter frame, and contains: high frequency amplifier - 1, mixer - 2, heterodyne oscillator - 3, automatic frequency control circuit - 4, and the quartz calibrator - 5 (see Figure 27).

142. The intermediate and the low frequency stages are composed of: first intermediate frequency amplifier - 6, frequency conversion circuit - 7, second intermediate frequency amplifier - 8, amplitude limiter stage - 9, discriminator amplifier - 10, low frequency amplifier - 11, d.c. amplifier - 12.

/ 143.

143. The receiver, like the transmitter, is tuned with the aid of a single knob.

High frequency amplifier

144. The tuned high frequency amplifier is composed of two identical stages (L-1, L-2), which are shunt fed and capacitively coupled.

145. The circuit diagram of the high frequency amplifier, including the input circuit, is shown in Figure 28. The amplifier circuit coils are made on ceramic forms, like the transmitter circuit coils.

146. The input circuit is coupled to the aerial through an auto-transformer.

147. The control grid bias of each valve is obtained as the automatic grid bias due to the voltage drop across a bias resistor in the cathode circuit.

148. The high frequency amplifier ensures sufficient amplification of the signal applied to the mixer, and also attenuates the image-frequency signal of the first I.F.

Mixer

149. The mixer (L-3) operates as a two grid frequency converter (Figure 29). The signal voltage from the high frequency amplifier second stage anode circuit is applied through the coupling capacitor C_{16} to the control grid of the mixer valve L-3. At the same time, the voltage from the heterodyne /local/ oscillator (L-5) is applied to the suppressor grid of this valve. In this case the suppressor grid of the mixer valve works as a second control grid.

150. In the mixer there takes place the conversion of the high frequency oscillations (66 to 70 Mc/s) of the received signal, into the first intermediate frequency oscillations of 6.6 Mc/s.

/ 151.

151. A band-pass filter in the anode circuit of the mixer valve (L-3) is composed of two circuits: L_6C_{25}, and L_7C_{27} coupled together through the capacitor C_{26}. Each circuit is separately screened. Screening shields serve also for the air-tight sealing of the circuits. The anode circuit coils have carbonyl powder cores. The first intermediate frequency voltage is brought from the circuit L_7C_{27} through a coaxial cable type RK-19 to the control grid of the valve (L-7) of the first intermediate frequency amplifier.

152. The grid bias for the control and the suppressor grids of the mixer valve is obtained automatically as a result of the voltage drop across the cathode resistors R_{10} and R_{11}.

Heterodyne /local/ oscillator

153. The heterodyne /local/ oscillator (L-5) is designed and operates in the same way as the master oscillator of the transmitter (Figure 22).

154. The suppressor grid voltage for the mixer valve (L-3) is taken from the anode circuit of the heterodyne oscillator.

155. The heterodyne /local/ oscillator of the receiver operates in the frequency range of 59.4 to 63.375 Mc/s.

First intermediate frequency amplifier

156. The first intermediate frequency voltage from the anode circuit of the mixer valve L-3 is applied through the separating capacitor C_{62} to the control grid of the valve L-7 of the first intermediate frequency amplifier (Figure 30). As a load in the anode circuit of the valve L-7 serves the band-pass filter composed of two sections: $L_{20}C_{64}$, and $L_{21}C_{66}$. Circuits of this filter are built in the same way as the anode circuits of the mixer. The control grid bias is obtained automatically as a result of the voltage drop across the resistor R_{32} in the cathode circuit of the valve L-7.

/ Second frequency....

Second frequency conversion circuit

157. The valve L-8 of the second frequency conversion circuit operates simultaneously as a second mixer and as a second, quartz stabilised, heterodyne [local] oscillator. The circuit diagram of the second frequency conversion stage is shown in Figure 31. The quartz crystal unit is connected between the control grid and the screen grid which acts here as the heterodyne oscillator anode. The quartz crystal frequency is 7.060 Mc/s. As a result of the action on the control grid of the valve L-8 of the first intermediate frequency oscillations, and of the quartz crystal natural vibrations of a frequency of 7.060 Mc/s, there appear in the valve anode difference frequency oscillations of 460 kc/s, which is the second intermediate frequency. The second intermediate frequency oscillations are selected and transmitted through the anode circuit filter composed of ten sections, and tuned to the frequency of 460 kc/s. The pass band and the necessary intervals between the operating wavelengths of the receiver are basically determined by the resonance curve [characteristic] of this filter. The pass band of the receiver, when the signal amplitude drops to half its value, is 48 kc/s, and when it drops to 1/1000 of its value - 90 kc/s [sic]. The ten section filter is built as a single, small, hermetically sealed box.

158. The control grid bias for the valve L-8 of the second conversion circuit is automatically obtained as a result of the voltage drop of the grid current across the resistor R_{42}.

Second intermediate frequency amplifier

159. In the three stage second intermediate frequency amplifier the first and the third stages (L-9, L-11) are identical. The load of each stage consists of a single resonant circuit. The circuit diagram of the WPCz-2 (second intermediate frequency amplifier) is shown in Figure 32. The second stage of the amplifier L-10 is loaded with two screened circuits coupled by the capacitor C_{98}. The circuit of this stage is similar to the circuit of the first intermediate frequency amplifier (Figure 30). In order to extend the pass band frequency range, all the circuits of the second intermediate

/ frequency...

frequency amplifier are shunted with additional resistances.

Amplitude limiter

160. The amplitude limiter stage circuit operates with grid detection and at reduced anode and screen voltages of the valve L-12 (about 50 V). The circuit diagram is shown in Figure 33. In proportion to the increase of the intermediate frequency voltage applied to the control grid of the limiter valve through the capacitor C_{103}, the negative grid bias increases. This bias develops across the resistor R_{62} due to the grid current. As the anode and the screen grid voltages are relatively low, the valve anode current soon attains its saturation value, reducing therefore the average value of the slope of the anode current characteristic of the valve, hence also reducing the amplification of the stage.

161. At a higher intermediate frequency voltage, the negative bias of the control grid increases, and the limiter begins to operate near the cut-off value of the anode current. The d.c. component of the anode current is then reduced, and therefore the anode and the screen grid voltages rise. As a result, the average value of the slope of the anode current characteristic, and the valve saturation current remain constant at all the intermediate frequency voltage values above the so called limiting threshold (Figure 34). Beyond the limiting threshold therefore, even a considerable rise in the intermediate frequency voltage (the received signal voltage) does not increase the voltage in the anode circuit of the limiter.

162. Similar to the above amplitude limiter is the operation of the second intermediate frequency amplifier valves L-11, L-10 and L-9 (at a high signal level at the receiver input), and also of the first intermediate frequency amplifier valve L-7, resulting in a constant signal value at the input of the frequency detector.

Frequency detector /discriminator/

163. The discriminator (L-13 and L-14) converts the frequency modulated second intermediate frequency oscillations into low frequency

oscillations. ....

oscillations. The circuit diagram of the discriminator is shown in Figure 33. The discriminator circuit uses two valves type 12ZIL connected as diodes (all the grids are short-circuited with the anode).

164. In the anode circuit of the amplitude limiter valve L-12 there is a resonant circuit composed of two coils L_{36} and L_{38} connected in series, and of the capacitors C_{110} and C_{108}. This circuit is tuned to the second intermediate frequency of 460 kc/s. The resistor R_{67} serves for widening the pass band of this circuit. With this circuit are inductively coupled two more circuits: the circuit $L_{37}C_{112}$ tuned to the frequency of 490 kc/s, and the circuit $L_{39}C_{114}$ tuned to the frequency of 430 kc/s. When an unmodulated signal is applied to the discriminator, then the voltages of the second intermediate frequency developed across the circuits $L_{37}C_{112}$, and across the circuit L_{39} and C_{114} are equal. These voltages are applied to the diodes L-13 and L-14. Currents rectified by the diodes will develop across the resistors R_{68} and R_{69} d.c. voltages of equal value but of opposite sign. The resultant voltage in the load between point A and the earth in this case will be zero.

165. If, on the other hand, the second intermediate frequency oscillations are frequency modulated, then with the change of frequency in any direction, voltages across $L_{37}C_{112}$ and across L_{39} and C_{114} will not be equal. In the case of a frequency increase ($460 + \Delta f_t$), voltage across the upper circuit $L_{37}C_{112}$ will be higher than the voltage across the lower circuit. As a result, current rectified by the upper diode L-13, and consequently the voltage across the resistor R_{68} will be higher than the current rectified by the lower diode and the voltage across the resistor R_{69}. In this manner, with an increase of frequency, point A will acquire a negative potential in relation to earth. In the case of a frequency decrease ($460 - \Delta f_t$) voltage rectified by the lower diode L-14 will predominate, and as a result

/ point A ....

point A will acquire a positive potential in relation to earth. The magnitude of the potential difference between point A and the earth varies in proportion to the magnitude of frequency deviation Δf_t.

166. The discriminator characteristic shown in Figure 35 shows the dependence of the resultant voltage values between the point A and the earth on the frequency deviations on both sides of the average frequency.

167. From the output of the discriminator (from point A), the low frequency voltage is applied to the low frequency amplifier through the capacitor C_{117}. From the same point, voltage is applied to the receiver automatic frequency control circuit.

<u>Low frequency amplifier</u>

168. The low frequency amplifier utilises valve L-15 (Figure 36) with transformer output. The low frequency voltage is applied from the discriminator load (point A, Figure 33) through the capacitor C_{117} to the voltage divider $R_{72} - R_{73}$, and from the resistor R_{73} of this divider to the control grid of the valve L-15. From the secondary winding of the step-down transformer Tr_1 (7:1) in the anode circuit of the valve, the low frequency signals are applied to the input of the multiplexing unit (Block 2).

169. The control grid bias for the valve L-15 is obtained automatically from the voltage drop across the resistor R_{75} in the cathode circuit. The valve L-15 operates as a triode (the screen and the suppressor grids being short-circuited to the anode), in order to reduce the non-linear distortions.

<u>Automatic frequency control circuit of the receiver</u>

170. The automatic frequency control circuit (APCz) is used for the purpose of reducing the de-tuning of the receiver frequency in relation to the transmitter frequency. It also eliminates the need for manual fine tuning corrections. The voltage across the discriminator load $R_{68} - R_{69}$ (Figure 33, point A), is applied to the control grid of the d.c. amplifier valve L-16 through a filter composed of the resistor R_{70} and the

/ capacitor C_{118}...

capacitor C_{118} (Figure 37). The time constant of this filter is so chosen that the AFC circuit does not respond to brief de-tunings due to the carrier frequency modulation. The AFC circuit can, therefore, operate during reception of frequency modulated signals.

171. The magnitude and the sign of the controlling voltage depends upon the magnitude and direction of the intermediate frequency de-tuning in relation to the average resonant frequency of the discriminator circuits (mid-frequency of the receiver pass band).

172. The d.c. amplifier uses the valve L-16. This amplifier serves for the increase of the AFC circuit regulation factor. The valve of the d.c. amplifier is connected as a triode. In order to prevent the AFC circuit reacting to the low frequency signals, in addition to the large time constant filter R_{70} - C_{118}, connected to the amplifier input, the anode of the valve L-16 is shunted with the large capacity of C_{104}. From the anode of the valve L-16 the amplified d.c. voltage is applied to the control grid of the frequency control valve L-6 through the potentiometer R_{57}, the switch W-7, and the resistor R_{27} (Figure 38). In order to compensate the positive voltage applied to the control grid of the valve L-6 from the anode of the valve L-16, a compensating voltage of 45 V is applied to the potentiometer R_{57} from a special supply source. The accurate compensation of the positive voltage is carried out with the aid of the potentiometer R_{57} located on the left-hand side wall of the WPCz (I.F. amplifier) of the receiver (Figure 20).

173. The automatic frequency control stage is connected to the grid circuit of the heterodyne oscillator through the separating capacitor C_{49} (Figure 38). The principle of operation of this stage is the same as that of the transmitter frequency modulator, which was described above. The voltage applied from the discriminator to the grid of the frequency control stage varies the frequency of the first heterodyne oscillator in such a way that the initial de-tuning between the receiver and the transmitter is reduced.

174. The automatic frequency control circuit of the R-401 station operates during de-tuning in the range of ± 25 kc/s. The final de-tuning when this circuit is operating does not exceed 3.5 kc/s.

Quartz calibrator

175. The quartz calibrator is used for the correction of the transmitter and the receiver frequencies after replacing the master oscillator and the modulator valves in the transmitter, after replacing the heterodyne oscillator and the frequency control stage valves in the receiver, and also during periodical testing of the frequency calibration and accuracy of setting of the transmitter and the receiver. A quartz calibrator is an integral element of any transmitting and receiving equipment. The valve (L-4) used in the circuit is of type 12ZIL connected as triode (Figure 39). The quartz crystal is connected between the anode and the control grid of the valve. The natural frequency of the quartz crystal equals half the first intermediate frequency of the receiver f_{kw} = 3.3 Mc/s. The anode circuit load consists of the resistor R_{19}. The switching on and off of the quartz calibrator is done with the switch W-5 located on the front panel of the transceiver unit. When the quartz generator starts oscillating, across the resistor R_{19} there appears a voltage of the natural frequency of the quartz crystal f_{kw}, and its harmonics nf_{kw}, where n is the order of harmonic, an integer. This voltage from the resistor R_{19} is applied to the grid circuit of the valve L-7 of the first intermediate frequency amplifier, and also to the receiver input. After amplification in the high frequency amplifier and conversion in the mixer (L-3), the 20th harmonic of the quartz crystal (for the first operating frequency), or the 21st harmonic of the quartz crystal (for the 45th operating frequency) is combined with the receiver heterodyne oscillator f_h, and produces the first intermediate frequency $f_{1-posr.} = nf_{kw}$ giving a voltage across the anode load of the mixer (L-3).

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176. The first intermediate frequency (f_{1-posr}) and the second harmonic of the quartz frequency ($2\ f_{kw}$), coming from the intermediate frequency amplifier, are combined after detection and produce a beat frequency at the output of the telephone channel. From the tone of the beats it is possible to estimate the degree of de-tuning of the first heterodyne oscillator of the receiver. When the receiver heterodyne oscillator is tuned accurately, a zero beat is obtained in the first telephone channel. The beats, the frequency of which does not exceed 500 c/s, are audible in the first telephone channel. If the beat frequency exceeds 4.5 kc/s, than it is audible in the second telephone channel. It is necessary to bear in mind that in this case, as the heterodyne oscillator de-tuning is being reduced, so the beat tone frequency in the second telephone channel will increase, because in this channel use is made of the lower side band frequency of the modulated carrier spectrum (see Chapter I).

4. Multiplexing Unit

177. In the multiplexing unit (Block 2) are assembled the telephone and the telegraph channel circuits. In addition, in this unit are located: the "talk-call" device, (URW); the audio calling signal generator (GZA); the calling signal converter (ZZ); and the d.c. vibrator converter of the line circuits. The voltages and currents in the various circuits, and the operating data for the multiplexing unit valves are given in Appendices 4 and 5.

Construction of Block 2

178. As a constructional base of the multiplexing unit use is made of an aluminum casting (chassis), to which the front panel is attached with bolts. In order to facilitate repairs, the front panel can be unscrewe 50X1-HUM removed from the chassis. For this purpose, the connections between the elements located on the chassis and the elements located on the front panel

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are made of flexible and specially lengthened wiring. The elements of the telephone channels are located on the left hand side, and the elements of the telegraph channels on the right hand side of the chassis and of the front panel of the unit. The external view of the unit is shown in the Figures 40, 41, 42, 43. The most important elements of the multiplexing unit (filters, oscillator and discriminator circuits, transformers, etc.) are hermetically sealed.

179. The housing of the unit is made of duraluminium sheet. On the rear wall there are holes for the half-connectors of the connecting cables.

180. The dimensions of the multiplexing unit including the housing are: 370 x 285 x 415 mm. Weight of the unit: 38 kg.

<u>The first telephone channel</u>

181. The first telephone channel is the natural speech frequency channel and occupies the frequency band of 400 to 2500 c/s.

182. The block diagram of the first telephone channel is shown in Figure 44. The connections shown in this diagram represent operation as a terminal station, with a two-wire input. The two-wire line coming from the telephone exchange is connected through the line panel (not shown in Figure 44), through the mode of operation switch W-1, the talking key K-1, the transit attenuator T_1 (0.5 N), to the hybrid junction unit (UR). The signal from the exchange, after passing through the hybrid junction unit, through the amplitude limiter, through the attenuator (1.8 N), through the switch W-3, through the low frequency filter F-I with a band-pass up to 2500 c/s, is applied at the level of - 4.2 N to the input of the modulation amplifier of the transmitter.

183. From the output of the radio-relay receiver, the signal of the level of + 0.7 N, after passing through the attenuator 0.5 N, the low frequency filter F-II with a band-pass up to 2500 c/s, and the attenuator T (1.8 N),

/ is applied....

is applied to the input of the low frequency amplifier. Into the anode circuit of the valve L-1 of this amplifier is inserted the level indicator WP, for checking of the channel output level. From the output of the amplifier, the signal, after passing through the mode of operation switch W-1, the attenuator T_5 (1.3 N), the hybrid junction unit UR, the attenuator T_1, the talking key K-1, and the mode of operation switch W-1, enters at the level of - 2 N into the two-wire line.

184. Let us consider now the path of the calling signal with a two-wire channel input. The magneto calling signal sent by the telephone exchange through the two-wire line, arrives through the switch W-1 to the receiver of the magneto calling signal OZI, and activates the relays P_1 and P_2 (see Figure 49). This connects the audio calling signal generator GZA to the transmitting part of the channel, and the audio calling signal of 800 c/s is applied to the input of the transmitter modulation amplifier.

185. From the output of the radio-relay receiver, the calling signal of 800 c/s is applied to the input of the low frequency amplifier, just as in the case of the telephone speech signal. In the anode circuit of the valve is the audio calling signal receiver OZA, which activates the relays P_3 and P_4 when the alternating voltage of 800 c/s is applied to it 50X1
As a result, the voltage of + 12 V is applied to the relay P_3, which activates the calling signal converter ZZ and connects it to the two-wire line leading to the exchange.

186. With a four-wire channel input with re-transmission of the magneto calling signal, the channel mode of operation switch W-1 should be set in position 3. In this case, the two-wire input terminals serve for reception only, and an additional pair of terminals is used for transmission.

/ 187.

187. Let us consider in turn the speech and the calling signal path with a four-wire telephone channel input. In this case the subscriber's calling signal arrives at the terminals "4-ro przew.nadaw."["4-wire transmission"], and from there, through the switch W-1 (contact 3) and the talking key K-1, is applied to the hybrid junction unit UR, and then to the input of the transmitter modulation amplifier, as in the case of the two-wire channel input. The signal arriving from a distant operator is applied to the input of the low frequency amplifier from the receiver output, similarly as in the case described above. From the amplifier output, this signal, through the switch W-1 (contact 3), and the attenuators T_3, T_4 arrives at the terminals "4-ro przew.odb." ["4-wire reception"], and from there, through the two-wire line is brought up to the subscriber.

188. The magneto calling signal arriving from the subscriber to the terminals "4-ro przew.nadaw." ["4-wire transmission"] is applied through the switch W-1 to the magneto calling signal receiver OZI. This will activate the relays P_1 and P_2, and the audio calling signal generator GZA will be connected to the input of the transmitter modulation amplifier, as described above.

189. The 800 c/s calling signal from the subscriber, after passing the receiving part of the channel, is brought to the audio calling signal receiver OZA, activates the relays P_4 and P_5, and as a result, the calling signal is sent into the line from the calling signal converter through the terminals "4-ro przew.odb." ["4-wire reception"].

190. In the case of the 4-wire channel input without re-transmission of the magneto calling signal, the channel mode of operation switch W-1 is set in position 2. This kind of operation is intended for the case of secondary multiplexing of the telephone channel by the telegraph channels with the aid of type P-313 equipment. In this case, in the transmitting part of the

channel, the amplitude limiter stage is switched off /disconnected?/ , and in the receiving part of the channel, the audio calling signal receiver OZA is so switched off /disconnected?/. On the transmitting side, the signal follows the following path: from the terminals "4-ro przew.nadaw." /"4-wire transmission"/, through the switch W-1 (contact 2), the attenuators T_1 and T_2, to the hybrid junction unit UR, from its output, through the contact 2 of the switch W-1, through the attenuator 1.8 N, the switch W-3 and the low frequency filter F-I, to the transmitter input.

191. From the receiver output the signal is brought up to the low frequency amplifier, and from there, through the switch W-1 (contact 2), the attenuator T_3, and switch W-1 (contact 2), it is applied to the terminals "4-ro przew.odb." /"4-wire reception"/.

192. With a two-wire telephone channel connection of the R-401 station to the telephone channel of the type P-310 equipment, or to the R-400, the switch W-2 should be set in position "Tranz.", which disconnects the attenuator T_1. In this case the speech and the calling signal pass in both directions in the same way as during the operation of the channel with a two-wire input.

193. The audio calling signal generator GZA, the calling signal converter ZZ, and the "talk-call" circuit URW, are common to both telephone channels.

194. The "talk-call" circuit makes possible the monitoring of the telephone channel communication, as well as the making of service calls between the radio-relay stations, and also between the stations and the telephone exchanges.

195. In order to provide the required stability of channel operation the re-transmission at the intermediate station is carried out by means of the 4-wire circuit. In this case the switch W-3 is set to the position

/ "Retr.",

"Retr.", and the switch W-1 to the position 1 ("2 przew.TF"). At such a position of the switches, the signal from the output of the filter F-II in the receiving part of the channel is brought to the second half-set. During re-transmission, the signal arriving from the receiver of the second half-set is fed into the attenuator 4 N, and then, after passing the low frequency filter F-II is applied to the input of the first half-set transmitter modulation amplifier. In the receiving part of the channel, the low frequency amplifier is connected through the attenuator 1.8 N to the audio calling signal receiver. In this way provision is made for the reception of the calling signal at the intermediate station.

196. If it is necessary to answer when the intermediate station receives a calling signal, then the switch W-3 should be set to the position of operation of the particular channel as a terminal station. With the aid of the "talking" key K-1, the "talk-call" circuit is connected towards the subscriber radio-relay station, and the conversation can be carried out. In order to send a calling signal from an intermediate station, the switch W-3 should also be set to the position of operation as a terminal station.

The hybrid junction unit

197. The hybrid junction unit serves for transition from a four-wire circuit into a two-wire line connecting the station with a telephone exchange. It enables the passage of the voice currents from the telephone exchange to the transmitter modulation amplifier only, and also the voice currents from the receiver - towards the telephone exchange only (Figure 45).

198. The hybrid junction unit is composed of a differential transformer $Tr_{1(10)}^{*}$, of a balancing network $R_{10(52)}$ $C_{2(51)}$, of the attenuator $T_{1(6)}$ in

/ the two....

* The figures in brackets indicate the numbering of the appropriate elements of the second telegraph channel.

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the two-wire side, of the transfer attenuator $T_{2(7)}$, and of the receiving side attenuator $T_{5(10)}$. In order to simplify the diagram, Figure 45 does not show the details of the connections between the attenuators $T_{1(6)}$ and $T_{2(7)}$ as this has already been described during the examination of the first telephone channel block diagram (Figure 44).

[Two pages of original and Figures 46, 47, 48 missing]

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199. By means of the potentiometer $R_{20(61)}$, the shaft of which is brought up through the front panel, the output level of the telephone channel can be adjusted. The calling signal voltage is applied to the control grid of the valve L-1(2) from the potentiometer $R_{20(61)}$ through the transformer $Tr_{5(14)}$. In the amplifier is applied a negative feedback due to the fact that the cathode resistors $R_{16(58)}$ and $R_{15(57)}$ are not shunted by the capacitors. The resistor $R_{15(57)}$ serves for checking [controlling] the operation of the valve L-1(2).

200. In the anode circuit of the valve there are two transformers connected in series. Transformer $Tr_{4(13)}$ is the audio calling signal receiver input transformer, and the transformer $Tr_{3(12)}$ is the amplifier output transformer. When the channel is operating in a two-wire system - the winding 3 - 4 of this transformer is connected to the hybrid junction unit; during operation in a four-wire system the windings 3 -4 and 5 - 6, connected in series, form the channel output. Winding 7 - 8 serves for the connection to the "talk-call" circuit URW, which operates in a four-wire circuit.

201. Part of the alternating voltage from the windings 3 - 4 and 5 - 6 is applied through the resistor $R_{11(53)}$ to the cuproxide rectifier D-4(10), which can be connected to the measuring instrument for the adjustment of the telephone channel output level.

The audio calling signal receiver

202. In parallel with the transformer $Tr_{4(13)}$ are two resonant circuits connected in series: one is a series resonant circuit $L_{2(19)}$, $C_{6(55)}$, the other is a parallel resonant circuit $L_{1(18)}$, $C_{5(54)}$. They are both tuned to the frequency of 800 c/s These circuits 50X1 are connected to the cuproxide rectifiers D-5(11) and D-6(12), the load of which consists of the polarized relay winding $P_{5(12)}$. The above circuit operates in the following way: on the arrival of the 800 c/s calling signal, the current in the relay winding connected to the parallel resonant circuit is at its maximum, and the current in the relay winding connected to the series resonant circuit is at its minimum. As a result, the arm of the relay $P_{5(12)}$ moves towards the contact L and shunts the relay $P_{4(11)}$. The arm of the relay $P_{4(11)}$ is released and closes the 12 V circuit comprising the pilot (signal) lamp $LN_{2(4)}$, and the additional relay $P_{3(10)}$.

203. The relay $P_{3(10)}$ disconnects the hybrid junction unit from the two-wire output, and connects it to the 600 ohms resistance. It also activates the calling signal converter, and connects it to the line connecting the station with the telephone exchange. In this way, on the reception of the calling signal from the radio-relay station, the red pilot /indicator/ lamp $LN_{2(4)}$ lights up, and a 20 to 30 c/s alternating current calling signal is sent into the line.

204. For all the frequencies different from 800 c/s, the current in the relay $P_{5(12)}$ winding connected to the series resonant circuit will be higher than at 800 c/s, and as a result the relay arm will be either at the

/ idle contact...

idle contact or in a neutral position. To prevent the possibility of sending a calling signal by the voice frequency currents, the calling signal receiver acts with a delay. This is obtained by the means of the delayed release of the relays $P_{4(11)}$ and $P_{5(12)}$ [?] (which have short-circuited windings).

The magneto calling signal receiver

205. The output of the magneto calling signal receiver is connected in parallel to the two-wire channel input terminals, or to the transmitter terminals with four-wire system operation (Figure 49). The magneto calling signal coming from the line, is applied through the choke $Dl_{1(4)}$ to the selenium rectifier bridge circuit D-1(7). The choke $Dl_{1(4)}$ presents a high impedance to the voice frequency currents, and so prevents the shunting of the speech circuit. For the 20 to 30 c/s frequency calling signal currents, this choke does not present practically any impedance. On reception of the magneto calling signal, the current rectified by the rectifier circuit D-1(7) flows through the winding of the relay $P_{1(8)}$. This relay closes the contacts which supply the voltage of + 12 V to the pilot [indicator] lamp $LN_{1(3)}$ and to the winding of the relay $P_{2(9)}$. As a result of the closing of appropriate contacts in the relay $P_{2(9)}$, the voltage + 12 V is applied to the windings of the bell Dz_1. At the same time the audio calling signal generator is connected to the transmitting part of the channel.

206. In this manner, when the magneto calling signal arrives from the exchange, the green pilot [indicator] lamp $LN_{1(3)}$ lights up, the bell Dz_1 rings, and a calling signal is sent by the radio-relay station. The frequency of this calling signal is 800 c/s, as the radio-relay does not transmit the 20 to 30 c/s frequency signals.

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The audio frequency calling signal generator

207. The audio frequency calling signal generator GP, which serves also for measurement purposes, is common to both telephone channels. This generator operates continuously, and is connected to the transmitting part of the telephone channel (Figure 49) when the calling signal is to be sent through this channel from the telephone exchange, and also when the calling signal or a measuring signal is sent from the radio-relay station.

208. The audio frequency calling signal generator (Figure 50) has a resonance circuit $L_{23}C_{68}$ between the control grid and the cathode of the valve L-3, and generates 800 c/s frequency oscillations. When a calling signal is sent, or during measurements in the first telephone channel, the voltage with f = 800 c/s is taken from the winding 5 - 6, and in the second telephone channel - from the winding 7 - 8 of the transformer Tr_{15}. The generator output level can be adjusted with the potentiometer R_{62} in the anode-screen circuit of the valve L-3.

209. The instrument indicating the measurement signal level in the first telephone channel is connected to the terminals ΠE, and in the second telephone channel - to the terminals ZZ.

The calling signal converter

210. The calling signal converter is common to both telephone channels. When the calling signal is being transmitted, or the magneto calling signal is being re-translated, the calling signal converter is switched with the aid of the relay $P_{3(10)}$ /?/ into the line of the particular channel. The converter consists of two relays, of the transformer Tr_8, and of the filter and spark-quenching circuits. The calling signal converter is supplied with a d.c. voltage of 12 V. The 20 to 30 c/s alternating current is obtained from the secondary winding of the transformer Tr_8. The converter gives a voltage of 70 V across a resistance of 2000 ohms.

/ Low frequenc-

Low frequency filters

211. The circuit diagrams and the characteristics of the low frequency filters F-I and F-II of the first telephone channel are identical. Induction coils of these filters are wound on alsifer rings of type TCzK-53 /? indistinct7. The filters have mica capacitors, and are hermetically sealed. The wave impedance of the filters is 600 ohms. As the first telephone channel occupies the frequency band from 400 to 2500 c/s, the low frequency filters for this channel are designed for the pass band up to 2500 c/s.

212. The filter attenuation for the frequencies of other channels of the station is not less than 6.8 N. The attenuation characteristic of the filter is shown in Figure 51 (curve 1).

The second telephone channel

213. The second telephone channel is an ultrasonic, or carrier, channel. The speech frequency band (400 to 2500 c/s) transmitted through this channel is first converted into an appropriate higher frequency band (4900 to 7000 c/s), which is then transmitted by the radio-relay channel.

214. The arrangement of the input circuits and connections of the second telephone channel, from the two-wire and the four-wire hybrid junction unit, is the same as in the first telephone channel (Figure 44). As far as the circuit diagram is concerned, the second telephone channel differs from the first channel only by the design of the transmitting and the receiving portion. The block diagram of the second telephone channel from the input of the hybrid junction unit, is shown in Figure 52.

215. The telephone speech signals, which occupy the frequency band from 400 to 2500 c/s, from the output of the hybrid junction unit, and after passing through the amplitude limiter stage and the attenuator T_{11} /?7, are applied to the ring-type modulator, to which are also applied 7.4 kc/s

/ oscillations....

oscillations from the local oscillator G. In the ring-type modulator, the amplitude of the oscillations of the generator G is modulated by the telephone speech signal. The lower side-band of the amplitude modulated oscillations 4.9 to 7 kc/s (see Figure 2) is separated with the aid of the band-pass filter F-III. The lower side-band frequency oscillations separated by the band-pass filter are applied to the input of the modulation amplifier of the transmitter.

216. During reception, the oscillations of the 4.9 to 7 kc/s frequency band of the second telephone channel are brought up from the receiver output through the band-pass filter F-IV and the attenuator T_{14} to the ring-type demodulator "Dem". At the same time, to the demodulator are applied the 7.4 kc/s oscillations from the local generator G. In the demodulator "Dem" the 4.9 to 7 kc/s frequency band oscillations are converted into the 400 to 2500 c/s frequency band oscillations (corresponding to the transmitted telephone speech) which, after being separated with the aid of the filter F-V, are applied to the input of the low frequency amplifier. From the amplifier, the amplified signals are sent to the subscriber, like the signals in the first telephone channel.

217. For the calling signal transmission through the second telephone channel use is also made of the 800 c/s frequency signal which, however, is converted in the modulator into a signal of 6600 c/s. In the receiving side, the 6600 c/s frequency signal is re-converted back to the 800 c/s frequency signal, which then activates the audio frequency calling signal receiver, as in the first telephone channel.

218. The re-transmission of the second telephone channel at the intermediate station is carried out without the re-conversion of the signal frequency band (without demodulation), i.e., at the frequency band of 4.9 to 7 kc/s.

219. The circuit diagram, the principle of operation, and the electrical parameters of the magneto calling signal receiver (Figure 49), of the amplitude limiter stage of the attenuators in the input circuits, of the hybrid junction unit (Figure 45), of the low frequency amplifier with the level indicator WP and the audio frequency calling signal receiver OZA in the second telephone channel, are the same as for the respective units and circuits in the first telephone channel. 50X1 50X1

The modulator

220. For the conversion of the speech frequency band in the second telephone channel, a ring-type modulator is used, composed of the transformers Tr_{16} and Tr_{17}, and of the cuproxide rectifiers D-15 (Figure 53). The cuproxide rectifiers D-15 are connected /in series/ to form a ring, hence the name. Let us examine the principle of speech frequency band conversion in a ring-type modulator.

221. An audio frequency voltage is applied to the winding 1-2 of the input transformer Tr_{16} (Figure 55a), and a 7.4 kc/s frequency voltage from the generator G is applied to the central points of the windings 5 - 6 of the transformers Tr_{16} and Tr_{17} (Figure 55b).

222. The resistance of the cuproxide rectifiers in one direction is very low, and in the opposite direction is very high. The 7.4 kc/s frequency voltage from the generator periodically alters the resistance of the modulator rectifiers in such a way that at the positive half-cycle of the voltage the current passes through the rectifiers in the longitudinal branches (Figure 54a), and at the negative half-cycle - the current passes through the rectifiers in the diagonal branches (see Figure 54b). As a result, the audio frequency current flows through the primary winding of the transformer Tr_{17}, and also through its secondary winding and the load resistor $R_{obc.}$ in one direction at the position half-cycle of the voltage of

/ the generator....

the generator G, and in the opposite direction at the negative half-cycle of this voltage. In this respect, the operation of the ring-type modulator can be compared to the operation of a current reversing switch, the rate of reversal of which equals 7.4 kc/s.

223. ...... [Two lines missing] at the modulator output alternates with a frequency of 7.4 kc/s, and its amplitude varies according to the audio frequency voltage which is applied to the modulator input. This means that amplitude modulated oscillations are obtained at the output of the ring-type modulator. The lower side-band frequency signal (4.9 to 7 kc/s) is separated with the aid of the band-pass filter F-III, and is then applied to the input of the transmitter modulation amplifier (Figure 52).

224. [First line illegible, but perhaps as follows: "To ensure the symmetry of"] the modulator circuit, thus eliminating the undesired 7.4 kc/s voltage, a balancing variable resistor R_{79} [?] has been employed at its output in the circuit.

225. The attenuation introduced by the modulator at the conversion of the speech frequency band is about 0.8 N.

The demodulator

226. The demodulator D-16 serves for the conversion of the 4.9 to 7 kc/s frequency band oscillations arriving from the receiver output, into the audio frequency band of 400 to 2500 c/s. The frequency conversion process which takes place in the demodulator is the reverse of the process taking place in the modulator. For this reason, the demodulator circuit diagram and the principle of operation do not differ from the circuit diagram and the principle of operation of the modulator (Figures 53, 54, 55). The only difference is that the demodulator does not require the balancing potentiometer. The 7.4 kc/s voltage is applied .... [two and a half lines missing] introduced by the demodulator during the frequency conversion of the received signals is about 0.5 N.

/ The generator

The generator

227. The 7.4 kc/s frequency generator operates as an electron coupled oscillator (Figure 56). Such a circuit gives high frequency stability, and also ensures that the load impedance does not greatly affect the frequency of the generated oscillations. The frequency of the generator oscillations depends on the parameters of the grid circuit $L_{24}C_{64}$. The resistor R_{76} serves for checking the operation of the valve L-4. In the valve anode circuit there is a resonant circuit $L_{25}C_{67}$, which is inductively coupled with the modulator (winding 3 - 5), and with the demodulator (winding 4 - 7). The generator resonant circuits are hermetically sealed.

The filters

228. The circuit diagrams and the characteristics of the band-pass filters F-III and F-IV of the second telephone channel are identical. These filters are designed for passing the frequency band within the limits of 4700 and 7000 c/s. For the frequencies of other channels they introduce an attenuation of not less than 5.8 N.

229. The characteristic of the second telephone channel band-pass filter is shown in Figure 51 (curve 2).

230. The second telephone channel low frequency filter F-V passes frequencies up to 2500 c/s.

231. /One or two words obliterated - "The filters?/ are wound on alsifer rings TCzK-55 /or 53?/. The filters use mica capacitors. Filters of the second channel are hermetically sealed. The rated characteristic impedance value of the filters is 600 ohms.

The "talk-call" unit

232. The "talk-call" unit (URW) serves for carrying out the service calls /conversations/ through any telephone channel between the radio-relay stations, or between a radio-relay station and a telephone exchange station,

and also....

and also permits the checking of the quality of communication in both telephone channels.

233. The "talk-call" unit is composed of the following elements: the "talking" keys K_1 and K_4 (one in each channel), the checking key K_2, the calling signal K_3, the bell Dz_1, the telephone hand-set MKT, and the auto-transformer Tr_9 [?].

234. During operation as a terminal station with two-wire channel input, the "talk-call" unit is connected into the channels also as a two-wire unit. The "talk-call" unit URW operates as follows: when the key K_1 (or K_4 in the second telephone channel) is set to the position "Centrala" ["Exchange"] or "Kan.rad." ["Radio channel"], the two-wire circuit between the input of the particular channel and the hybrid junction unit is disconnected (Figure 44), and at the same time the telephone hand-set of the URW is connected towards the telephone exchange or towards the radio-relay through the auto-transformer Tr_9 [?]. The microphone is energised through the contacts of the "talking" key. In this case, when the calling signal arrives from the disconnected direction, the appropriate pilot [indicator] lamp lights up, and the bell rings. The calling signal does not pass any further.

235. In order to send the calling signal from the URW, the calling signal key K_3 should be set in position "Zew" ["calling signal"]. Key K_1 (or K_4) in this case should be in a position corresponding to the direction where the calling signal is to be sent ("Centrala" or "Kan.rad.").

236. With the aid of the checking key K_2 the earphone of the telephone of the hand-set of the URW can be connected in parallel to either telephone channel, and thus to check the transmission of the telephone conversation without interfering with the communication in the other channel.

/ 237.

237. When the station operates as intermediate, in order to carry on a service conversation between the stations, the particular channel should be switched on to terminal operation with the aid of the switch $W_{3(7)}$, and the URW should be connected to this channel with the aid of the key $K_{1(4)}$. The mode of operation switch of the particular channel should be in the position "2 TF".

238. /Some words obliterated/ checking key K_2.

239. The "talk-call" unit enables one to maintain service communication with the telephone exchange when the station transmitter and receiver are disconnected.

The telegraph channels

240. The telegraph channels are ultrasonic. Their operation is based upon the principle of telegraph pulse transmission with the aid of frequency modulated oscillations. The block diagrams of both channels are identical. The principle of telegraph pulse transmission with the aid of frequency modulated oscillations was described in Chapter I. The frequency bands occupied by the telegraph channels within the frequency spectrum transmitted by the radio-relay are shown in Figure 2.

241. The telegraph channel is composed of a transmitter receiver, and of a line unit. The transmitter serves for the conversion of d.c. pulses coming from the line into frequency modulated oscillations. It consists of a relay PN, an ultrasonic frequency generator G, a matching attenuator T, and a band-pass filter FTG (Figure 57).

242. The receiver serves for the conversion of the received frequency modulated oscillations into d.c. pulses. It consists of a receiving filter FTG, an amplifier (which is also an amplitude limiter), a frequency detector /discriminator/, cuproxide rectifiers, and a receiving relay PO (Figure 58).

243. /Some words obliterated/ connects the line circuits with the ultrasonic circuits.

The ultrasonic frequency generator

244. The ultrasonic frequency generator operates with inductive coupling /feed-back/. The resonant circuit is in the grid circuit of the valve, and is composed of the coils L, $L_{113(132)}$, and of the capacitors $C_{117(147)}$ and $C_{118(148)}$.* The generator circuit diagram is shown in Figure 59. The generator valve L-6(8) is connected as a triode. The resistor $R_{118(150)}$ inserted in the cathode circuit permits the valve operation to be tested.

245. The generator oscillation frequency depends on the position of the arm of the transmitting relay $P_{102(104)}$. When the arm touches the left-hand contact L (Figure 59), then the resonant circuit consists of the inductance coils L, $L_{113(132)}$ connected in series, and of the capacitors $C_{117(147)}$, $C_{118(148)}$ connected in parallel. In this case the first telegraph channel generator oscillates at a frequency of 8500 c/s, and the second telegraph channel - at a frequency of 12200 c/s.

246. When the $P_{102(104)}$ transmitting relay arm touches the right-hand contact P, then part of the coil $L_{113(132)}$ is short-circuited to ground (its inductance is reduced), and the capacitor $C_{118(148)}$ is connected into the circuit through the very high resistance of the resistor $R_{119(151)}$, so that in practice it is disconnected. In this case .... /about two lines obliterated/ during the passage of the arm from one contact to the other, the generator resonant circuit consists of: the coils L + $L_{113(132)}$ and of the capacitor $C_{117(147)}$. The capacitor $C_{118(148)}$ is then disconnected from

/ the circuit...

* The numbers in brackets refer to the appropriate components of the second telephone /sic/ channel.

the circuit, the first telegraph channel generator generates oscillations of the frequency of 8300 c/s, and the second telegraph channel generator oscillates at a frequency of 12500 c/s.

247. The voltage developed across the second winding of the transformer is applied to the band-pass filter FTg-2 (FTg-4) through the voltage divider (attenuator) $R_{115(147)}$, $R_{114(146)}$, which makes it possible to select the right level at the channel output.

<u>The telegraph signal receiver</u>

248. The telegraph signal receiver is composed of an amplitude limiter stage, an amplifier, and frequency and amplitude detectors (Figure 60). The frequency modulated telegraph signals are separated by the filters FTg-1 (FTg-3) from the whole spectrum of the received signal frequencies (Figure 2), and they are then applied through the transformer $Tr_{101(102)}$ to the control grid of the amplifier valve L-5(7) (Figure 60). To this grid is also applied the composite grid bias, namely the voltage drop across the resistor $R_{107(139)}$ connected to the cathode circuit of the valve, and the voltage drop across the resistor $R_{106(138)}$, due to the grid current. The amplitude limitation for the purpose of elimination of the parasitic amplitude modulation of the signal, is obtained in this circuit by the grid current of the valve. The limitation starts at the transformer $Tr_{101(102)}$ input voltage of 0.25 to 0.3 V. The resistor $R_{108(140)}$ serves for testing the valve operation.

249. Two resonant circuits, $C_{112(142)}$, $L_{109(128)}$, $L_{110(129)}$ and $C_{113(143)}$, $L_{111(130)}$, connected in series in the anode circuit of the valve, constitute the frequency detector /discriminator/ which, together with the cuproxide rectifiers, converts the frequency modulated oscillations into d.c. pulses. These current pulses flow through the windings of the receiving relay $P_{101(103)}$, so that the arm of this relay reproduces the d.c.

/ telegraph ....

telegraph pulses within the line circuit of the telegraph instrument. The resonant circuits in the anode circuit of the valve L-5(7) are tuned in the first telegraph channel to the frequency of 8500 c/s and 9100 c/s, and in the second telegraph channel - to the frequencies of 12200 c/s and 12800 c/s.

250. The variable inductance coil $L_{109(128)}$ serves for tuning the circuit to the lower frequency of the telegraph signal.

251. The variable resistor $R_{120(152)}$ serves for the maintenance of the current balance in the windings of the receiving relay.

252. In Figure 61 is shown the frequency characteristic of the telegraph channel receiver, which gives the graph of the dependence of the currents in the receiving relay windings on the degree of de-tuning Δf in relation to the average frequency of the channel (8.8 kc/s or 12.5 kc/s respectively).

The band-pass filters of the telegraph channels

253. The receiving filter FTg-1, and transmitting filter FTg-2, of the first telegraph channel are designed for the pass-band of 8400 to 9200 c/s. The receiving filter FTg-3 and transmitting filter FTg-4 of the second telegraph channel are designed for the pass-band of 12100 to 12900 c/s. At the other channel frequencies, the first telegraph channel filters introduce an attenuation of not less than 3 N., and the second telegraph channel filters - of not less than 3.5 N. The attenuation characteristic of the telegraph channel band-pass filters is shown in Figure 51 (curves 3 and 4). The filter coils are wound on alsifer rings of type TCzK-55. Mica capacitors are used in the filters. Filters are hermetically sealed.

254. The rated characteristic impedance value of the filters is 600 ohms.

The line portion

255. The line portion of the telegraph channels permits the following modes of telegraph equipment operation:

uni-directional

- uni-directional (single-polarity) pulse operation, with un-separated directions of transmission and reception /i.e., single-channel operation?/ (operation of the sets ST-35 in a simplex system);
- uni-directional (single-polarity) pulse operation, with separate directions of transmission and reception /double-channel operation?/ (operation of the sets ST-35 in a duplex system);
- two-directional (double-polarity) pulse operation, with separate directions of transmission and reception (operation of the Baudot instruments).

256. During uni-directional operation of the ST-35 sets in a simplex system, five windings are used in the transmitting relay (Figure 62a). Two windings (1-2 and 3-4) of 1250 turns each, and connected in parallel, form the line windings. The line windings circuit is closed through the receiving relay contacts. The next two windings (5-8) of 1250 turns each, are connected in series, and serve for the holding of the transmitting relay arm in position, should the receiving relay be activated accidentally. The fifth winding (12-13) of 5000 turns serves for shifting the arm from the right hand to the left hand contact, when a no-current pulse arrives from the line. In this case the line circuits are supplied from the side of the ST-35 set.

257. During duplex operation of the ST-35 sets, the receiving and the transmitting circuits are separated (Figure 62b), and therefore the winding 5-8 is not required. The line circuits in this case are also supplied from the side of the ST-35 sets.

258. During two-directional /double-polarity/ operation of the Baudot instruments with separated transmission and reception direction instruments (Figure 62c), only the windings 1-2 and 3-4 are used as in this case the

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/ operation...

operation is carried out with the aid of the two-directional [double-polarity] currents. A voltage supplying the line circuits (± 60 V) is applied to the receiving relay contacts. The transmitting relay is supplied from the side of the Baudot instrument.

259. The switch-over of the telegraph channels from one mode of operation to the other is done by means of the rocking keys K_{102} and K_{104} which are located on the front panel of the multiplexing unit.

260. In all cases the "earth" is brought to the telegraph instrument either by a separate wire, or the same purpose can be served by the mid-point of the telephone service line between the station and the telegraph exchange. For the purpose of connecting the telegraph instruments with the radio-relay station use can also be made of the mid-points of the repeating coils connected to the telephone lines between the station and the signals [communications] centre.

261. Resistors R_{131} and R_{164} in the telegraph channel transmitting circuits serve for the adjustment of the rated current values (25 mA for Baudot, and 50 mA for the ST-35 sets). The shafts of these resistors are brought out through the front panel of the unit and are located in the apertures marked with a sign "Prad lin." ["line current"]. In order to carry out the receiving relay balance adjustment, when the radio-relay is used with the Baudot instruments, the shafts of the resistor R_{130}[?] and R_{164}[?], which are marked "Rownowazenie" ["Balancing"], are brought out through the front panel of the multiplexing unit.

262. The operation of the telegraph channels can be tested by measuring the currents of the transmitting valves L-6 and L-8, and of the receiving valves L-5 and L-7, and also the currents in the windings of receiving relays P_{101} and P_{103}, and the transmitting relays P_{102} and P_{104} (the line currents during the transmission).

/ 263.

263. The design of the multiplexing unit permits the testing of the channel efficiency without using the telegraph instruments by means of the so called "self-contained operation" [praca na siebie]. The telegraph channels can operate when the station is used either as a terminal station, or as an intermediate [repeater] station. There is also provision for the extraction of any telegraph channel from the intermediate station.

The line panel

264. The line panel is used for connecting the telephone and telegraph lines coming from the communications centre, in the case when the equipment is removed for operation outside the truck (operation by remote control). The external view of the line table is shown in Figure 63.

265. During operation from the truck, the line panel is connected by a cable to the appropriate panel of input terminals located outside on the truck body, and to the multiplexing unit (Block 2).

266. On the line panel and on the input terminals panel there are two rows of similarly numbered terminals, serving for the connection of the lines brought up to the station. The purpose of each terminal is marked on the line panel.

267. The line panel is provided with lightning protection of the lines. In each lead circuit there is a 0.25 A fuse and a mica lightning arrester.

268. Each line panel has two line transformers with centre taps. With the aid of a switch, any telegraph channel can be connected to the centre tap of any transformer, and when the two-wire line connecting the station to the communications centre [exchange] can be used simultaneously for telephone and telegraph operation. Mounted on the line panel is the bell of the appropriate half-set.

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5. Power Supply Unit....

5. Power Supply Unit

Block diagram of the station power supply

269. The block diagram of the station power supply is shown in Figure 64. The principal, primary source of the station electric power supply are the storage batteries. Each half-set of the station has three groups of batteries. Each group consists of two batteries type 5 NKN-45 of a rated voltage of 12 V.

270. The batteries are connected to the appropriate half-set charging panels by means of flexible cables SZ-8.

271. From the charging panel, the voltage from the operating battery group is brought to the rectifier unit through the cable SZ-3, (Block 3) and to the lamps illuminating the interior of the truck through the cables K-3 and K-4.

272. From the rectifier unit, the voltage is applied through the connector SZ-1-3 to Block 2 (connector SZ-1-2) and to Block 1 (connectors SZ-1-1A). The batteries are charged from a petrol-driven generator set type PES-0.75, comprising an engine type 2 SD and a generator [dynamo] GSK-1500. The station is equipped with two such power supply sets.

273. In order to charge the batteries, the generator set should be removed from the truck and connected to the input terminal panel by means of cable N-3 (half-connector "12-27 V"). The half-connectors "12-27 V" on the input terminal panels are connected by a cable SZ-9 to the charging panels inside the truck.

274. The adjustable field voltage for the generator GSK-1500 is applied through the cables N-3 and SZ-9. The charging panels are connected with each other by means of the cable SZ-11. This makes it possible to charge any battery group of any half-set from one generator set by connecting it to any input terminal panel. Not more than three battery groups can be charged simultaneously (in any sequence).

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275. When the station is supplied from the batteries, then the anode and screen circuits, as well as the grid bias circuits are supplied from vibrator converters.

276. Three vibrator converters form part of each half-set:

- the transmitter vibrator converter;
- the receiver and the multiplexing unit vibrator converter;
- the telegraph circuit supply vibrator converter.

277. The station can also be supplied from 127/220 V a.c. mains. For this purpose each half-set is provided with a rectifier unit (Block 3). The a.c. is brought to the station through the cable N-4, connected to the half-connector marked "127/220 V" on any input terminal panel. The station is equipped with three N-4 cables, two of them 25 m. long, and one 50 m. long. The half-connectors "127/220 V" mounted on the input terminal panel, are interconnected in parallel through the cable K-1. The voltage from the mains is brought to the mains attachment by the cable SZ-10 from the half-connector "127/220 V" of the left-hand input terminal panel. The mains attachment serves for the connection and adjustment of the voltage from the mains, which is brought up to the rectifier unit through the cable SZ-4, and to the lamps lighting the interior of the truck through the cable K-5.

278. From the rectifier unit, the rectified voltage is fed through the connectors SZ-1-3 to the appropriate units of the equipment.

<u>The charging panel</u>

279. Inside the metal housing of the charging panel (Figure 65) are located:

- one single-pole on-and-off laminated /pakietowy/ switch of the petrol-driven mobile generator;
- three double-pole, three-way, change-over, laminated battery switches;
- one change-over voltmeter switch;

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/ - generator....

[redacted] SECRET

- generator field rheostat;
- reverse current relay;
- three rheostats and other elements for charging current adjustment.

280. All the switches and the rheostat knobs are located on the front panel of the charging panel. In addition, on the front panel are located three ammeters of 20 A range, a voltmeter of 30 V range, and four pilot /indicator/ lamps.

281. On the lower part of the battery charging panel, behind hinged flaps, there are four fuses: one 50 A fuse in the charging assembly circuit, and three 15 A fuses, one in each of the storage battery group charging circuit. In parallel with the 50 A fuse there is a pilot lamp marked "AGR" /mobile generator/ and in parallel with the 15 A fuses there are pilot lamps marked "I", "II", "III", which correspond to the numeration of the storage battery groups.

282. On the lower board of the battery charging panel there are four half-connectors for cables SZ-8, SZ-3, SZ-9 and SZ-11, two terminals marked "+ 12 V" and "- 12 V", and also the earth connector which serves at the same time as a common negative (- 12 V). In addition, on the right hand side wall of the panel there is a socket marked "12 V" for connecting the soldering iron, or the portable lighting lamp. On the left-hand side wall there is a socket for connection of the relay and telegraph channel adjustment instrument.

283. The battery charging panel is fixed to the wall of the truck body by means of a bar welded to its rear wall.

284. The battery charging panel makes it possible to:

- connect the petrol-driven generator for battery charging;
- switch on any battery group for charging, discharging, or to the position "Wyłaczone" /"Off"/;

/ - adjust....

- adjust the battery charging current;
- measure the voltage of any of the battery groups.

The vibrator converter

285. As was mentioned above, when the station operates on batteries, the anode and screen circuits, the grid bias circuits, and the telegraph line circuits are powered from vibrator converters. Each vibrator converter is fed with a voltage of 12 V from the battery, and serves for the conversion of the low voltage d.c. into a much higher d.c. voltage. The voltage step-up is obtained by converting the d.c. voltage obtained from the battery into an a.c. voltage, stepping-up this voltage to the required value with the aid of a transformer, and then rectifying this higher voltage. For this purpose, use is made of a five-contact vibrator of type WS-12. This vibrator consists of an electro-magnet A and of three groups of static and vibrating contacts a, b, c (Figure 66). The vibrating contacts are fixed on a common arm. The whole vibrator is located in a screening box, covered inside with sponge rubber for damping, and for reducing the audible noises developed by the vibrator. Within the vibrator converter, the vibrator proper is an interchangeable element.

286. The principle of operation of the vibrator converter can be explained by means of the simplified circuit diagram given in Figure 66. At standstill the contacts 6 - 8 are closed. When the voltage from the battery is switched on, current flows through the windings of the electro-magnet A, which attracts the arm. As the arm is attracted by the electro-magnet, contacts 6 - 8 open, and the current through the windings of the electro-magnet A stops. The arm is no longer attracted to the electro-magnet but, under the action of the spring, it returns to its initial position, thus closing once more the contacts 6 - 8. In this manner the arm begins to vibrate.

287. The arm vibration frequency (closing and opening the contacts) is about 100 c/s. When the arm vibrates, the contacts 7 and 1 are alternately connected to the negative terminal of the battery, and as a result the current direction in the primary winding of the transformer Tr alternates, producing an alternating magnetic field in the transformer core. An alternating e.m.f. is thus induced in the secondary winding of the transformer.

288. The alternating voltage induced in the secondary winding of the transformer is in turn rectified with the aid of the stationary contacts 3 and 5 and of the vibrating contact 4. Contact 4 located on the arm vibrates synchronously with the other group of contacts. A full-wave rectification of the alternating voltage takes place, and the rectified voltage is doubled with the aid of the capacitors C_1 and C_2, which are charged in turn through contacts 3 and 5. The polarity of the voltage across the capacitors remains constant. As the capacitors are connected in series in relation to the load, a double voltage is obtained across both capacitors and across the load. Each vibrator converter in the station constitutes a separate element assembled on a rigid, cast frame. In order to ensure proper screening, the frame is divided into separate compartments closed at the top and at the bottom with metal covers.

289. For elimination of the radio frequency disturbances caused by the vibrator, the converter includes spark-quenching circuits and anti-interference filters.

290. The grid bias for the transmitter and receiver valves is also obtained with the aid of the vibrator converters. For this purpose the transformers of the transmitter and receiver vibrator converters have additional windings which supply the required voltage to the selenium rectifiers.

The mains attachment

291. The mains attachment structurally consists of a rectangular housing with holes in the side walls (Figure 67). Inside the housing is an auto-transformer (130 W) and a step-down transformer Tr_1 (Figure 68).

292. On the rear wall of the housing are located the half-connectors for the connection of cables (SZ-4 and SZ-10), the terminals Z_3 and Z_4 for tapping the 12 V voltage, the socket for the connection of the testing voltmeter SzT_1, and the terminal "Ziemia" /"Earth"7.

293. On the left hand side wall there are two 12 V sockets for the connection of a soldering iron or a portable lamp. With the aid of the auto-transformer, the voltage 127 V can be maintained when the mains voltage fluctuates within the limits of - 20% to + 10% /presumably "Variac" type auto-transformer7. The mains voltage is measured with the aid of a voltmeter located on the table between the racks. The dimensions of the mains attachment are: 263 x 137 x 231 mm. The weight of the attachement is 11.5 kg.

The rectifier unit

294. The rectifier unit (Block 3) is used when the station is powered from the mains. The rectifier circuits of the unit convert the 127 V a.c. voltage into the d.c. voltage required for the supply of the station. From Block 3 the rectified voltages are fed to Block 1 and Block 2. The construction and the elements of Block 3 are shown in Figures 69, 70 and 71.

295. The rectifier circuits are divided into three groups. Each group has its own transformer. The first group, connected to the transformer Tr_1, supplies power to the transmitter and the telegraph line circuits. In the primary winding of the transformer there is a 2 A fuse and a pilot lamp in parallel with it. Both the fuse and the pilot lamp are located on the front panel (first from the left). This transformer can be switched on by means of the "mode of operation" switch "Prac.-Dyz." /"Operation -

/ Stand by"7....

Stand by"/, which is located on the front panel of Block 1. Transformer Tr_1 has four secondary windings, and the same number of rectifiers. The rectification takes place with the aid of full-wave bridge circuits built on selenium elements.

296. The output voltage of the rectifier D-1 is about 170 V. In the rectified voltage circuit there is a filter and a 0.15 A fuse with a pilot lamp. Both the fuse and the lamp are located on the front panel of the unit (second from the left).

297. The output voltage of the rectifier D-2 is 25 V, which is applied as a negative bias to the control grid of the output stage valve of the transmitter. In the rectified voltage circuit there is a filter composed of resistors and capacitors.

298. The output voltage of the rectifiers D-4 and D-5 is ± 60 V. It is used for the supply of the telegraph line circuits. In the output circuit of each rectifier there is a filter and a 0.25 A fuse with a pilot lamp located on the front panel of the unit (third and fourth from the left).

299. Resistors R_3 and R_4 at the output of the rectifiers D-4 and D-5 filters serve for levelling out /equalisation/ of the voltage drop after the load is switched off. /Not quite clear, presumably bleeder resistors/.

300. The second group of rectifiers, connected to the transformer Tr_2, supply power to the receiver and to the multiplexing unit. In the transformer primary winding there is a 2 A fuse and a pilot lamp located on the front panel of the unit (fifth from the left). The primary winding of transformer Tr_2 is switched on by means of the "type of supply" switch, which is located in Block 1. The transformer Tr_2 has three secondary windings. The rectifier D-6 connected to the winding 11-12-13 gives a voltage of 160 V for the supply of the receiver and multiplexing unit valves. In the rectified voltage circuit there is incorporated a filter and a 0.15 A fuse with the pilot lamp located on the front panel of the unit (seventh from the left).

301. The rectifier D-7 connected to the winding 9 - 10 supplies a voltage of 45 V for the d.c. amplifier. This voltage can be adjusted by means of the variable resistor [potentiometer] the shaft of which is located in a cut-out on the front panel of the unit. In the rectified voltage circuit there is a filter composed of resistors and capacitors.

302. The centre tap (3) of the winding 1 - 5 is earthed. This winding supplies the 12 V a.c. voltage for the filament circuits of all the valves in the station.

303. The valve of the transmitter power amplifier draws its filament voltage of 4.8 V from a part (2 - 4) of this winding. The transmitter valve filament circuits can be switched on and off by means of the switch "Prac. - Dyz." ["Operation - Stand by"] located on the front panel of Block 1.

304. The third rectifier group is connected to the transformer Tr_3. In the primary winding circuit of this transformer there is a 2 A fuse with a pilot lamp located on the front panel of the unit (sixth from the left). The primary winding of the transformer Tr_3 is connected in parallel with the primary winding of the transformer Tr_2, and can be switched on and off by means of the "type of supply" switch located on the front panel of Block 1. The transformer Tr_3 has three secondary windings. The rectifier D-8, connected to the winding 3 - 4 - 5, supplies a voltage of 12 V to the calling signal converter, to the relay, and to the bell.

305. The rectifier D-9, connected to the winding 6 - 7, supplies the voltage of 12 V for the telephone channel limiter stages, to the transmitter output valve suppressor grid, and to the microphone. At the output of the rectifier D-9 there is a filter.

306. The windings: V of the transformer Tr_1, IV of the transformer Tr_2, and II of the transformer Tr_3 have special taps for stepping up the

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/ voltage....

voltage, which is necessary in the event of the aging of the selenium rectifiers.

307. The elements of the rectifier unit are assembled on a chassis to which the front panel is attached with bolts. The front view of the rectifier unit is shown in Figure 69. Over the fuses located on the front panel of the unit, are marked the values of the currents. The elements of the unit are located both under and over the chassis (Figures 70 and 71).

308. Dimensions of the rectifier unit: 364 x 150 x 402 mm. Weight of the unit: 15.4 kg.

309. The rectifier unit draws a current of about 1.6 A. This current is divided among the various groups as follows:

- rectifiers of the first group (Tr_1): - 0.44 A;
- rectifiers of the second group (Tr_2): - 0.70 A;
- rectifiers of the third group (Tr_3): - 0.43 A.

310. The rated values of the voltages and currents supplied by the rectifiers of Block 3 are specified in Appendix 6.

<u>The petrol-driven mobile generator for battery charging</u>

311. For charging of the station batteries use is made of a petrol-driven mobile generator type PES-0.75, consisting of a one-cylinder, two-stroke engine type 2 SD, and a four-pole, shunt d.c. generator type GSK-1500 (Figure 72).

312. Technical specification of the 2 SD engine:

- power: - 2 HP
- r.p.m.: - 3000
- cooling: - air
- petrol tank capacity: - 3.75 litres
- petrol consumption: - 0.9 kg/hour
- weight of engine: - 20 kg.
- fuel: - petrol A-66.

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/ 313.

313. Technical specification of the GSK 1500 generator:

- rated power: - 1000 W
- rated voltage: - 24 V
- rated current: - 36 A
- rated r.p.m.: - 3000
- operation conditions: - continuous rating
- weight (not exceeding): - 12.6 kg.

314. A detailed description of the design and operation of various elements of the engine is given in the special PES-0.75 instruction manual, "Instruction for the maintenance, operation and adjustment of the 2 SD engine".

315. Weight of the PES-0.75 assembly is 55 kg.

6. Aerial and Mast Equipment

316. Each station is equipped with two complete sets of the aerial-mast assembly. Each set is composed of two "Yagi" type aerials forming a cruciform structure, of aerial feeders, of a mast with a hoist, and of the mast rigging.

The aerial assembly

317. The receiving and the transmitting aerials of each half-set are assembled on a common horizontal boom at right-angles to each other, and form one cruciform structure. The vertical aerial is tuned to the frequency of 69 Mc/s, and covers the frequency range of 68 to 70 Mc/s (operating waves 28 to 54). The horizontal aerial is tuned to the frequency of 67 Mc/s, and covers the frequency range of 66 to 68 Mc/s (operating waves 1 to 27). The horizontal aerial dipoles are marked with white stripes.

318. The whole of the aerial assembly is collapsible. The dipoles are fixed on the aerial boom by means of special clamps. The active dipoles of the aerial are half-wave dipoles connected to the receiver or the transmitter by a feeder cable.

319. In order to eliminate distortions of the aerial radiation pattern the feeder is connected to the dipole through a balancing device /balun/. The balancing devices of the vertical and of the horizontal aerials are located inside the aerial boom. The half-connectors for the connection of the aerial feeders to the aerials are located under the aerial boom, behind the reflector. The vertical aerial half-connector is painted white, and the half-connector of the horizontal aerial is painted with camouflage paint.

320. When attaching the aerial to the aerial boom, it is necessary to pay attention to the numbers marked on the dipoles and their clamps. The aerial boom, together with the aerials, is attached by a special clamp to the wooden insulator which forms the end section of the mast. The external view of the deployed aerials of both half-sets is shown in Figure 11.

321. When the station is dismantled, all the elements of the aerial assembly are packed inside a duraluminium case (Figure 10), which is carried under the body of the truck. Each station has two cases with aerials.

322. Figures 73 and 74 show the horizontal radiation patterns of both aerials (vertical and horizontal) of the R-401 station, and the widths of the principal lobes of these patterns.

The aerial feeders (cables)

323. For the connection of the aerials located on the mast to the receiver and the transmitter of the station, use is made of a coaxial cable (feeder) of type RK-1, which has a characteristic impedance of 75 ohms. Each half-set has two feeders, 25 metres long.

324. At each end, the feeders are terminated with half-connectors. The half-connector of the vertical aerial is marked with white paint.

325. Before the erection of the mast, the feeders are fixed with a special clamp to the base of the wooden section of the mast.

326. The feeders are carried inside the aerial packing cases.

The mast and the mast hoist

327. Each station has two collapsible masts and two hoists. One mast is composed of nine sections. The top section is made of wood. It is 2 m. long and serves as an insulator. The other eight sections of the mast are made of duraluminium tubes, 1.6 metres long, one fitting into the other.

328. The mast hoist is 2 metres long, and is also made of duraluminium tube. It has a winch for lifting the mast, and a mechanism for holding the mast when lifted. The hoist has a metal base at the bottom, on which the whole mast rests.

329. In order to erect the mast, the mast sections are fastened one after another to the hoist and then lifted up.

330. The total height of the mast is 14.5 metres. The mast is held in a vertical position by means of twelve guy-ropes fixed at four different levels. At each level there are three guy-ropes at an angle of 120° to one another. The guy-rope fixing pegs are driven into the ground at a distance of 8 metres from the mast base. The pegs form the corners of an equilateral triangle (Figure 75).

331. The mast, when erected, can be turned around its axis. To hold the aerial in the desired position, there are two additional guy-ropes fixed to the ends of the aerial boom.

332. Sections of the mast are carried in a metal case attached underneath the truck body. The hoists together with the top, wooden, sections of the mast are attached to the body of the truck on both sides of the driver's cabin. The winch and the locking mechanism of the hoists is protected with covers.

/ Rigging

Rigging

333. The rigging of the mast is composed of three metal pegs, twelve guy-ropes and three half-rings. A mallet, which is included in the station equipment, is used for driving the pegs into the ground. All the guy-ropes are made of a steel cable, the strands of which consist of 2 mm. diameter wires.

334. At the top ends of the guy-ropes there are locking hooks or ordinary hooks for attaching the guy-ropes to the half-rings which are inserted into the grooves between the mast sections. At each level, two guy-ropes have locking hooks, and one has an ordinary hook.

335. In order to facilitate the erection of the mast, the lower ends of the guy-ropes are prolonged with hemp ropes, and have small wooden boards for adjusting the length of the guy-ropes. When the station is packed up, the rigging of the masts is contained in special packings (see Figure 10), which are stored in the right-hand case inside the truck.

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CHAPTER III

OPERATION OF THE R-401 STATION

1. Protection of the Station against Damage

336. The proper handling of the equipment is a necessary condition for the maintenance of reliable and uninterrupted communication.

337. When using the station it is necessary to:

- pay attention to the mains or battery voltage;
- protect the equipment and the interior of the truck against dust and dirt;
- when repairing the equipment or when removing it from the truck, to protect it against shocks and knocks;
- handle carefully the feeders and the connecting cables, and take care to maintain their efficiency;
- protect the aerial mast section joints against dirt;
- avoid throwing the aerial mast sections when setting up or dismantling the aerial;
- protect the aerial dipoles against dirt and humidity, and prevent any bending of the dipoles;
- handle very carefully the aerial feeders and cables during deployment and dismantling of the aerial. Avoid kinking them, especially during winter;
- when in transit, make sure that the blocks in the racks are properly secured and protected with covers;
- carry out the tests and technical examinations (Appendix 2).

338. The spare parts and accessories should always be in their proper places, and should be properly secured.

2. Choice of Site for the Deployment of the Station

339. When setting up the station in the field, the following factors

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should be considered:

- location of the command posts;
- conditions of radio wave propagation, (ground);
- vehicular accessibility and equipment unloading facilities;
- concealment and camouflage of the station;
- the necessity of protecting the station;
- necessity of protecting the station against industrial interference, against interference by other stations, and against deliberate jamming by the enemy.

340. The radio-relay station should be sited in conformity with principles of anti-nuclear defence.

341. The terminal radio-relay stations should as a rule be located as near as possible to the communications centres. This reduces the number of cables required for the construction of the connecting links, and also improves the quality and reliability of communication. The distance between the terminal stations and the communications centres depends upon the specific conditions, the capacity of the equipment, and the type of cable used for the connecting links. The permissible attenuation for telephone lines is 1.25 N.

342. The connecting wire lines, inspite of their short length as compared with the radio-relay links, form an important element which exerts a considerable influence upon the continuity and reliability of the whole radio link operation. It is recommended that the connecting lines should use PKA, and that they should be kept under constant supervision.

343. In an afforested, moderately undulating terrain, or in a steppe, in order to ensure communications over short distances, if the masts are erected to their full height, no special care in the choice of route is necessary.

344. Practical experience has shown that it is possible to maintain infallible communication even if the line of sight of the aerials of

/ corresponding ....

corresponding stations is interrupted by a ground obstacle 50 to 75 metres high. An example of such a route is shown in Figure 76. It should, however, be borne in mind that a prior careful selection of a radio-relay route may considerable increase the stability (certainty) and range of communication.

345. Over open routes (free from obstructions, Figure 77) it is possible to maintain communication between two stations at considerable distances. It is possible therefore, in certain cases, to avoid using intermediate stations, or to reduce their number, if the ground conditions and tactical considerations permit the selection of open routes.

346. With a careful selection of the radio-relay route (with the smallest obstacle on the optical line-of-sight) it is possible to reduce the height of the aerials, which facilitates the camouflage of the station, and also makes more difficult the interception of messages and jamming of the station by the enemy.

347. For the above reasons, it is advisable to operate the station at reduced heights of the aerials even for long distance communication.

348. The erection of the aerial mast at less than full height requires much less time, and therefore reduces the time required for establishing communication. It is, however, necessary to bear in mind that in the presence of obstructions on the route, a reduction of the height of the aerial may affect the quality, or even cause an interruption of communication.

349. For this reason, in order to ensure a good quality of communication when operating at reduced aerial height, it is necessary to check the profile of the route and select either an unobstructed route, or a route with as few ground obstructions as possible.

350. Selection of an unobstructed route or a route with few obstructions is of a great importance, especially at a long distance between the

stations .....

stations, and when there are more than two intermediate re-transmitting stations.

351. In mountainous areas it may happen that communication will have to be established not only across open routes, but also across routes with considerable obstructions in the shape of mountain ridges. In this case the station should be placed at least at such a distance from the obstructing mountain that the top of the mountain is visible from the station. Figure 78 shows the profile of a mountain route on which continuous communication was maintained even with an obstacle about 450 m high.

352. The selection of a radio-relay route is made on a map. The procedure when selecting a route is described below.

353. The site for the deployment of the station should be selected so as to ensure a proper clearance between the aerials of the stations in correspondence. Steep slopes of plateaux, high embankments, stone and reinforced concrete buildings, metal structures and transverse power and communication lines situated in front of the aerials, all have a screening effect upon metre-wave propagation. The station should therefore be placed as far as possible from the above features. It is advisable, on the other hand, to utilize them for hindering the enemy from interception and jamming.

354. The area required for the deployment of one aerial is 15 x 15 metres, and for two aerials 30 x 15 metres.

355. The distance between the aerials of adjoining half-sets of the station should be about 16 to 20 metres, and the distance between the mast and the truck should be about 10 metres.

356. The aerials of different half-sets should be located in such a manner that they do not interfere with one another when radiating.

357. The correct lay-out of the aerials is shown in Figure 79.

358. To avoid interference from industrial sources which may affect the quality of communication, the stations should be placed at least 300

/ to 500 metres .

to 500 metres away from roads, industrial buildings, garages, electric railways, high-voltage power lines, powerful short-wave stations, and radar sets.

359. When siting the station according to the principles of anti-nuclear defence, one should remember to arrange proper field engineering protection, and camouflage of the station site.

360. The truck must be placed inside a concealed trench. The trench should be 0.5 m deeper than the height of the truck. The fuel and lubricants should be placed in a special trench 20 to 25 metres distant from the trench with the truck. The area around the POL dump should be cleared of all inflammable materials and objects.

361. In case of necessity, the station equipment can be removed from the truck and placed in a shelter.

362. When operating by remote control, the units are fixed on a special cruciform structure. It is forbidden to place the equipment in front of the entrance to the shelter.

363. When arranging the shelter for remote control operation, it is necessary to provide for:

- outlets for two aerial feeders, and for seven two-wire lines;
- careful camouflaging and burying of the feeders and cables at a depth of 20 to 40 cms in the ground;
- electric power supply for the station (spare storage batteries and their charging);
- sites for the proper deployment of the aerials, and their camouflage;
- spare parts, and operational accessories (aerials, feeders, aerial sections, guy-ropes, radio valves, fuses, etc.).

364. The shelter should have a telephone connection with the telephone exchange. When the station is deployed at a considerable distance from the communications centre, service communication can be established with the aid of portable ultra-short-wave radio sets.

50X1

365. During combat, when there is not enough time for building covers and shelters, in order to establish communication the station may be deployed without a specially prepared place of concealment. In such a case, however, one should utilize the camouflage characteristics of the ground. Gorges, ravines, ditches, subterranean structures, caves, etc. can be used for concealment. At the same time work should start on the preparation of concealment and shelters for the personnel and equipment.

3. Selection of the Radio-relay Route

366. The radio-relay route is selected with the aid of maps on a scale of 1:50,000 or 1:100,000. The work carried out with the help of the maps consists of a study of the terrain between the points where the radio-relay communication is to be established, and of the division of the selected route into re-transmission sections.

367. The sites for the radio-relay stations are selected according to the requirements given in Chapter III, section 2.

368. It is recommended that the radio-relay route should be selected in the following way. The sites of the aerials, and the highest points of the terrain are marked on the map (Figure 80).

369. In Figure 80 the terminal stations are located at points A and D, and the intermediate [re-transmission] station is at point B.

370. The approximate assessment of the route consists of the comparison of half of the sum of altitudes of points A and B (mean value including the heights of the masts), with the sum of the highest altitude on the route between the points A and B, and the height of the arc of the curvature of the earth, corresponding to the given distance between the points A and B.

371. If one half of the sum of the altitudes of the points A and B is greater than the sum of the altitudes of the highest point and the height of the arc of the curvature of the earth, then at the first approximation

/ it can be .....

it can be considered that the line-of-sight between the aerials located at points A and B is unobstructed. In the opposite case, the line-of-sight is obstructed. The difference between the first and the second value indicates the degree of the obstruction of the optical line-of-sight.

372. The rise of the arc of the curvature of the earth is approximately expressed in the following formula:

$$H = \frac{R^2}{50}$$

where: R - distance in kilometres,

H - height of the curvature arc in metres.

373. As an example, let us check whether there is an unobstructed line-of-sight between the aerials of the stations located at points A and B. The distance between the stations, estimated from the map is R_1 = 50 kms. Assuming that the masts of both stations are 14 metres high, the altitudes of the aerials above sea level will be:

at point A: 174.2 + 14 = 188.2 m.

at point B: 160.0 + 14 = 174.0 m.

Half of the sum of altitudes of the aerials above sea level is:

$$\frac{188.2 + 174.0}{2} = 181.1 \text{ m.}$$

The height of the earth curvature arc is:

$$H = \frac{50 \times 50}{50} = 50 \text{ m.}$$

The sum of the altitude of point C and the height of the earth curvature is

160 + 50 = 210 m.

374. By comparing the value of half of the sum of the aerial altitudes with the sum of the altitude of the highest obstruction on the route and the height of the earth curvature, we find that the first value is less than the second. It can be stated therefore that there is no direct, unobstructed line-of-sight between the aerials.

375. From the above example it can be seen that the obstruction in

[redacted] the sector .....

the sector AB (Figure 80) amounts to 210 - 181.1 = 28.9 m. Since, in the case of the R-410 radio-relay the permissible height of the obstruction on the route is 50 to 75 metres, it can be assumed that it is possible to establish communication along this route.

376. By similar calculation, it is easy to prove that in the sector BD there is a direct, unobstructed line-of-sight between the aerials (Figure 80).

377. For the accurate determination of the route profile, it is necessary to draw the arc of the earth curvature and then plot onto it all the principal heights along the route. In order to trace such an arc, one first calculates its height with the help of the above formula. One then marks a series of points as shown in Figure 81, where A and B are the sites of the stations, and C, D, E, F, G are the supplementary points. Through these points is traced a curve which corresponds to the arc of the earth curvature.

378. On the arc are plotted on an appropriate scale the altitudes of various heights along the route, as read from the map. These points, connected by a continuous line, give the profile of the route (Figure 82).

379. Example: trace the arc of the earth curvature for a 50 km long sector of the route.

$$H = 50 \text{ m.}$$

$$\frac{R}{6} = 8.3 \text{ km.} \quad \frac{8\,H}{9} = 44 \text{ m.} \quad 0.36\,R = 18 \text{ km} \quad \frac{H}{2} = 25 \text{ m.}$$

380. The earth curvature arc traced with the aid of the above values will appear as shown in Figure 83.

381. Instead of tracing the earth curvature arc every time it sis also possible to use special tracing forms which are prepared in advance. The routes traced with the aid of such forms are shown in Figure 76 and 77.

4. Selection...

4. Selection of the Operating Frequencies

382. A very important problem when preparing the documents necessary for the organisation of radio-relay communication, is the selection of the operating and reserve frequencies.

383. If the operational frequencies are selected incorrectly, then the transmitter of the neighbouring half-set of the station, or the transmitters of other stations nearby, may interfere with the operation of the receiver.

384. In the case when a powerful signal from an interfering transmitter enters the input of the receiver, its capacity for the reception of signals from the station in correspondence will be reduced. In addition, an audible beat frequency may appear at the receiver output resulting from the coincidence of the interfering signal with the signal from the station in correspondence.

385. When selecting the operational waves,one should be guided by the principles laid down in this manual. It has also been found in practice that the harmonics of the short-wave and ultra-short-wave transmitters of other stations interfere seriously with the operation of the radio-relay stations located nearby. The simultaneous operation of such transmitters and of the radio-relay stations located in their vicinity can be carried out without interference only when the operational frequencies are so distributed that the harmonics of the short-wave and the ultra-short-wave transmitters do not coincide with the frequency of the signal received by the radio-relay station. The above remarks should be especially taken into consideration when the radio-relay stations are being used for remote control.

5. Deployment and Dismantling of the Station.

Deployment of the aerial and mast equipment

386. The aerial and mast equipment is deployed by the station personnel composed of five persons. The deployment is carried out under

/ the supervision ...

the supervision of the station commander.

387. The deployment of the aerial and mast equipment is performed in two stages:

- assembling the aerial and installing the hoist;
- raising the mast;

[A few words missing] " ..... on the command of the station commander: "Begin to deploy the aerial".

388. At this command the members of the station team take the following action:

- Number One selects and indicates the aerial site;
- Numbers Two and Three take out the cases with the aerial and carry them to the aerial site;
- Number Four takes out the cover with the aerial mast rigging from its case, and carries it to the aerial site;
- Number Five removes from the truck the hoist with the wooden section of the mast, and carries it to the aerial site;
- Numbers Four and Five carry the mast sections to the aerial site;
- Number One removes the aerial cables (feeders) from the case and unrolls them from the truck to the mast in such a way that they do not interfere with the deployment of the station, and then connects the cables to the aerial and the station equipment, according to the assigned operational wave-lengths.

<u>Remark</u>

1) The aerial feeder with white markings, should be connected to the aerial having a half-connector painted white (vertical aerial). The unmarked feeder should be connected to the aerial with half-connector painted in camouflage colour (horizontal aerial). The covers of the aerial half-connector and of the aerial cable half-connectors should be tied together.

2) When connecting the aerial cables (feeders) to the equipment it must be borne in mind that the aerials are tuned to different frequencies. The horizontal aerial is tuned to the frequencies of the first half of the frequency range (unmarked 50X1-HUM

/ cable) 50X1

cable), and the vertical aerial is tuned to the frequencies of the second half of the frequency range (cable marked white).

- Number Three removes the aerial boom with the mast end piece from the chest, and holds it in his hands while the mast is being assembled.

- Number Two removes the dipoles from the chest and fixes them to the appropriate points on the aerial boom.

Remarks

1) The upper, vertical dipoles, marked with a white stripe should be fixed in the upper vertical sockets of the aerial boom, which are painted white, and according to the numbering on the dipoles and on the sockets. The lower vertical dipoles are not fixed at this stage.

2) The horizontal dipoles (without the white stripes) are fixed in the horizontal sockets of the aerial boom, according to the numbering on the dipoles and on the sockets.

3) In order to fix the dipole correctly in its socket, one should: insert the dipole into the socket as far as it will go; turn the dipole clockwise in the socket, again as far as it will go, and then pull the dipole towards oneself.

- Number Five holds the hoist in a vertical position, and removes cover from the hoist.

- Number Four removes the guy-rope pegs from the packing, and drives them into the ground 8 metres from the base of the mast at points indicated by Number One. He then removes from the packing the guy-ropes of the first level, attaches them to the top part of the hoist, and then unrolls them towards the pegs.

Remark

The pegs should be driven into the ground at an angle of 45^{o} leaning away from the mast. When the aerial is assembled (without the lower halves of the vertical dipoles) it is then fixed to the top of the wooden section of the hoist.

389. For this purpose:

- Number Five inclines the hoist;

- Numbers Two and Three attach the aerial to the wooden section the hoist;

of the hoist;

- Number Five lifts the hoist back to the vertical position;
- Number Two fixes the lower dipoles of the aerial;
- Number Three takes out the ropes and attaches them to the aerial;
- Number Four secures the guy-ropes to the pegs and tightens them, thus steadying the hoist;
- Number One checks whether the hoist is vertical, and aims the aerial towards the correspondent station;
- Numbers Two, Three and Four unroll the guy-ropes of the 2nd, 3rd, and 4th level from the hoist towards the pegs.

390. On the command of Number One: "Begin to raise the mast", the following action is taken:

- Number Two hoists up the wooden section of the mast with the aerial, then takes the duraluminium section of the mast, puts it into the socket in the wooden section, and turns it to make the pin enter the groove, places the holder of the hoist under the lower end of the mast section, and hoists upwards the mast with the aerial until the groove for the half-ring with guy-ropes is above the supporting mechanism of the hoist;
- Number One fastens the aerial cables (feeders) to the mast, inserts the half-ring into its groove, and fastens to it the guy-ropes of the fourth level, helps Number Two with the hoisting [of the mast?], ensures its vertical positioning by giving appropriate orders to the Numbers standing at the guy-ropes, and fastens the guy-ropes of the next levels to the mast;
- Number Two hoists the mast upwards. When attaching the next section, he lowers the holder of the hoist and puts it under the next section of the mast. He repeats these operations until the

/ mast .....

mast is lifted to the required height;

- Numbers Three, Four, and Five hold the guy-ropes, watching the mast and keeping it vertical, following Number One's instructions.

Remarks

1) The guy-ropes of the third level are installed between the 7th and 6th sections of the mast, and the guy-ropes of the 2nd level - between the 5th and 4th sections.

2) When attaching the last section of the mast - the holder of the hoist is placed under it, but the mast is not lifted.

3) As a rule, the mast should be erected to the height of seven metal mast sections. The mast is erected to the height of eight metal sections only when there is an excessive noise level in the telephone channels.

- Number Two releases slightly the braking mechanism of the hoist, and turning the crank slowly, lowers the mast on to its base; Then, together with Number Three, attaches the guy-ropes of the 2nd, 3rd, and 4th level guy-ropes to the pegs. He does the same with Number Four;
- Number Three, together with Number Five, also attaches the 2nd 3rd, and 4th level guy-ropes to the pegs;
- Number One gives instructions necessary for aligning the mast in the vertical position, and Numbers Three, Four and Five adjust accordingly the tension of the appropriate guy-ropes;
- Numbers One and Four aim the aerial towards the correspondent station, and then fasten the aerial guy-ropes to their respective pegs;
- Numbers Two, Three and Four collect the remaining equipment and tools, and put them in their proper place;
- Number Five earths the station. The second mast can be erected in the same way, when required.

/ Dismantling of the aerial .....

Dismantling of the aerial and mast equipment

391. On the order of Number One: "Lower the aerial", the following operations are carried out:

- Numbers Three, Four and Five take up positions near the pegs, loosen the guy-ropes, and hold the mast in the vertical position;
- Number Two lifts the mast slightly, so that the lowest section of the mast can be removed, takes off from this section the holder of the hoist, and removes the lowest section of the mast. He then cranks up the holder of the hoist, puts it on the next section of the mast, releases the braking mechanism of the hoist, and lowers the mast by turning the crank slowly. When the lower end of the section is about 10 to 15 cm. from the ground, he stops lowering the mast, and removes the next section of the mast;
- Number One directs the lowering of the mast, and also helps Number Two; as the mast is being lowered, he unhooks the guy-ropes, removes the half-rings, and disconnects the aerial feeders from the mast. The whole mast is lowered in the same way.

392. After the mast has been lowered:

- Number Two holds the aerial hoist;
- Numbers Three, Four and Five detach the guy-ropes from the pegs, and straighten them;
- Number Five detaches the guy-ropes from the hoist, and holds the hoist;
- Number Four rolls up the guy-ropes and packs them;
- Numbers Two and Three bring up the aerial cases, remove the lower vertical dipoles, and put them inside the cover marked with a white stripe;

/ - Number Five .....

- Number Five inclines the hoist and holds it in this position;
- Numbers Two and Three remove the aerial;
- Number Five puts on the cover over the hoist, and attaches it to the body of the truck;
- Number Three holds the aerial while it is being dismantled;
- Number Two removes the dipoles, and places them in their respective covers;
- Number One detaches the guy-ropes and disconnects the aerial feeders from the aerial and from the equipment, screws on the cups over the half-connectors of the aerial and feeders, rolls the feeders up and places them in the aerial case;
- Number Three, when the aerial is dismantled, places the aerial boom in the aerial case;
- Number Two and Three place the case with the aerial into the case under the body of the truck, and lock it;
- Numbers Two and Three roll up the guy-ropes, pull out the pegs, and place them in their respective covers;
- Number Five places the mast sections in the chest, and disconnects the earth connection from the truck;
- Number Four puts the parcel with the mast rigging into the right-hand case inside the truck.

393. The second aerial mast equipment is dismantled in a similar way.

6. Switching on, Establishing Communication, and Switching off the Station

Connection of a.c. mains

394. The a.c. mains are connected to the station in the following way:

1) Before connecting the a.c. mains it is necessary to:-

- check the mains voltage with the aid of the instrument TT-2.

he mains .....

- set the mains on-off switch (on the left-hand side of the mains attachment) to the position "Wylaczono" ["Off"];
- set the "127/220 V" change-over switch (on the right-hand side of the mains attachment) to the position corresponding to the rated value of the mains voltage;
- turn anti-clockwise the mains voltage adjustment knob as far as it will go;
- check whether the truck is earthed.

2) Plug in the mains cable N-4 half-connector into any half-connector marked "127/220 V" on the left or right-hand side of the truck.

3) Connect the cable N-4 to the a.c. mains.

<u>Remarks</u>

1) When connecting the mains, the safety regulation must be observed (see Appendix 1).

2) IT IS FORBIDDEN TO CONNECT THE STATION TO D.C. MAINS.

<u>Connection of the power supply of the equipment, when the station is connected to a.c. mains.</u>

395. When the station is connected to a.c. mains, the switching on of the power supply should be carried out in the following way:

- the mains switch on the mains attachment should be set to the position "Wlacz", ["On"];
- turning clockwise the voltage adjustment knob on the mains attachment, adjust the voltage to 127 V, using the measuring instrument [voltmeter] located between the racks (the white lamp on the mains attachment, which shows the presence of the mains voltage, should light up);
- the change-over switch "Praca - Dyz" ["Operation - Stand-by"] which is on the front panel of block 1 (see Figure 17) should be set to the position "Dyz", [Stand-by];
- the type of supply switch, which is located in the middle of 50X1

/ the front panel .....

the front panel of Block 1, should be switched from the position "Wylacz" ["Off"] to the position "Siec" ["Mains"], (the radio receiver, and the telephone channels of the multiplexing unit are now switched on).

Switching on the station battery power supply

396. Each half-set can be supplied from any one of the three groups of batteries belonging to it.

397. The battery supply should be switched on in the following way:

- the switch "Ladowanie - Wylacz. - Rozladowanie" ["Charging - Off - Discharging"] of the selected battery group, which is located on the charging panel of the respective half-set, should be switched from the position "Wylacz." ["Off"] to the position "Rozladowanie" ["Discharging"];
- the switch "Praca - Dyz." ["Operation - Stand-by"] which is located on the front panel of Block 1, should be set to the position "Dyz.", ["Stand-by"];
- the type of supply switch, which is located on the front panel of Block 1, should be switched from the position "Wylacz." ["Off"] to the position "Akumulatory" ["Batteries"];
- the voltmeter change-over switch located on the charging panel of the half-set, should be set to the position corresponding to the selected group of batteries.

Remarks

1) It is forbidden to discharge the batteries below 11 V. Batteries whose voltage has dropped to 11 V. should be switched on to the charging position. Another group of batteries should be used for supplying the station during this time.

2) The switching on of the transmitter power supply is described under the heading "Establishing communication".

3) The switching on of the telegraph channel power supply is described under the heading "Switching on of the telegraph channels" .....

channels" (see Section 8 of this Chapter). [Page 109].

Setting of the operating frequencies

398. The setting of the operating frequencies of the receiver and transmitter takes place when the station is connected for "Stand-by" operation.

399. IT IS FORBIDDEN TO ALTER THE TUNING OF THE TRANSMITTER DURING ITS OPERATION.

400. The operating frequencies of the receiver and transmitter are set in the following way:

- the switch "Swiatlo - Wylacz." ["Light - Off"] on the Block 1 front panel should be set to the position "Swiatlo" ["Light"] (the dial lights of the receiver and the transmitter are then lit up);
- unscrew to the left the receiver and transmitter dials locking screws;
- rotate the knobs marked "Fala" ["Wave"] until the dial markings [divisions] corresponding to the selected wave-length numbers coincide with the vertical hairline pointers on the dial;
- lock the receiver and transmitter dials by turning the locking screws to the right;
- set the switch "Swiatlo - Wylacz." to the position "Wylacz." ["Off"].

Establishing communication

401. Communication is established when the station is operating as a terminal station. Communication should be established in the first place with the station serving the immediate superior.

402. Before establishing communication, the switches on the transceiver block and the multiplexing unit front panel should be set to the following positions:

- the "Konc. - .....

- the "Konc. - Retr." ["Terminal - Re-transmission"] switch, to the position "Konc." ["Terminal"] (operation as a terminal station);
- the telephone channel switch "Tranz. - Konc." ["Transit - Terminal"] to the position "Konc." ["Terminal"];
- the telegraph channels "type of supply" switch, to position "Wylacz." ["Off"];
- the quartz calibrator switch, to position "Wylacz. ["Off"];
- the ARCz [Automatic Frequency Control] switch, to position "Wylacz." ["Off"];
- the type of multiplexing switch, to position "Wewn. zwiel" ["Internal multiplexing"];
- type of telephone channel operation switches, to the position "2TF";
- the telephone channel rocking keys, to the central position;
- the Block 2 instrument switch, to the position "TF";
- the Block 1 testing instrument left-hand switch, to the position "Ant." ["Aerial"] (testing of the transmitter output power).

403. For the purpose of establishing communication, the following actions should be performed:

- set the operational frequencies, and switch on the power supply of the equipment;
- set the switch "Praca - Dyz." ["Operation - Stand-by"], on the front panel of Block 1 to the position "Praca" ["Operation"]. One should then hear the noise of the operating transmitter converter. When the transmitter valves have warmed up (15 to 20 secs.) the pointer of the testing instrument should lie within the marked sector of the instrument dial;
- the "talking" key of the first telephone channel should be set to the position "Kan. rad." ["Radio channel"]. In the

/ absence of the ....

absence of the carrier wave of the distant station [correspondent station], strong receiver noise should be audible in the earphones;

- send the calling signal to the distant station. For this purpose, the calling signal key should be tilt d to the position "Zew" ["Calling signal"], and then returned to the central position;
- call the correspondent by sending his and own identification call signs. The presence of the carrier wave of the correspondent station can be recognised by the disappearance of the receiver noise.

404. When the correspondent station has answered, the receiver automatic frequency control should be switched on, and the testing and adjustment of the telephone channel levels should begin;

- in the case when a calling signal comes from the correspondent station, the red pilot lamp lights up on the multiplexing unit and the bell rings. Having received the calling signal, it is necessary to answer the correspondent. For this purpose the "talking" key of the channel which received the calling signal should be set to the position "Kan. rad." ["Radio channel"]. During the conversation, one should depress the telephone handset pressel switch.

405. If correspondence is not established within 15 minutes after the pre-arranged time, one should start testing own station equipment (see sub-heading 7, item "Testing the station by self-contained operation").

406. Having tested the equipment by "self-contained operation" method, one should again try to establish communication with the correspondent station. If, after renewed trial, communication is not established within 10 to 15 minutes, then it will be necessary to try to establish communication through indirect links - over the wire lines, or other available routes, while continuing the attempts to establish communication by means of the radio-relay (one should periodically call the correspondent

/ station .....

station). When establishing communication, and during service calls only the service calls panel should be used.

Adjustment of the telephone channel levels

407. The adjustment of the telephone channel levels comprises the following actions:

- the adjustment of the transmission level;
- the adjustment of the reception level.

Adjustment of the transmission level

408. On the multiplexing unit, one should:

- set the change-over switch of the instrument to the position "GP_1";
- set the "on-off" switch of the instrument to the position "TF";
- set the calling signal key to the position "GP";
- by rotating the knob of the potentiometer of the measurement [testing] generator "GP", set the measuring instrument pointer to the Figure 50 (which is marked with a stroke);
- set the first telephone channel "talking" key to the position "Kan. rad." ["Radio channel"] (the bell will then ring).

409. On the transceiver unit, one should:

- set the left-hand switch of the measuring instrument to the position "Wej. nad." ["Transmitter input"];
- using the potentiometer "Ustawienie poziomu" ["Level adjustment"], adjust the frequency deviation by means of the measuring instrument, according to the [calibration ?] table supplied with each transmitter.

Remarks

1) The transmitting level in the second telephone channel is also set after the adjustment of the transmitter frequency deviation, and after the adjustment of the receiving level in the first telephone channel in the second station. The only difference is that the measuring instrument switch is set to the position "GP_2", and the measurement [testing] generator signal level, which has already been adjusted, is transmitted in the second channel.

2) One should not adjust the transmitter frequency deviation according to the transmitting level of the second telephone channel.

Adjustment of the receiving level

410. The receiving level should be adjusted in the following way:

- the Block 2 measuring instrument switch should be set to the position "U_1";
- the "talking" key of the first telephone channel should be set to the position "Kan. rad." ["Radio channel"];
- turning the knob of the first telephone channel potentiometer "I", the pointer of the measuring instrument should be set to the figure 50, which is marked with a stroke. (During the reception of the testing [measurement] signal from the correspondent station, the bell will ring);

411. The reception level in the second telephone channel is adjusted in the same way, with the difference that the measuring instrument switch should be in this case set to the position "U_2", while the level is adjusted with the aid of the potentiometer "II".

Switching off the equipment

412. When the station is supplied from the mains, the equipment should be switched off in the following way:

- the type of power supply switches in Blocks 1 and 2 are set to the position "Wylacz." ["Off"];
- the mains attachment switch is set to position "Wylacz." ["Off"];
- the voltage adjustment knob is turned anti-clockwise as far as it will go;
- the power supply cable is disconnected, first from the mains, and then from the input terminals panel;
- the power supply cable is rolled up and placed in the left-hand case , under the table with the equipment;
- the earth connection is disconnected from the truck.

/ Remark .....

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Remark

When the equipment is being switched off temporarily, only the first action is performed.

413. When the station is supplied from the batteries, the equipment should be switched off in the following way:

- the power supply switches in Blocks 1 and 2 are set to the position "Wylacz." ["Off"];
- the charging panel switches are set to the position "Wylacz." ["Off"];
- if the batteries were being charged, the petrol-driven generator unit is switched off;
- the power supply cable is disconnected from the petrol generator unit and from the truck, and is then rolled up;
- the generator unit is covered with its metal housing, carried into the truck, and placed under the table;
- the earth connection is disconnected from the truck.

Remark

When the equipment is being switched off temporarily, only the first action is performed.

7. Checking the Readiness of the Equipment for Operation

Checking the supply voltages, and the operating conditions of the valves.

414. For this purpose it is necessary:

- to switch on the equipment;
- check the presence of all the voltages.

415. For this purpose, the left-hand switch of the measuring instrument should be set in turn to positions: "+ 160 nad." ["+ 160 transmitter"], "+ 120 V", "- 25 V", "- 45 V", "+ 160 odb." ["+ 160 receiver"].

416. When the voltages are normal, the measuring instrument pointer should deflect to the marked sector of the instrument scale;

/ - check .....

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- check the operating conditions of the receiver valves.

417. For this purpose, the left-hand switch of the measuring instrument should be set to the position "Odb." ["Receiver"], and the right-hand switch should be set in turn to all the positions marked with numbers 1 to 16, which are located on the smaller circle (these numbers correspond to the numbers of the valves on the basic circuit diagram).

418. If the valves operate within the rated conditions, then in each position of the switch, the measuring instrument pointer should deflect to the marked sector of the instrument scale. In position "4", the instrument pointer will deflect only if the quartz calibrator is switched on:

- check the operating conditions of the transmitter valves.

419. For this purpose, the left-hand switch should be set to the position "Nad." ["Transmitter"], and the right-hand switch should be set in turn to all the positions from 1 to 6 (these numbers are located on the external circumference of the circle).

420. If the valves operate within the rated conditions, then the instrument pointer should deflect to the marked sector of the scale:

- check the supply voltages and the operating conditions of the valves in the telephone portion of Block 2.

421. For this purpose, the measuring instrument switch "TF - TG" should be set to the position "TF", and the second switch should be set successively to positions: "160", "12", "L-4", "L-3", "L-1".

422. In each position of the switch, the measuring instrument pointer should deflect to the marked section of the scale:

- check the supply voltages and the operating conditions of the valves in the telegraph portion of Block 2.

423. For this purpose, the switch "TF - TG" should be set to the position "TG", and the second switch of the measuring instrument should be successively set to positions: "LB_1", "L-5", "L-6", "LB_2", "L-7", "L-8".

/ In each .....

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In each position of the switch, the measuring instrument pointer should deflect to the marked sector of the scale. In positions "IB", one measures the voltage of the line circuit vibrator converters. The particular telegraph channel should be at this time connected for operation with the Baudot apparatus.

Checking the transmitter power

424. For this purpose it is necessary to:

- load the transmitter output with a dummy aerial;
- set the left-hand measuring instrument switch to the position "Ant." ["Aerial"];
- switch on the transmitter. At rated voltages of the power supply sources, the instrument pointer should deflect to the marked sector of the scale. Should the transmitter power prove to be too low, the resonant circuit at the output should be trimmed. To gain access to the trimming capacitor it is necessary to loosen the screw marked "Obw. wyjsc." ["Output circuit"] on the front panel of Block 1. The output circuit can be trimmed when the left-hand switch is in the position "Nad." ["Transmitter"], and the right-hand switch is in position "1" (numbers on the external circumference of the circle). The capacitor shaft should be turned until the minimum deflection of the instrument pointer is obtained (minimum anode current in the output valve). Having done this, the power delivered to the dummy aerial by the transmitter should be checked.

Testing the transmitter modulation

425. In order to test the transmitter modulation, the left-hand switch of the measuring instrument of Block 1 should be set to the position "Wejscie nad." ["Transmitter input"], and the "talking" key of one of the telephone channels should be set to the position "Kan. rad." ["Radio channel"].

/ The calling signal .....

426. The calling signal key should be set to the position "ZeW" ["Calling signal"] or "GP". The measuring instrument pointer should then deflect. The measuring instrument pointer should also deflect when one blows into the microphone.

Testing the receiver operation

427. For this purpose it is necessary to:

- set the "talking" key of the first or of the second telephone channel to the position "Kan. rad." ["Radio channel"];
- check for the presence of noise in the earphones;
- check whether this noise disappears when the quartz calibrator is switched on;
- check whether beats (varying pitch of the tone) are audible in the first telephone channel, when the receiver is tuned to the frequencies corresponding to the points marked on the scale.

Remark

The full capacity of the receiver for operation is tested by the "self-contained" operation method.

Checking the accuracy of calibration of the receiver and correction of frequency.

428. Checking of the accuracy of calibration of the receiver and the correction of frequency is carried out at the rated voltages of the primary current sources (12 V with the battery power supply, and 127 V with the mains power supply), after the warming up of the receiver (the warming up period should be not less than 1 hour, with the transmitter switched on), and using for this purpose the first telephone channel.

429. The receiver calibration should be checked with the aerial feeder disconnected, and in the following way.

430. The receiver dial should be set exactly to the determined calibration frequency, which is marked with a point on the dial.

431. The transmitter is then tuned to a frequency which differs

/ not .....

not less than 5 operating wavelengths from the receiver frequency. The receiver automatic frequency control unit is then switched on. In order to obtain a better audibility, the first telephone channel type of operation switch should be set to the position "4 TG". After having set the telephone channels control [testing] key into position "I", the receiver hum should be heard in the earphone of the telephone handset.

432. The quartz calibrator is then switched on. If the beat frequency can be heard in the earphone of the handset connected into the first telephone channel, it means that the receiver detuning remains within the admissible limits. In such a case, there is no need for frequency correction.

433. If there is no beat frequency in the earphone of the handset, it means that either the receiver is accurately calibrated, and the frequency marked on the dial corresponds exactly to the frequency of the receiver tuning, or that, on the contrary, the receiver is considerably out of tune. It is possible to find out which is the case by turning the knob marked "Fala" ["Wave"]. If on slight rotation of the knob marked "Fala" to the right and to the left the beat frequency tone becomes audible, and it begins on a low note, rising in pitch as the detuning increases, this means that the receiver is calibrated exactly.

434. In such a case there is no need for frequency correction.

435. If, on the other hand, there is no beat frequency audible in the earphone of the telephone andset, then the detuning should be increased by turning the knob to the right and to the left until the beat frequency becomes audible in the earphone. The presence of the beat frequency at another point of the scale, beyond the point marking the the calibration frequency, proves that the receiver is out of tune. In such a case it is necessary to proceed with the frequency correction.

436. For the purpose of frequency correction, the following

/ operations 50X1-HUM

operations should be performed:

- remove the leaden seal, and screw out the bolt marked HO (receiver heterodyne oscillator);
- find out on which side of the calibration point the beat frequency tone can be heard - whether on the side of the higher, or of the lower, wavelengths numbers;
- set the receiver dial exactly to the calibration frequency, which is marked with a dot;
- turning the shaft of the tuning capacitor, located on the right-hand side of Block 1, obtain a zero beat at the output of the first telephone channel. If the zero beat has been previously obtained on the side of the lower wavelength numbers, the capacitor shaft should be turned clockwise, and vice versa;
- check the accuracy of calibration at another calibration point. The detuning of the receiver at this point should lie within the admissible limits.

Remark

For frequency correction, use should be made of the special screw-driver, which is provided in the station equipment. When the local heterodyne oscillator valve L-5, and the frequency tuning valve L-6 have been replaced, it is essential to check the receiver calibration, and to perform the frequency correction.

Checking the calibration accuracy of the transmitter and correction of the frequency.

437. The calibration accuracy of the transmitter is checked at the rated voltages of the power supply sources, one hour after the equipment has been switched on.

438. In order to check the calibration it is necessary to:

- remove the leaden seal, and screw out the bolt marked ZG (master oscillator);
- put the receiver and the transmitter on load with dummy aerials;

/- with the quartz .....

- with the quartz calibrator switched on, tune the receiver to the calibration frequency, which is marked with a dot, in order to obtain a zero beat;
- set the transmitter dial exactly to the frequency corresponding to the frequency of the receiver. If the beat frequency tone can be heard at the output of the first telephone channel (or if there is a zero beat), it means that the detuning of the transmitter is within admissible limits, and that there is no need for the frequency correction. If, however, at the accurate setting of the transmitter scale to the frequency corresponding to the receiver frequency, there is no audible beat frequency, and the zero beat appears only when the transmitter is tuned to a frequency differing from the correct frequency, this means that the transmitter is out of tune, and that a frequency correction is necessary.

439. The frequency correction of the transmitter should be performed in the following way:

- set the transmitter tuning dial exactly to the appropriate calibration frequency (according to the receiver frequency);
- through the aperture in the side wall of Block 1, turn the shaft of the tuning capacitor, until a zero beat is obtained at the output of the first telephone channel;
- check the accuracy of the transmitter calibration according to the receiver in the second calibration channel.

440. At this point, the detuning should be within the admissible limits.

Remark

Before checking the transmitter calibration, the receiver should be set to zero beat at the point marking the calibration frequency. If the zero beat cannot be obtained by tuning the receiver, the accuracy of the transmitter calibration should be tested at one of the adjacent calibration frequencies. One should first check the receiver calibration accuracy at the nearest calibration point. The receiver scale should be set very accurately to the given calibration frequency, as otherwise the calibration error of the transmitter will be increased

/ by the error .....

by the error due to the inaccurate setting of the receiver frequency.

- screw in the cap into the aperture ZG, and fix the leaden seal.

Testing the operation of automatic frequency control.

441. The operation of the automatic frequency control should be tested at the rated values of the sources of supply voltages, and at the scale settings corresponding to the calibration frequencies.

442. The operation of the AFC should be tested in the following way:

- tune the receiver to the calibration frequency;
- set the first telephone channel type of operation switch to the position "4TG";
- set the telephone channel testing key to the position "I";
- switch on the quartz calibrator;
- set the left-hand switch of Block 1 to the position "Odb." ["Receiver"], and the right-hand switch to the position "L-6" according to the markings on the interior circumference of the circle;
- turning slowly the knob "Fala" ["Wave"], tune the receiver for zero beat in the earphone;
- switch on the AFC (set the switch "AFCz" to the position "Wlacz." ["On"]). If after switching on the AFC the beat frequency pitch in the earphone of the handset changes, this shows that the AFC is tuned correctly.

443. When the AFC is adjusted correctly, the current of valve L-6 in the receiver should not change when the AFC is switched on and off.

444. If the current does change, the AFC should be re-adjusted.

Adjustment of the AFC [Automatic frequency control] when the station is powered from batteries.

445. For this purpose, it is necessary to:

- check the AFC operation;
- remove the leaden seal and screw out the cap marked "AFCz";

/- with the aid .....

- with the aid of the potentiometer R_{37}, located on the left-hand wall of the chassis of Block 1 (see Figure 20), adjust the circuit so that when switching the AFC on and off, the valve current does not change, and the beat frequency tone pitch at the output of the first telephone channel also remains constant;
- screw in the cap into the aperture marked "AFCz", and re-fix the leaden seal.

Adjustment of the AFC [Automatic frequency control] when the station is powered from the mains.

446. When the station is powered from the a.c. mains, the adjustment of the AFC is performed in a similar manner as in the case of the battery power supply, with the difference, however, that the circuit is now adjusted with the aid of the potentiometer located on the front panel of Block 3.

Remark

In order not to disturb the adjustment of the AFC when passing from one kind of supply to the other, the circuit should be adjusted first with the battery power supply, and then with the power supply from the a.c. mains.

Checking the operation of the station by the method of "self-contained" operation.

447. The "self-contained" operation consists of the co-operation of the transmitter of one half-set with the receiver of the other half-set, or of the co-operation of the transmitter of a half-set with the receiver of the same half-set.

448. Both in the first and in the second case, the half-sets should be switched on for operation as in a terminal station.

449. As a rule, in self-contained operation, the transmitter of one half-set is used with the receiver of the other half-set. In this case the transmitter should be loaded with a dummy aerial, and the receiver is connected to the aerial with the aerial feeder.

/ In order to .....

450. In order to perform the "self-contained" operation test, the transmitter should be tuned to the receiver frequency (it can also be done the other way round, by tuning the receiver to the operating transmitter frequency). If after the transmitter and the receiver are tuned to the same frequency, the noise in the telephone channels is considerably reduced then in turn one should test the channels for conversation and calling signal transmission. The testing methods have been described in the appropriate sections of this manual. The correct transmission of telephone conversation, and of the calling signals proves the efficiency of the equipment. Such tests should be performed with different aerials connected to the receiver (the vertical and the horizontal aerial). The efficiency of the aerial and the aerial feeder is determined by the degree of the drop of the noise level in the telephone channels.

451. If the "self-contained" operation test is performed with the transmitter and receiver of the same half-set, the transmission of the telephone conversation should not be tested when using the "talk-call" circuit of Block 2. For this purpose of testing the efficiency of telephone conversation and calling signal transmission through the telephone channels, they should be switched into operation in the circuit "4TF", and the telephone instrument TAI-43 should be connected to the terminals 3, 4 or 7, 8 of the line terminals panel. Speech from the telephone instrument should be heard in the handset earphone of the "talk-call" circuit of Block 2 (the testing selector switch should be set to the position corresponding to the channel being tested).

452. When the calling signal is sent from the telephone instrument, the bell should ring.

453. All the defects found during the self-contained operation test should be removed forthwith.

/ 8. Use of .....

8. Use of the Equipment when Operating as a Terminal Station

454. The wire lines connected to the terminal station should be marked with the numbers of the central exchange sockets to which they are connected, and with the appropriate code names.

455. As telegraph lines, one can use either separate wire lines, or two-wire telephone lines of the first and the second telephone channels, which in this case should be connected at both ends through the line transformers. The connection of the line transformers to the wire lines is made in the radio-relay station with the aid of switches located on the line panel. For instance, in order to use the lines of the first telephone channel for the operation of the first or the second telegraph channel, the switch "1TF" on the line panel should be set to the position "1TG" or "2TG" respectively.

456. If separate wire lines are used for the telegraph operation, the switches "1TF" and "2TF" on the line panel should be set to the position "Wylacz." ["Off"].

457. The process of establishing communication, and of the adjustment of levels in the telephone channels when the station operates as a terminal station, has been already described in the sub-heading 6 of this chapter. We shall now examine the types of operation and the maintenance of service communication when the station operates as a terminal station.

Operation of the station when using own multiplexing equipment

Use of the telephone channels

458. In order to prepare for use the telephone channels of the station the following steps should be taken:

- connect the wire lines of the first and the second telephone channels to the terminals "1 - 2" and "5 - 6" respectively, on the input terminal panel (outside the truck);

/ - check .....

- check the transmission of speech and of the calling signals from the station to the exchange and vice-versa. For this purpose the "talking" key of the respective channel should be set to the position "Centr." ["Exchange"];
- check the quality of transmission of speech and of the calling signals through the radio-relay route from one terminal exchange station to the other, and vice-versa. The "talking" keys should in this case be set to the middle position. The transmission of the calling signals through the radio-relay is indicated by the pilot lamps marked "Centr." ["Exchange] or "Kan. rad." ["Radio channel"], and by the bell. When the calling signal comes from the exchange station, the green pilot lamp marked "Centr." lights up. When the calling signal comes from the side of the radio relay correspondent [distant] station, the red pilot lamp marked "Kan. rad." lights up;
- the transmission of speech through the radio relay route can be tested with the aid of the telephone handset, by setting the testing key marked "Kontr." ["Test"] to the position I or II.

<u>Switching on the telegraph channels</u>.

459. The telegraph channels should be connected in the following way:

- the telegraph channel type of power supply switch located on Block 2 should be set to the position corresponding to the particular type of power supply (mains or battery);
- set the switch "Konc. Retr." ["Terminal Re-transm."] to the position "Konc." ["Terminal"];
- set the channel switch "Norm. Odwrotn." ["Normal Reverse"] to the position "Norm.", both for the "ST-35" and for "Baudot" operation;

/ - set .....

- set the type of operation key "Bodo - Dupleks - ST-35 - Simpleks" ["Baudot - Duplex - ST-35 - Simplex"] to the appropriate type of operation.

460. In order to test the telegraph channels by the "self-contained" operation method the following steps should be taken:

- set the measuring instrument switch to the position "TG";
- set the type of operation switch to the position "Baudot";
- set the measuring instrument selector switch to the position "8.5 - 9.1" ("12.2 - 12.8")*;
- set the telegraph channel key to the position "Sprawd. 9.1" (12.8) ["Check 9.1"]. In this case, the + 60 V voltage is applied to the line winding of the transmitting relay, and the ultra-sonic frequency generator output is connected to the input of the telegraph signals receiver. The measuring instrument pointer should deflect to the right and should remain in the marked sector of the scale;
- the testing key should be set to the position "Sprawdz. 8.5" (12.2). In this case to the line winding is applied the - 60 V voltage. The measuring instrument pointer should deflect to the left, and should remain in the marked sector of the scale;
- check the deviation of the transmitter for each telegraph channel. For this purpose, the left-hand switch of the measuring instrument located on Block 1 should be set to the position "Wejsc. nad." ["Transm. input"], and the switch "Praca - Sprawdz." ["Operation - Testing"] located on Block 2 should be set to the position "Praca" ["Operation"]. The measuring instrument

/ pointer .....

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* Note Positions for the second telegraph channel are given in brackets.

pointer on Block 1 should deflect and should indicate the same number of scale divisions as is given in the table of deviations (it should be remembered that the deviation of the telephone channels has already been adjusted beforehand).

Adjustment of the telegraph channels

461. The radio relay station telegraph channels are adjusted by means of the instrument included in the equipment of the station.

462. For this purpose, one should:

- at the terminal stations: connect the terminal "Nad." ["Transmission"] of the instrument for adjusting the telegraph channels and relays, with the terminal "11" or "13" of the line panel; the terminal "Odb." ["Reception"] - with terminals "12" or "14", as required;. the terminal "Z" - with the terminal "Ziemia" ["Earth"] of the line panel. The keys of the telegraph channels should be set: one in the position "Bodo" ["Baudot"], and the other in the position "Praca" ["Operation"];
- set the change-over switch "2 biegun. - 1 biegun" [presumably: "Bi-directional - Uni-directional"] on the instrument for adjusting the telegraph channels and relays, to the position "2 biegun.";
- set the switch "Sprawn. - Symetr. - Bad. kan." ["Efficiency - Symmetry - Channel test"] to the position "Bad. kan." ["Channel test"];
- set the switch "Bad. kan. - Sprawdzanie" ["Channel test - Checking"] to the position "Sprawdzanie ["Checking"], and the switch "Normaln. - Odwrotn." ["Normal - Reverse"] to the position "Normaln." [Normal"];
- switch on the instrument for adjusting the telegraph channels and relays;
- turn the knob marked "Rownowazenie" ["Balancing"] until the

pointer .....

pointer oscillates about the zero mark. This shows that the positive and the negative pulses are equal;

- set the switch "Bad. kan. - Sprawdzanie" ["Channel test - Checking"] to the position "Bad. kan." ["Channel test"]. The properly adjusted telegraph pulses will then be sent to the transmitting part of the telegraph channel, and the telegraph pulses received from the other station will be applied through the receiving part of the channel to the measuring circuit and the instrument;
- set the instrument switch located on Block 2 to the position "LT_1" ("LT_2"). Then press the button "LT" on the instrument for adjusting the telegraph channels and relays, and with the aid of the potentiometer "Prad liniow." ["Line current"], located on Block 2, adjust the current until the pointer indicates the number 25;
- with the aid of the potentiometer of the telegraph channel being tested, located on Block 2 and marked "Rownowazenie" ["Balancing"], adjust the telegraph channel, until the pointer of the milliammeter oscillates about the zero mark.

Remarks

1) The Baudot instruments operate with bi-directional pulses, and the ST-35 instruments operate with uni-directional pulses. As mentioned above, the channel adjustment is performed simultaneously in both directions, both for the duplex operation of the ST-35 instrument, and for the operation of the Baudot instruments. The telegraph channel adjustment for the simplex operation of the ST-35 instruments is performed also in the Baudot circuit.

2) The basic data concerning the instrument for adjusting the telegraph channels and relays are given in the section 8 of this chapter.

Preparation of channels for operation with the telegraph instruments

463. For duplex operation with the Baudot or ST-35 instruments,

/ the wire lines .....

the wire lines connecting the instruments with the telegraph channels should be connected to the input terminals panel in the following way:

- the lines intended for transmission in the first and the second telegraph channels should be connected to the terminals "11" and "13" respectively;
- the lines intended for reception in the first and the second telegraph channels, should be connected to the terminals "12" and "14" respectively. For simplex operation of the instruments ST-35, the lines of the first and the second channels should be connected to the terminals "11" and "13" respectively.

Remarks

1) For operation with the ST-35 instruments, the line circuits are fed with power from the side of the telegraph instruments. For operation with the Baudot instruments, the receiving line circuits are fed with power from the side of the radio-relay station, and the transmitting line circuits are fed from the line side.

2) When operating the ST-35 instruments, one can earth the negative or the positive terminal of the battery, on the Baudot instrument side.

3) If the positive terminal of the battery is earthed - the switch "Normaln. - Odwrotn." ["Normal - Reverse"] should be set to the position "Odwrotn." ["Reverse"].

464. The key "Sprawdz. - Praca" ["Check - Operation"] should be set to the position "Praca" ["Operation"].

465. Adjust the valves of the line currents. For this purpose, the multiplexing unit measuring instrument switch should be set to the position "TG", and the step-by-step switch of the instrument to the position "LT_1" or "LT_2" (the line current of the appropriate channel).

466. At the radio-relay station, in all the cases, only the line input currents energising the telegraph transmitting relays are adjusted. The rated value of the line current can be obtained with the aid of potentiometers marked "Prad liniowy" ["Line current"].

467. For the operation of the ST-35 instruments, the line current should be adjusted in such a way that the meter pointer indicates the division

50X1

marked 50; this corresponds to a line current of 50 mA. During operation of the Baudot instruments, the line current should be adjusted until the pointer indicates 25; this corresponds to a line current of 25 mA.

468. Communicate with the telegraph exchange in order to check whether the telegraph instrument operation through the radio-relay link is correct.

469. On completion of the above steps, the telegraph channels will be ready for use.

<u>Operation of the station with external multiplexing</u>

470. When the station operates with external multiplexing, the second telephone channel and both the telegraph channels are disconnected. On the other hand, the first telephone channel works normally, and can be used both for operational communication, as for service communication.

471. For operation with the external multiplexing equipment, the following steps should be taken:

- establish communication, and adjust the levels in the first telephone channel;
- connect the transmitting path wire line of the external multiplexing unit to the terminals "15 -16" located on the input terminals panel, and the receiving path wire line to the terminals "17 - 18";
- set the left-hand switch of Block 1 measuring instrument to the position "Wejsc. nad." ["Transm. input"];
- set the type of operation switch on Block 2 to the position "Zewn. zwielokrotn." ["External multiplexing"];
- adjust the transmitting level in the external multiplexing channel (the level adjustment is described later in this manual).

/ <u>Earthing</u> .....

Earthing of the station

472. In order to ensure the correct operation of the telegraph channels, one should carefully earth the station.

473. To earth the station, proceed as follows:

- dig two holes about 30 to 50 cms. deep, and at a distance of 15 to 20 m. from one another;
- drive earthing pegs into the holes, and connect these pegs by special leads to the terminals "Ziemia" ["Earth"] on the input terminal panel.

474. The holes should be dug in low-lying sites, in damp ditches, in the vicinity of streams, etc.. When the ground has low conductivity (sand, stony surface, rocks,) one should bring an additional lead from the communication centre to serve as a return connection for the telegraph channels.

Checking the state of the connecting lines and the quality of the earthing

475. The state of the connecting lines and the quality of the earthing is checked from the communication centre; the measurement should be applied to "the insulation" and "the earth" of the line being tested.

476. For the purpose of testing the insulation of any lead, it should be disconnected from the input terminal panel.

477. For the purpose of testing the insulation of a circuit through its mid-point, the switch "1TF" or "2TF" (according to the line being tested) must be set to the position "Wylacz." ["Off"].

478. In order to measure the "earth" of any circuit, the terminal of the appropriate lead on the lines panel should be connected with the terminal "Ziemia" ["Earth"].

479. In order to measure "the earth" through the "mid-point of the circuit", the terminals "11" or "13" on the line panel should be connected to the terminals "Ziemia" ["Earth"], and the switch "1TF" (or "2TF"),

/ should be set .....

should be set as required to the position "1TG" or "2TG".

<u>Adjustment of the level during external multiplexing by means of triple carrier telephony equipment</u>

480. For this purpose, one should:

- set the key "Sprawdzanie - Praca" ["Checking - Operation"] to the position "Praca" ["Operation"];
- switch on the first telegraph channel power supply, and after the valves have warmed up (15 to 20 seconds) take a reading of the Block 1 measuring instrument;
- switch off the telegraph channel power supply;
- set the type of operation switch on Block 2 to the position "Zewn. zwielokrotn. konc." ["External multiplexing, terminal"];
- send testing signals of a normal measuring level from the first channel of the triple carrier telephony equipment;
- by turning the shaft of the potentiometer marked "Zewn. zwielokrotn." ["External multiplexing"] located on Block 2, set on the instrument of Block 1 the same value of readings as at point 2.

481. On completion of all the above steps, the external multiplexing channel will be ready for operation.

<u>Adjustment of the level during external multiplexing by means of the single carrier telephony equipment</u>

482. For this purpose, one should:

- send from the second telephone channel of the station a signal at the normal transmission level, and take the measuring instrument reading on Block 1;
- set the type of operation switch of Block 2 to position "Zewn. zwielokrotn. konc." ["External multiplexing, terminal"];
- send a calling signal from the carrier channel of the single carrier telephony equipment;
- turn the shaft of the potentiometer marked "Rtr." ["Re-transmission"] located on Block 2, set the same level as that of the second

telephone channel of the station (see above).

483. On completion of all the above steps, the external multiplexing channel will be ready for operation.

Secondary multiplexing of the telephone channels

484. By means of the multiple telegraphy equipment, multiplexing with three or six telegraph channels can be applied to each of the station telephone channels.

485. The multiple telegraphy equipment should be connected to the four-wire circuit of the station telephone channel in the following way:

- in the case of multiplexing the first telephone channel, the transmitting direction line of the multiple telegraphy equipment should be connected at the input terminal panel to the terminals "3 - 4", and the receiving direction line to the terminals "1 - 2". In the case of the multiplexing of the second telephone channel— the transmitting direction line should be connected at the input terminal panel to the terminals "7 - 8", and the receiving direction line - to the terminals "5 - 6";
- the type of operation switch of the telephone channel to which the multiplexing is applied, should be set to the position "4TG".

486. The remaining channels are connected for operation in the manner described under the heading "Operation of the station when using own multiplexing equipment".

Transit [Re-transmission] operation of the telephone channels

487. The multiplexing unit of the radio relay station makes it possible to connect the telephone channels for transit operation [re-transmission] in a two-wire or in a four-wire circuit. The transit operation is used when the station channels are connected directly with one another, or with the channels of a multi-channel station of the same type, or with the wire channels of a carrier telephony system.

/ 488. .....

[redacted] SECRET

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488. The multi-channel stations and the sextuple carrier telephony systems permit transit connections with the telephone channels of the station in a two-wire circuit only.

489. The transit connection of the channels with a single carrier telephony system is possible both in a two-wire, and in a four-wire circuit.

490. In order to connect the telephone channels for transit operation in a two-wire circuit, the following steps are necessary:

- set the type of operation switch of the appropriate telephone channel to the position "2TF";
- set the "Konc. - Retr." ["Terminal - Re-transmission"] switch to the position "Konc." ["Terminal"];
- set the "Tranz. - Konc." ["Transit - Terminal"] switch to the position "Tranz." ["Transit"];
- connect the wire connection lines assigned to the first telephone channel to the terminals "1 - 2", and those assigned to the second telephone channel to the terminals "5 - 6" (on the input terminal panel).

491. In order to connect the telephone channels for transit operation in a four-wire circuit, the following steps are necessary:

- set the type of operation switch to the position "4TF";
- set the "Retr. - Konc." ["Re-transmission - Terminal"] switch to the position "Konc." ["Terminal"];
- connect the first telephone channel wire lines of the transmitting direction to the terminals "3 - 4", and of the receiving direction to the terminals "1 - 2". The wire lines of the second telephone channel should be connected to the terminals "7 - 8" and "5 - 6", respectively.

<u>Service communication</u>

492. Before using a telephone channel for service communication,

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/ the testing key .....

[redacted] SECRET

the testing key should be tilted into position I or II in order to check whether the particular channel is not being used for an operational conversation.

493. For the purpose of carrying out a service conversation, the "talking" key of the unoccupied channel should be tilted to the position "Kan. rad." ["Radio channel"] or "Centr." ["Exchange"]. The calling signal should then be sent.

494. Calling of the distant radio relay station is done by sending a pre-determined number of calling signals. After sending the calling signals, the desired station should be called by sending its call-sign, and the call-sign of one's own station.

495. In order to answer the calling signal from a terminal station, the "talking" key of the calling channel should be tilted to the position "Kan. rad." or "Centr." [Radio channel" , or Exchange"] according to where the signal came from.

496. When the conversation is finished, the "talking" keys of the telephone channels should be set to the mid-positions.

497. Service conversations can be carried out only in exceptional cases, after obtaining permission from the main [head] station. For service communication between the terminal station and the elements of the communication system there exists as a rule a separate line which is connected to the terminals "9 - 10" on the input terminal panel. To the terminals "9 - 10" on the line panel is connected the telephone instrument TAI-43, which is included in the station equipment.

498. It should be borne in mind that by making a service call along any section of the radio relay route, the communication between the telephone exchanges is interrupted. If the station receives a calling signal when a service conversation is in progress, then a green pilot lamp marked "Centr." ["Exchange"] lights up on Block 2 and the bell rings.

/ 499. .....

499. In such a case the channel should be quickly cleared, and turned over to operational communication. At the same time efforts should be made to secure a good passage of the operational conversations.

500. During external multiplexing, the service calls can be carried out only through the first telephone channel, in the same way as described above.

501. During secondary multiplexing, the service calls are carried out only through the channel which is not multiplexed.

502. During two-wire circuit transit, service calls in both directions are carried out in the same way as when the station is operating with own multiplexing equipment.

503. During four-wire circuit transit operation of the telephone channel, service communication with the radio-relay of the correspondent station is maintained in the following way:

- in order to answer a calling signal, the type of operation switch of the appropriate channel should be set to the position "2TF", and the rocking key "Kan. rad. - Centr." ["Radio channel - Exchange"] to the position "Kan. rad." ["Radio channel"]. If only one channel is used for transit, then the service calls should be carried out in the other channel, in the way described above.

504. When the station is temporarily switched off, and the connecting lines with the communications centre are not removed, then in order to retain the possibility of receiving a calling signal from the exchange, the power supply should not be switched off on the terminal station charging panel.

9. Use of the Equipment when Operating as an Intermediate Station

Preliminary steps, and establishing of communication

505. In an intermediate station, both half-sets operate on re-trans-

/ mission .....

mission. To prepare the station for the re-transmitting operation one should:

- connect both half-sets, and establish communication with the correspondent stations in both directions. Communication with the correspondent stations is established in the same way as when the station operates as a terminal station. The method of establishing the communication has been described under sub-heading 6 of this chapter;
- adjust the station channels. The method of the channel adjustment has already been described;
- notify the correspondent stations of the readiness of the station to go over to re-transmitting operation.

Re-transmission when the station operates with own multiplexing equipment

506. When at an intermediate station both half-sets operate as at a terminal station, then in order to go over to re-transmission, in the case of the operation with own multiplexing equipment, the switches of the telephone and telegraph channels should be set to the position "Retr." ["Re-transmission"].

Remark

During re-transmission, the telegraph channel power supply is not switched on. The type of operation switches of the telephone channels should be set to the position "2TF".

507. Having done this the terminal stations establish mutual communication through the intermediate stations, and, if necessary, adjust the levels.

508. The levels are adjusted in the following way: the terminal station sends a signal at the rated measurement [testing] level through the first telephone channel. This signal is received at the intermediate station, for instance by the receiver of the half-set "A", and then through the cable "SZ-2" is applied to the transmitter input of the half-set "B".

/ On Block 1 .....

On Block 1 of the half-set "B", the left-hand switch of the measuring instrument should be set to the position "Wejsc. nad." ["Transmitter input"]. If the level of the received signal ensures the normal frequency deviation of the transmitter of half-set "B", then the measuring instrument pointer should deflect to the value given in the transmitter frequency deviation adjustment table. If the level is too low, then with the aid of the potentiometer of half-set "B" of Block 1, marked "Regulacja poziomu" ["Level adjustment"] the instrument pointer deflection should be adjusted to the value given in the table. This will correspond to the normal deviation of the transmitter frequency.

509. Having completed the level adjustment at the first intermediate station, the levels of the next intermediate stations should be adjusted in the same way. The level of the terminal station should be adjusted in the way described in sub-heading 6 of this chapter. The levels in the opposite direction are adjusted in a similar way.

Re-transmission when the station operates with external multiplexing

510. When the terminal stations operate with external multiplexing equipment, then in order to obtain the re-transmission at the intermediate station, the following steps should be taken:

- the type of operation switches of own multiplexing equipment of both half-sets should be set to the position "Zewn. zwielokrotn. retr." ["External multiplexing, re-transmission"];
- the first telephone channel switches should be set to the position "Retr." ["Re-transmission"];
- the first telephone channel type of operation switches should be set to the position "2TF";

Remark

The second telephone channels and the telegraph channels of the

/ station .....

station multiplexing equipment do not operate.

Testing and service communications

511. During operation with own multiplexing equipment of the station, the passing of the calling signals along the radio relay channels is indicated at the intermediate station by the ringing of a bell, and by the signal [pilot] lamps marked "Kan. rad." ["Radio channel"] of the particular channel on the half-set from the side of which the calling signal arrived.

512. On receipt of the pre-arranged call-sign, indicating the calling (of own station by the correspondent), one should switch oneself in for listening by means of the telephone channel testing key of the channel which received the calling signal. After hearing one's own call-sign, the "talking" key of the channel concerned should be switched to the position "Kan. rad." ["Radio channel"], and the switch "Konc."- Retr." ["Terminal - Re-transmission"] to the position "Konc." ["Terminal"]. The calling station should then be answered.

513. When the conversation is finished, the switch "Konc. - Retr." ["Terminal - Re-transmission"] should be set to the position "Retr.", and the "talking" key to the mid-position.

514. The telephone exchange or any radio relay station can be called from the intermediate station in exactly the same manner. Before using a channel for the service call, it is necessary to check which of the channels leading in the desired direction is free, by switching in for listening by means of the testing key. If one of the channels is free, the "talking" key of this channel should be set to the position "Kan. rad." ["Radio channel"], and the "Konc. - Retr." switch - into position "Konc." ["Terminal"]. Next, tilting into the appropriate position the key "GP - ZEW", one sends the calling signal, calling the desired station or exchange. After the conversation is completed, the key "Kan. rad. - Centr." ["Radio

/ channel - Exchange...

channel - Exchange"] should be set to the mid-position, and the switch "Konc. - Retr." ["Terminal - Re-transmission"] to the position "Retr." ["Re-transmission"].

515. Should a calling signal from another direction arrive during a service conversation, then the bell will ring, and on the other half-set the pilot lamp marked "Kan. rad." ["Radio channel"] will light up. In such a case the service conversation should be stopped at once, and the channel should be cleared.

516. The transmission of conversations can be tested at the intermediate station by switching the testing key "I - II" to the appropriate position. From one half-set, one can check the transmission of the conversation in one direction only. Testing of the transmission in the other direction can be done in a similar way from the other half-set.

517. In the case of re-transmission with external multiplexing, the service calls can be carried out from the intermediate station through the first telephone channel. The testing of the operation, and the making of service calls, is done in this case in the same way as during re-transmission with own multiplexing.

<u>Extraction of channels from an intermediate station</u>

(<u>Operation as a main repeater station</u>)

518. It is possible to extract telephone and telegraph channel from an intermediate station in two-wire and four-wire circuits. The extraction of the channels from an intermediate station is only possible when the own multiplexing equipment is being used. In order to extract a channel from an intermediate station, the switches "Konc. - Retr." ["Terminal - Re-transmission"] of the appropriate channel in both half-sets should be set to the position "Konc." ["Terminal"].

519. The principles of maintenance of communication through the extracted channels are the same as in the case of the terminal station.

/ 10. Operation using .....

10. Operation using the Portable Equipment

520. The portable equipment serves for operation away from the truck. In many cases it may be necessary to place the station in shelters, in buildings, on the hills, etc., where it is not possible to bring up the truck. The design of the station makes possible the speedy removal of the equipment from the truck, and establishing communication from another site.

List of components of the portable equipment

521. The portable equipment is composed of the following items:

- Block 1	1
- Block 2	1
- Line panel	1
- Connecting cables (SZ-1, SZ-2, SZ-5, SZ-12)	1 set
- Telephone handset	1
- 5NKN-45 batteries	2
- Box with aerial and aerial feeders	1
- Package with the mast sections	1
- Mast hoist with the wooden mast section	1
- Packing with the mast rigging	1

522. The cable SZ-2 is required only in the case when the intermediate station is deployed outside the truck and both half-sets are removed from the truck. When it is not necessary to erect the aerial to its full height, the number of the mast sections for the portable equipment can be reduced.

Removing the equipment from the truck

523. In order to prepare the portable equipment for removal from the truck, the following steps are necessary:

- disconnect the connecting cables from the blocks on the rack and the line panel. Only one half-connector SZ-1-3 should be disconnected from Block 3;
- remove the line panel from its holders;

/ - disconnect..

- disconnect the telephone handset from Block 2;
- remove Blocks 1 and 2 from the rack;
- place the line panel and Blocks 1 and 2 inside the knapsacks. In the line panel knapsack place also the connecting cables and the telephone handset;
- remove from underneath the truck the case with the aerial;
- remove the mast hoist from the truck;
- place in the packing the required number of mast sections;
- remove from the case the two 5NKN-45 batteries, and attach to them the carrying belts.

524. When carrying the portable equipment to the deployment site, the various elements should be protected against knocks and must not be thrown about.

Preparing the portable equipment for operation. Special features of its operation

525. At the deployment site of the portable equipment one should:

- prepare the deployment site, and take steps necessary for concealing the equipment and its personnel;
- erect the masts with the aerials, taking into account the local topographical conditions;
- remove the line panel and Blocks 1 and 2 from knapsacks;
- Place Block 1 on Block 2;
- connect the cables to the line panel and to Blocks 1 and 2;
- lengthen the cable SZ-1 with the aid of the cable SZ-12;
- connect cable SZ-12 to the batteries;
- connect the aerial feeders to the receiver and the transmitter;
- connect the wire lines to their appropriate terminals on the line panel;
- connect the telephone handset to Block 2;
- switch on the equipment, set the operating wave-lengths,

/ establish the communication .....

establish the communication, and adjust the channels of the station.

526. When setting up the intermediate station outside the truck, both half-sets should be placed side by side. The multiplexing blocks of both half-sets should be inter-connected by means of the cable SZ-2 (Figure 84).

527. A peculiarity of the portable equipment is the fact that in most cases it will be powered from batteries only. Therefore, if the operation from outside the truck is expected to last for some time, it will be necessary to arrange for the batteries to be charged.

528. On finishing work, the equipment is brought back to the truck and replaced in its usual position. When installing the equipment inside the truck, special attention must be paid to securing it firmly in position.

11. Battery Charging

529. When servicing and using the batteries and the petrol-driven generator assemblies, one should adhere to the following instructions contained in the station:

- "Servicing manual for cadmium-nickel batteries";
- "Servicing, use, and adjustment manual for the engine 2 SD";
- "Form for the generator type GSK-1500".

530. The station battery charging should be performed in the following way:

- remove the generator assembly from the truck, place it at a distance of about 15 to 20 meters from the truck, and prepare for operation;
- connect the cable N-3 with the half-connector "12 - 27 V", located on the input terminal panel;
- open the lids of the battery boxes and unscrew the vent plugs;

/ - before charging ..

- before charging the batteries, the level of the electrolyte should be checked, and if necessary, topped up;
- start the generator engine;
- the switch "AGR" ["Mobile Generator"] on the charging panel, to which the generator set is connected, should be set to the position "Wlacz." ["On"];
- set the voltmeter switch on the charging panel to the position "AGR";
- adjust the generator voltage by means of the field rheostat knob. This voltage should be 18 to 20 V;
- set the switches of the battery group to be charged to the position "Ladowanie" ["Charging"]. With one generator assembly, not more than two battery groups can be charged at the same time. When it is necessary to charge more than two groups, another generator assembly should be used;
- adjust the charging current of each group to 1.25 A [?]. The normal charging should last about 7 hours. When necessary, an accelerated charging rate is admissible. This is performed in the following way: 2.5 hours at a double rate, followed by 2 hours charging at the normal charging current.

531. After 10 to 12 charging cycles, or when the station is not used regularly, an intensified charging should be performed once a month. The intensified charging is performed in the following way: during 6 hours the batteries are charged at the normal charging current, and during the next 6 hours - at a current equal to one half of the normal charging current;

- if during the battery charging the electrolyte has been spilled, it should be removed from the battery with the aid of the rubber bulb syringe;

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/ - during .....

- during battery charging it is forbidden to approach the batteries with a naked flame.

532. When the batteries are being charged simultaneously by two generator assemblies, the cable SZ-11 should be disconnected from one of the charging panels.

533. Battery charging by means of the generator assemblies should be performed according to the above instructions.

534. After the charging is completed, the following steps should be taken:

- set the switch on the charging panel to the position "Wylacz." ["Off"];
- stop the engine and close the petrol tank cock;
- disconnect cable N-3, roll it up, and place it on the mobile generator;
- cover the generator assembly, and place it inside the truck.

12. Instrument for the Adjustment of the Telegraph Channels and Relays

535. This instrument serves for the adjustment of the station telegraph channels, both for uni-directional and for bi-directional pulse operation. It also makes it possible to estimate the degree of the telegraph signal distortion in a channel, and to check the efficiency and symmetry of the telegraph relays.

536. The instrument is powered from a 12 V d.c. source. Its line circuits are supplied from a vibrator converter installed inside the instrument. The description, the circuit diagrams, and the principle of operation of the instrument for the adjustment of the telegraph channels and relays are given in the factory manual for the instrument, which is included in the station equipment. The external view of the instrument is shown in Figures 85, 86 and 87.

/ Switching .....

Switching on the instrument

537. The supply voltage for the instrument is taken from the battery charging panel. The socket with the voltage for the instrument is located on the left-hand side of the charging panel. When connecting the instrument it is necessary to pay attention to the polarity (+, -). The instrument power supply is switched on with the switch located on the front panel of the instrument. This switch should be set to the position "Wlacz." ["On"].

538. When the voltage is switched on, the yellow pilot lamp lights up and the vibrator converter, and the pulse generator relay begin to operate. The pulse frequency (the telegraphic speed) of the generator is 50 bauds.

The testing and adjustment of the telegraph relay symmetry

539. Before starting the relay symmetry test, the pulse generator should be adjusted to give equal length of the positive and the negative pulses.

540. When adjusting the pulse generator for bi-directional operation, the sequence of operations is as follows:

- set the switch "1 bieg. - 2 bieg." ["Uni-directional - Bi-directional"] to the position "2 bieg." ["Bi-directional"];
- set the switch "Sprawn. - Symetr. - Bad. kan." ["Efficiency - Symmetry - Channel testing"] to the position "Bad. kan." ["Channel testing"];
- set the switch "Bad. kan. - Sprawdzanie" ["Channel testing - Checking"] to the position "Sprawdzanie" ["Checking"];
- switch on the power supply. When the power is switched on, the pulse generator starts to operate. If the instrument pointer does not oscillate about the zero mark, it means

/ that the length .....

that the length of the positive and negative pulses is not equal;

- adjust the pulses for equal length.

541. In order to obtain equal length of pulses, the knob of the potentiometer marked "Przewazanie" ["Out of balance"] should be turned until the pointer oscillates about the zero mark.

542. The telegraph relay is checked for symmetry in the following way:

a) the relay to be tested should be inserted into the socket marked "Bad. przekazn." ["Relay testing"].

b) set the switch "Sprawn. - Symetr. - Bad. kan." ["Efficiency - Symmetry - Channel testing"] to the position "Symetr." ["Symmetry"].

543. If the relay is correctly adjusted for symmetry, the instrument pointer will oscillate about the zero mark. If the relay is incorrectly adjusted, the pointer will oscillate about the scale division which indicates the percentage distortion of the telegraph signals by this particular relay.

Measurement of relay efficiency

544. After having tested the relay for symmetry, the switch "Sprawn. - Symetr. - Bad. kan." ["Efficiency - Symmetry - Channel testing"] should be set to the position "Sprawn." ["Efficiency"] for the relay efficiency test. The efficiency of a relay, given as a percentage, is found from the expression : $K = 100 - A$; where A is the number of divisions indicated by the oscillating pointer of the instrument.

/ 13. Possible .....

13. Possible Faults and Methods of their Elimination

No.	Nature of fault	Cause	Method of elimination
1	When checking the receiver or the transmitter valve operating conditions (see sub-heading 7) the Block 1 instrument pointer does not deflect.	The particular valve of the receiver of of the transmitter is defective.	Replace the valve. (The valve numbers are engraved on the chassis near each valve).
2	When checking the multiplexing block valve operating conditions, the Block 2 instrument pointer does not deflect.	The particular valve of the telephone or telegraph channel is defective. Break in the circuit.	Replace the valve. Check the circuit.
3	The telephone or telegraph signals from the station channels do not enter the line.	Blown line panel fuse of the wire line concerned.	Replace the fuse.
4	When the calling signal is coming from the direction of the radio-relay or of the telephone exchange, the bell rings, but the pilot lamp does not light up.	Burnt-out bulb of the pilot lamp of this channel and direction. Break in the pilot lamp circuit.	Replace the bulb. Check the circuit.
5	The radio-relay station does not receive the calling signal the (bell does not ring and the pilot lamp does not light up).	Defective calling signal receiver relay RP-15 of the particular channel. Break in the "OZA" circuit.	Rep ace the relay. Check the circuit.
6	The telegraph signals do not pass either in the direction of the radio-relay, or in the direction of the wire line.	Defective transmitting or receiving relay type RP-4 of the telegraph channel. Blown fuse in the line panel circuit concerned	Replace the relay. Replace the fuse.

No.	Nature of fault	Cause	Method of elimination
7	Crackling noises in earphones, speech intermittently disrupted.	Defective contacts in the handset earphone. Break in the handset cord.	Correct the contacts in the earphone. Replace the cord.
8	No modulation of the transmitter by the micro-telephone.	Defective handset microphone. One of the modulation amplifier valves faulty. No current in the handset	Replace the microphone. Replace the valve. Check the handset current supply circuit.
9	No power or too low power at the transmitter output.	Defective valve 4-PIL (L-1).	Replace the valve.
10	In one of the telephone channels speech does not pass towards the radio-relay.	Defective contact in the switch "Kan. rad. - Centr."	Bend the appropriate springs in the switch.
11	No receiver hum and no correspondent station signals in one of the telephone channels.	Defective contact in the switch "Kan. rad. - Centr.". Break in the potentiometer for the receiving level adjustment. Defective valve in Block 2 WMCz [Low frequency amplifier].	Re-bend respective springs in the switch. Replace the the potentiometer. Replace the valve.
12	The pilot lamp on the charging panel lights up when a group of batteries is connected for charging.	Blown fuse in the charging circuit of the battery group concerned.	* Replace the fuse.
13	No + 160 V anode voltage in the transmitter.	Blown left-hand fuse in Block I. Same in Block 3.	* Replace the fuse. * Replace the fuse.

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* If the new fuse blows again, the appropraite circuit should be checked

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No.	Nature of fault	Cause	Method of elimination
14	No + 160 V and 45 V (supply voltages) in the receiver.	Blown right-hand fuse in Block 1.	* Replace the fuse.
15	No ± 60 V line circuit supply voltage.	Blown fuse in Block 2.	* Replace the fuse.
16	No receiver, transmitter or line circuit supply voltage, or too low supply voltage.	Defective vibrator of the vibrator converter concerned.	Replace the vibrator.
17	One of the pilot lamps on Block 3 lights up.	Blown fuse.	* Replace the fuse.
18	After the batteries are connected for charging, the charging panel ammeter pointer does not deflect. Engine revolutions are normal.	Generator voltage too low, causing the reverse current relay to be inactive.	Increase the generator voltage by raising the field current
19	After the batteries are connected for charging, the pilot lamp on the charging panel does not light up.	Blown fuse.	* Replace the fuse.
20	No voltage from the GSK-1500 generator.	No excitation in the generator. Break in the field circuit.	Check the field circuit and remove the defect.
21	Considerable fluctuations of the generator voltage and charging current during battery charging	Sparking at the generator brushes due to dirty commutator or insufficient contact.	Clean the commutator. Adjust brushes correctly.
22	Insufficient power of the petrol engine of the mobile generator.	Dirt in the petrol pipe or in the carburetter. Carbon on the sparking plugs	Clean the petrol pipe and the carburetter. Replace sparking plugs.

* If the new fuse blows again, the appropriate circuit should be checked.

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No.	Nature of fault	Cause	Method elimination
23	White pilot lamp on the mains attachment does not light up.	No mains voltage, or burnt-out pilot lamp bulb.	Switch over to battery power supply. Find the reason of mains voltage failure.
24	White pilot lamp on the mains attachment lights up.	Blown fuse.	* Replace the fuse.
25	Voltmeter does not show any voltage. Green pilot lamp on the mains attachment lights up.	Break in the voltmeter circuit.	Check and repair the defect.
26	When the instrument for the telegraph channel and relay adjustment is switched on, the pilot lamp does not light up and the telegraph pulse generator does not operate.	Break in the power supply cord. Blown fuse	Repair the cord. *Replace the fuse.
27	The telegraph pulse generator of the instrument for the telegraph channel and relay adjustment does not operate.	Contacts in one the RP-4 relays are sticking.	Replace the relay.

* If the new fuse blows again, the appropriate circuit should be checked.

CHAPTER IV

MEASUREMENT OF THE BASIC PARAMETERS OF THE STATION

1. Measurement of the Transmitter Power

545. The transmitter power is measured at rated voltages of the primary power supply sources.

546. For the purpose of the transmitter power measurement, a dummy aerial should be connected at the transmitter output.

547. Prior to the measurement, the transmitter should be tuned for maximum output power. The transmitter loaded with a dummy aerial is tuned by means of the knob marked "Obwod wyjsciowy" [Output circuit"] to the minimum of the valve anode current. This current is measured with the instrument located on Block 1, when the left-hand switch is set to the position "Nad." ["Transmitter"], and the right-hand switch to the position "I".

548. The power is measured indirectly by the measurement of the high frequency voltage across the dummy aerial, with the help of a thermionic voltmeter type WKS-7.

549. The power value is obtained from the expression:

$$P = \frac{V^2}{R}$$

where: P = transmitter power in watts,

V = measured voltage in volts,

R = impedance of the dummy aerial, equal to 75 ohms.

550. To make the measurement of the high frequency voltage possible, there is a special hole in the dummy aerial shield. When measuring the voltage, the tip "W" of the voltmeter probe should be inserted through this hole in order to contact the dummy aerial, and the terminal "Z" should be applied to the shield of the aerial.

551. When measuring high frequency voltages, one must not use long leads.

/552.

552. The transmitter power should be measured at three points of the frequency range.

553. The power delivered by the transmitter to the station aerial, or to the dummy aerial may also be measured with the transmitted power meter, which has a scale calibrated directly in watts.

2. Measurement of the Aerial Feeder Efficiency

554. The aerial feeder efficiency factor η is the ratio of the power P_2 at the output of the feeder loaded with the aerial to the input power P_1.

$$\eta = \frac{P_2}{P_1};$$

This factor is usually expressed as a percentage:

$$\eta\,\% = \frac{P2}{P_1} \times 100.$$

555. The measurement of the efficiency factor η consists of the measurement of power at the input and at the output of the feeder.

556. The feeder efficiency factor is measured in the following way:

- one measures the power P_1 consumed by the dummy aerial when connected directly to the transmitter output;
- one measures the power P_2 consumed by the dummy aerial when connected to the transmitter through the aerial feeder;
- one calculates the efficiency factor. The efficiency factor η can be measured by means of the thermionic voltmeter type WKS-7, or by means of the transmitted power meter.

3. Measurement of the Receiver Sensitivity

557. The receiver sensitivity is equal to the lowest high frequency signal voltage value at the receiver input, which would give at the output of the telephone channel a ratio: $\frac{V_{signal}}{V_{noise}} = 20$ when the frequency deviation is 6 kc/s.

/558.

558. The receiver sensitivity both for the first and for the second telephone channel is measured in the following way:

- when the station is connected for "self-contained" operation adjust the rated output level (105 mV across 600 ohms load) with the aid of the station instruments, or by means of a thermionic voltmeter connected to the output of the telephone channel.
- switch off and disconnect the transmitter.
- disconnect the aerial feeder from the receiver, and apply to the receiver input from the generator (GSS) an unmodulated signal of the same frequency as the frequency to which the receiver is tuned.
- connect a sensitive thermionic voltmeter, or a psophometer to the telephone channel output loaded with 600 ohms.
- set the signal generator GSS output voltage value to obtain 5 mV noise voltage at the output of the telephone channel. The generator GSS should be tuned to the receiver frequency for minimum noise voltage value at the telephone channel output. The high frequency signal voltage at the output of the generator GSS, giving 5 mV noise voltage at the output of the telephone channel, and expressed in micro-volts, corresponds to the receiver sensitivity value.

4. Determination of the Operating Level Setting Error (the Overall Attenuation) in the Telephone Channels by means of the Station Instruments.

559. The operating level setting error (the overall attenuation) in the telephone channels is determined by comparing the readings of the station instruments with the readings of the instruments in the measuring case [walizka pomiarowa] type "ICz".

/560.

560. To determine this error, one should:

- when the station is connected for "self-contained" operation, or when it operates with another station, set the output level at the output of the telephone channels in (both directions) to the normal value with the aid of the station instruments;
- on the transmitting side, at the input of the telephone channel apply from the measuring case a voltage of a frequency of 800 c/s and a level of -1 N.;
- on the receiving side, remove the receiving relay and measure with the help of the measuring case the output level at the output of the telephone channel, comparing it with the rated output level. The difference between the two values gives the operating level setting error;
- the overall attenuation of the telephone channels is determined by the difference between the levels measured at the transmitting and at the receiving end of the channel.

<u>Remarks</u>

1) The normal telephone channel output level in a two-wire circuit is -2 N. (105 mV across a 600 ohms load).

2) The overall attenuation in the telephone channel in a two-wire circuit is 1 N.

3) The overall attenuation setting error when adjusted by means of the station instruments should not exceed ±0.2 N.

5. Cross-Talk Measurement

561. By the term "cross-talk" is meant the effect of the penetration of the modulating voltage from one channel into another.

562. The cross-talk in the channels of the R-401 radio-relay station is determined by comparison of the results of the psophometric noise measurements in a channel without cross-talk (no modulation of the other channel)

/ and in ....

and in presence of cross-talk (modulation of the other channel).

563. The noise in the telephone channel is measured at the terminals of the appropriate channel, located on the line panel, with the aid of a psophometer. The psophometer is a thermionic voltmeter with a square-law scale, and a very wide voltage range (from tenth parts of a millivolt to several volts). Thanks to suitable filters, the sensitivity of the psophometer allows during measurement for the unequal influence of interferences originating from different frequencies.

564. The block diagram of a psophometer is shown in Figure 88. A psophometer should not be used as a thermionic voltmeter for the measurement of voltages of different frequencies, or for the taking of the frequency response curve, as it indicates the correct voltage only at the frequency of 800 c/s.

565. The noise voltage measured with a psophometer at the output of the telephone channel, with a load of 600 ohms, is known as the psophometric noise voltage.

566. Prior to the measurements, the psophometer should be adjusted according to its instruction manual. The cross-talk testing can be performed either with the station connected for "self-contained" operation, or with two stations, located at a short distance and both operating as terminal stations.

567. Prior to the measurements it is necessary to set:

- the normal frequency deviation of the transmitters with the normal input levels at the inputs of the telephone channels;
- the normal telephone channel output levels.

568. The noise (cross-talk) measurement is performed in the following manner. One of the channels is modulated with a signal of 1000 c/s frequency and the rated channel input level, taken from an audio frequency generator

/(or from the .....

(or from the measuring case type ICz). The modulating signal is switched periodically on and off. At the opposite station, a psophometer and a load of 600 ohms is connected to the output of the other telephone channel. The noise voltage is measured in presence and in the absence of the modulating signal in the other channel. The cross-talk voltage is determined from the following expression:

$$U_{cross-talk} = \sqrt{U_2^2 - U_1^2} ;$$

where: $U_{cross-talk}$ = psophometric cross-talk voltage;

U_2 = psophometric noise voltage in one channel in presence of a modulating signal in the other channel;

U_1 = psophometric noise voltage in one channel after the modulating voltage in the other channel is switched off.

6. Telegraph Distortion Measurement.

569. The telegraph distortions in the channels of the R-401 station can be measured with great accuracy by means of a stroboscope. By means of a stroboscope one can also determine the measurement error of the instrument for the adjustment of the telegraph channels and relays. It /the stroboscope/ is included in the station equipment. For this reason, before making measurements, the telegraph channel should be first adjusted by means of the station instrument (the method of adjustment was described in Chapter III.). The telegraph channel distortions should then be measured by means of the stroboscope.

570. The telegraph distortions should not exceed 10%.

/Appendix 1

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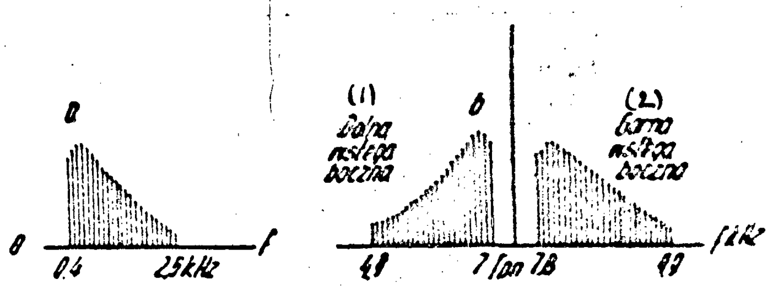


Rys. 1. Przekształcanie pasma częstotliwości:
a — pasmo częstotliwości sygnału mowy; b — przekształcone pasmo częstotliwości

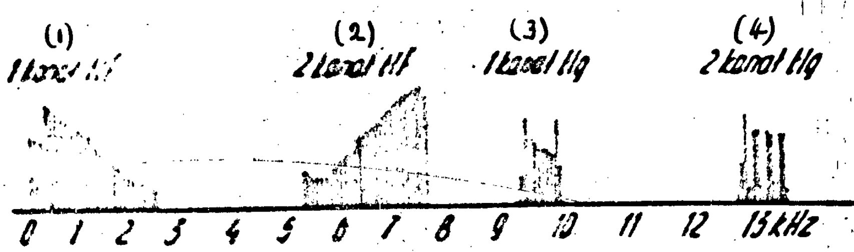
Figure 1: Transformation of the frequency band

a) speech signal frequency band

b) transformed frequency band

KEY: (1) lower side band

(2) upper side band



Rys. 2. Rozmieszczenie pasm częstotliwości kanałów telefonicznych i telegraficznych

Figure 2: Distribution of the frequency bands of the telephone and telegraph channels

KEY: (1) 1st Telephone Channel (2) 2nd Telephone Channel
(3) 3rd Telephone Channel (4) 4th Telephone Channel

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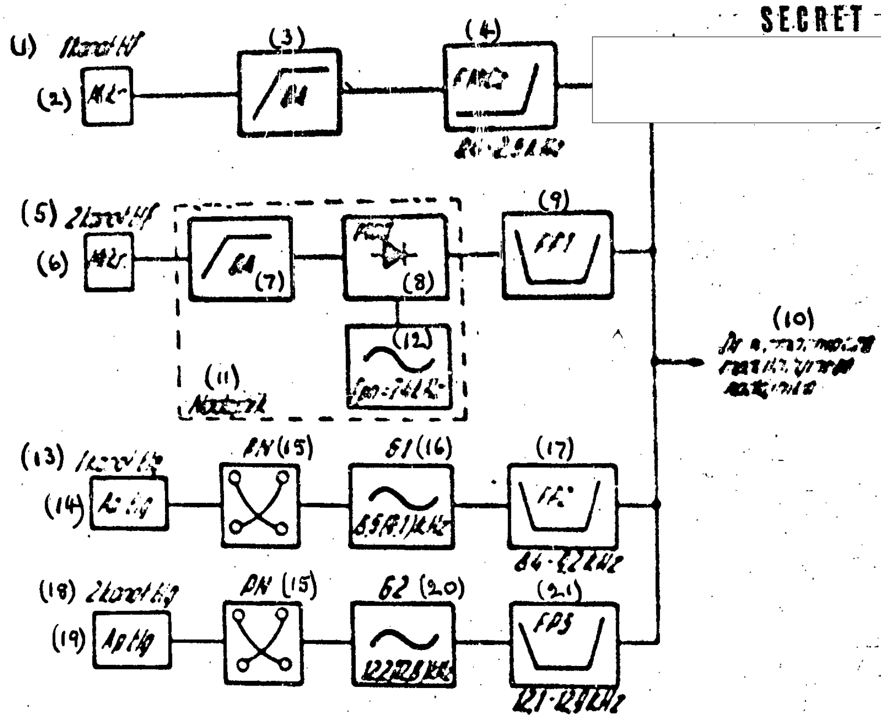
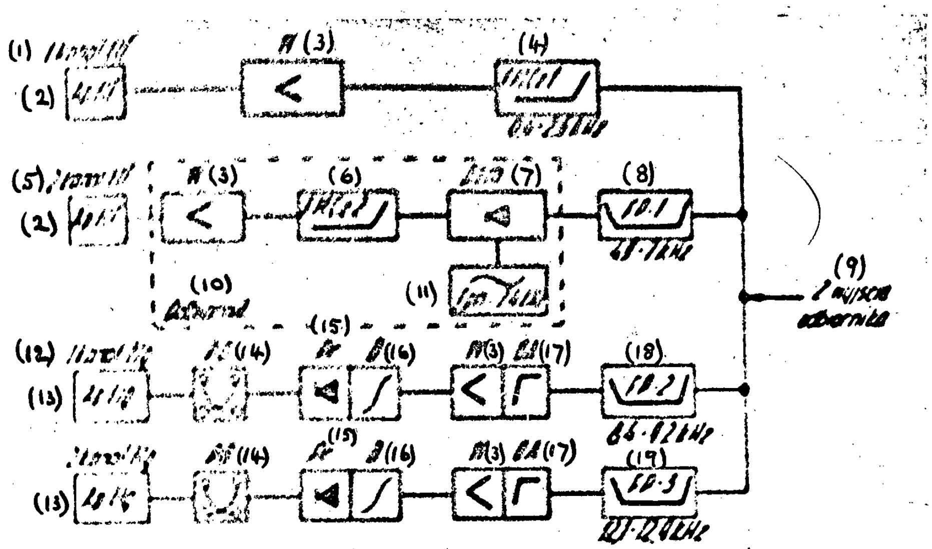


Rys. 3. Schemat blokowy nadawczej części bloku zwielokrotnienia.

Figure 3: Block diagram of the transmitting portion of the multiplexing block

KEY:
(1) 1st Telephone Channel
(2) Handset
(3) Amplitude Limiter
(4) Low Frequency Filter
(5) 2nd Telephone Channel
(6) Handset
(7) Amplitude Limiter
(8) Modulator
(9) Band-pass Filter FP1
(10) To modulation amplifier of transmitter
(11) Transmitter
(12) Sub-carrier frequency (fpn) = 7.4 kc/s
(13) 1st Telegraph Channel
(14) Telegraphic Instrument
(15) Transmitting Relays
(16) 1st Local Oscillator G1
(17) Band-pass Filter FP2
(18) 2nd Telegraph Channel
(19) Telegraphic Instrument
(20) 2nd Local Oscillator G2
(21) Band-pass Filter FP3



Rys. 4 Schemat blokowy odbiorczej części bloku zwielokrotnienia

Figure 4: Block diagram of the receiving portion of the multiplexing block

KEY:
(1) 1st Telephone Channel
(2) Telephone Instrument
(3) Amplifier W
(4) Low Frequency Filter FMCz1, 0.4-2.5 kc/s
(5) 2nd Telephone Channel
(6) Low Frequency Filter FMCz2
(7) Demodulator
(8) Band-pass Filter FP1, 4.9-7.0 kc/s
(9) From receiver output
(10) Receiver
(11) Sub-carrier frequency (fpn) = 7.4 kc/s
(12) 1st Telegraph Channel
(13) Telegraphic Instrument
(14) Receiving Relays
(15) Rectifier
(16) Detector
(17) Amplitude Limiter
(18) Band-pass Filter FP2, 8.4-9.2 kc/s
(19) Band-pass Filter FP3, 12.1-12.4 kc/s

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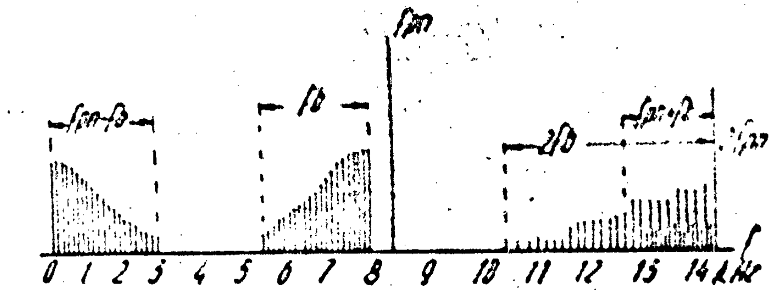
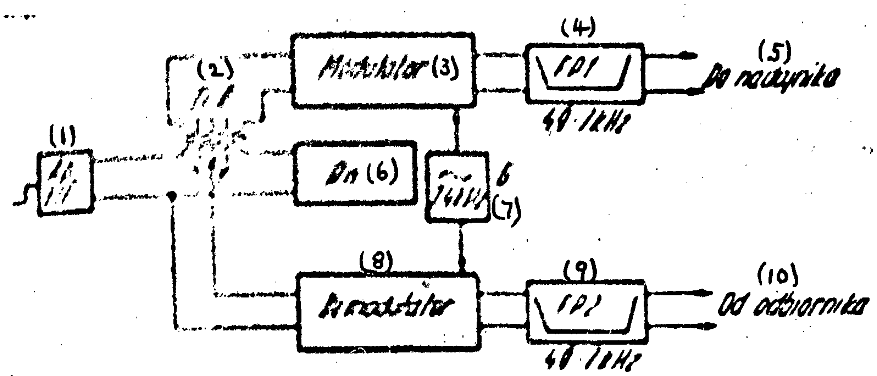


Rys. 5. Widmo częstotliwości na wyjściu demodulatora

Figure 5: Frequency spectrum at the output of the demodulator (kHz = kc/s)



Rys. 6 [illegible] schemat blokowy [illegible] telefonicznego

Figure 6: Simplified block diagram of second telephone channel

KEY:
(1) Telephone Instrument
(2) Differential Transformer TrR
(3) Modulator
(4) Band-pass Filter FP1, 4.9-7.0 kc/s
(5) To transmitter
(6) Balancing network Rn
(7) Local Oscillator G, 7.4 kc/s
(8) Demodulator
(9) Band-pass Filter FP2, 4.9-7 kc/s
(10) From receiver

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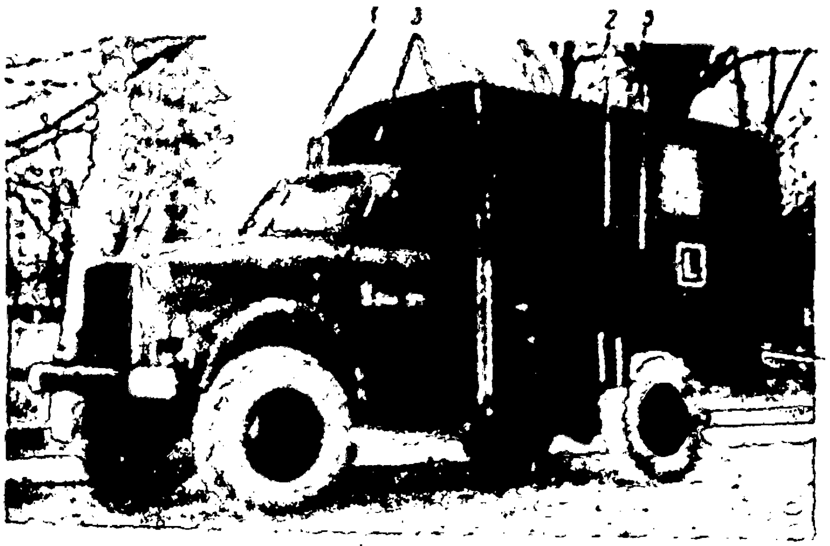

Figure 7: The Station in march order

KEY: (1) Mast hoist
(2) Output terminal panel
(3) Aerial cable entries
(4) Case with mast sections
(5) Battery breather opening

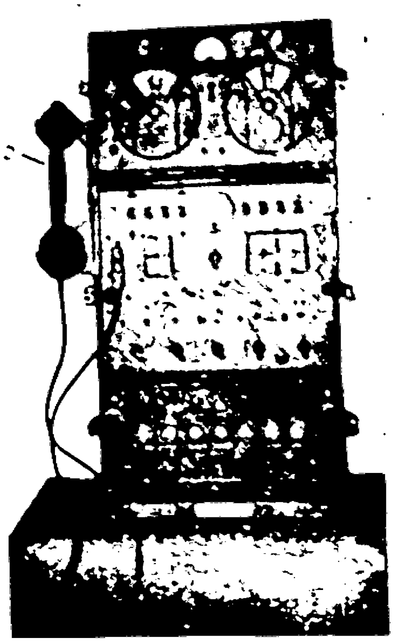

Figure 8: The rack of one half-set

KEY: (1) Rack frame
(2) Transceiver unit (Block 1)
(3) Multiplexing unit (Block 2)
(4) Rectifier unit (Block 3)
(5) Handset

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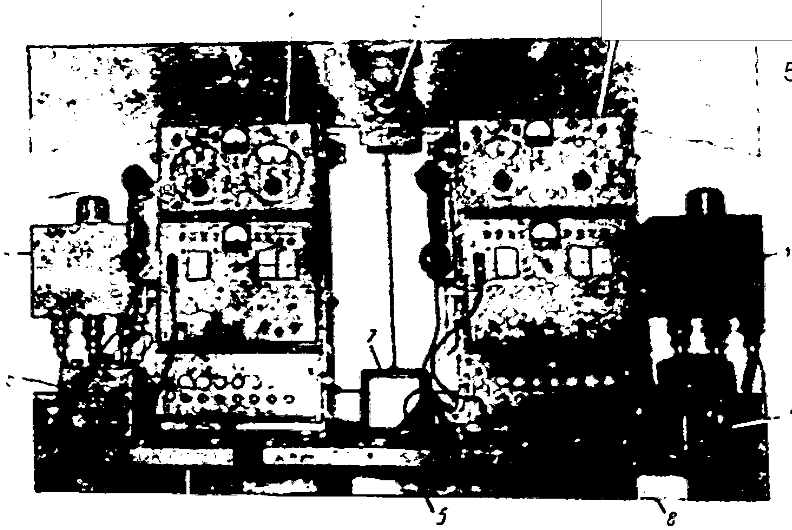
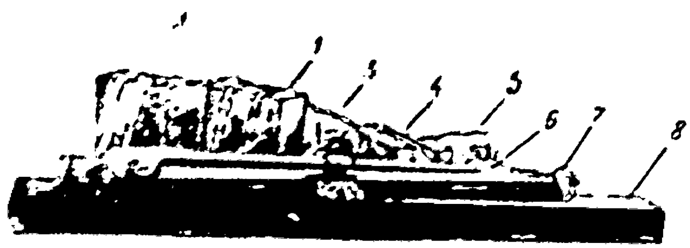


Rys. 9. Rozmieszczenie aparatury w samochodzie:
[illegible] półkompletu A: 2 — stojak półkompletu B; 3 — aparat telefoniczny [illegible] linowe; 5 — zespół spalinowo-elektryczny do ładowania akumu- [illegible] — przystawka sieciowa; 7 — woltomierz; 8 — szafka do narzędzi i części zapasowych; 9 — zegarek

Figure 9: Location of equipment inside truck

KEY:
(1) Rack of half-set A
(2) Rack of half-set B
(3) Telephone instrument TAI-43
(4) Line panels
(5) Petrol-driven generator for battery charging
(6) Main attachment
(7) Volt-meter
(8) Tools and spares cabinet
(9) Clock



[illegible]

Figure 10: Remote-control equipment of the Station

KEY:
(1) Transceiver unit (Block 1)
(2) Multiplexing unit (Block 2)
(3) Bag containing line panel, handset and cables
(4) Batteries
(5) Rigging, in bag
(6) Mast sections, in bag
(7) Mast hoist
(8) Case with aerial

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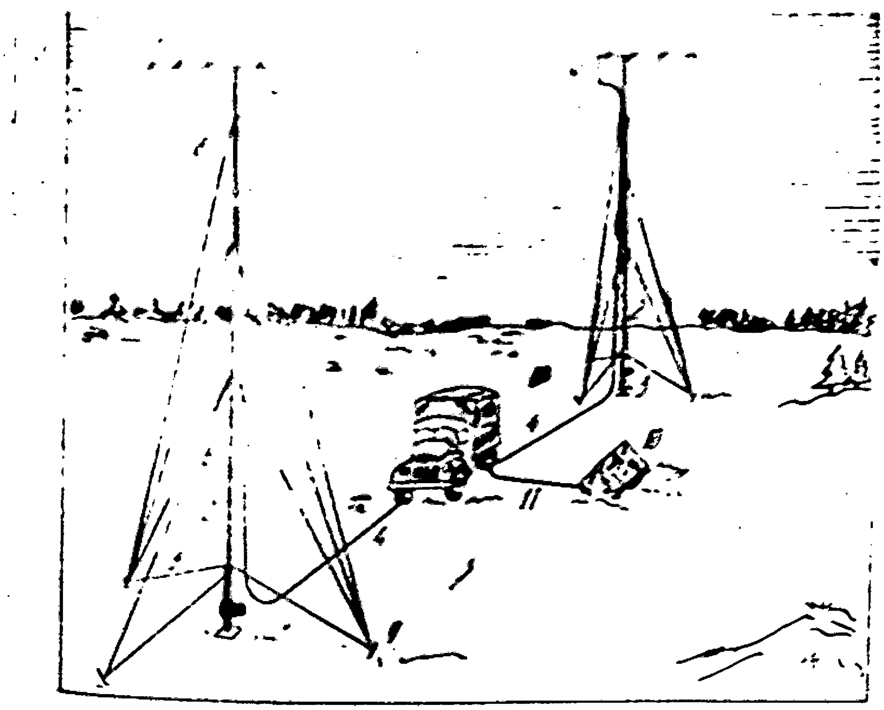

Rys. 11. Stacja rozwinięta do pracy:
1 — anteny typu „Yaga" konstrukcji krzyżowej; 2 — maszty; 3 — podnośnik masztu; 4 — kable antenowe; 5 — pierwszy poziom odciągów; 6 — drugi poziom odciągów; 7 — trzeci poziom odciągów; 8 — czwarty poziom odciągów; 9 — kołki odciągowe; 10 — namiot dla zespołu spalinowo-elektrycznego; 11 — kabel od zespołu spalinowo-elektrycznego

Figure 11: Station deployed for operation

KEY:

(1) 'Yagi'-type aerial, of cruciform construction
(2) Masts
(3) Mast hoist
(4) Aerial feeder cables
(5) First guy-rope level
(6) Second guy-rope level
(7) Third guy-rope level
(8) Fourth guy-rope level
(9) Pegs
(10) Tent containing mobile petrol-driven generator
(11) Power cable from mobile generator

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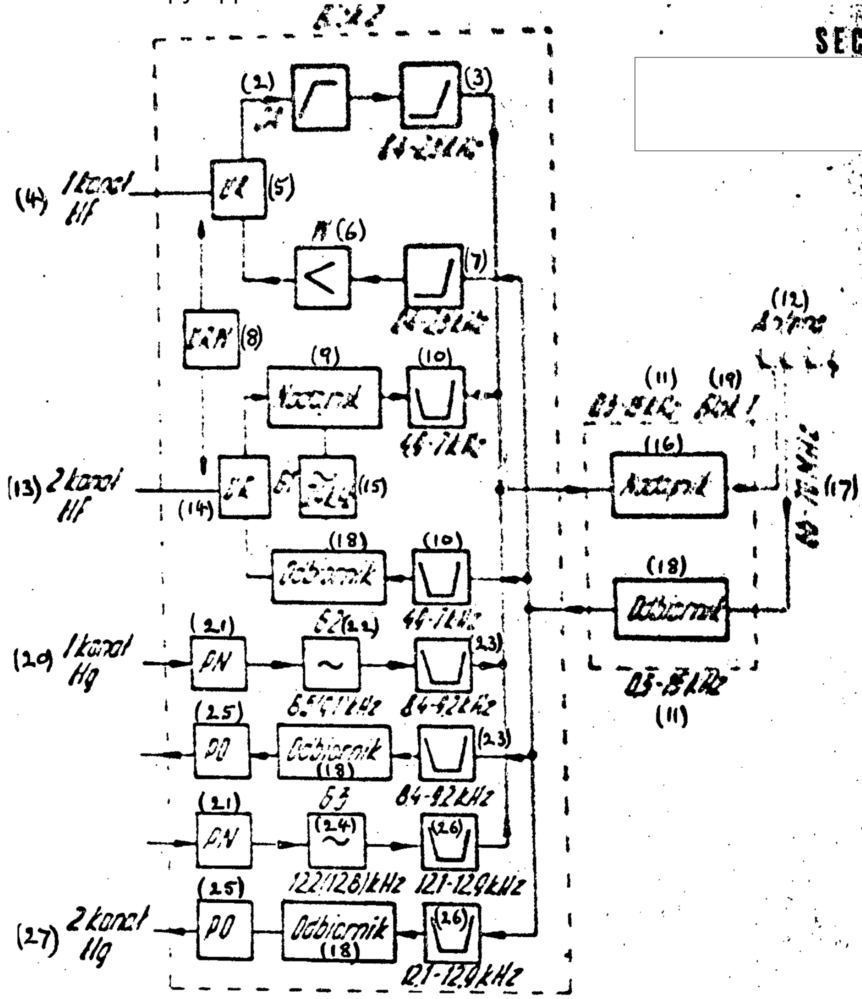

Rys. 12. Schemat blokowy półkompletu przy pracy stacji w charakterze końcowej

Figure 12: Block diagram of half-set during operation of the Station as a terminal station

KEY:
(1) Block 2
(2) Amplitude limiter
(3) Low-frequency filter, 0.4-2.5 kc/s
(4) 1st Telephone Channel
(5) Hybrid junction unit UR
(6) Amplifier
(7) see (3)
(8) Talk-call circuit
(9) Transmitter
(10) Band-pass filter, 4.9-7.0 kc/s
(11) 0.3-15 kc/s
(12) Aerial
(13) 2nd Telephone Channel
(14) Hybrid junction unit
(15) Local oscillator G1, 7.4 [?] kc/s
(16) Transmitter
(17) 66-70 Mc/s
(18) Receiver
(19) Block 1
(20) 1st Telegraph Channel
(21) Transmitting relays
(22) Local oscillator G2, 8.5 (9.1) kc/s
(23) Band-pass filter, 8.4-9.2 kc/s
(24) Local oscillator G3, 12.2 (12.8) kc/s
(25) Receiving relays
(26) Band-pass filter, 12.1-12.9 kc/s
(27) 2nd Telegraph Channel

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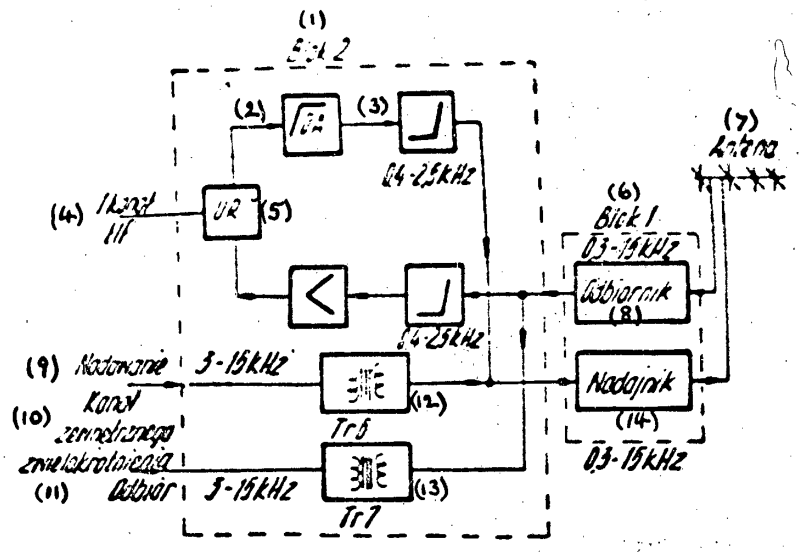
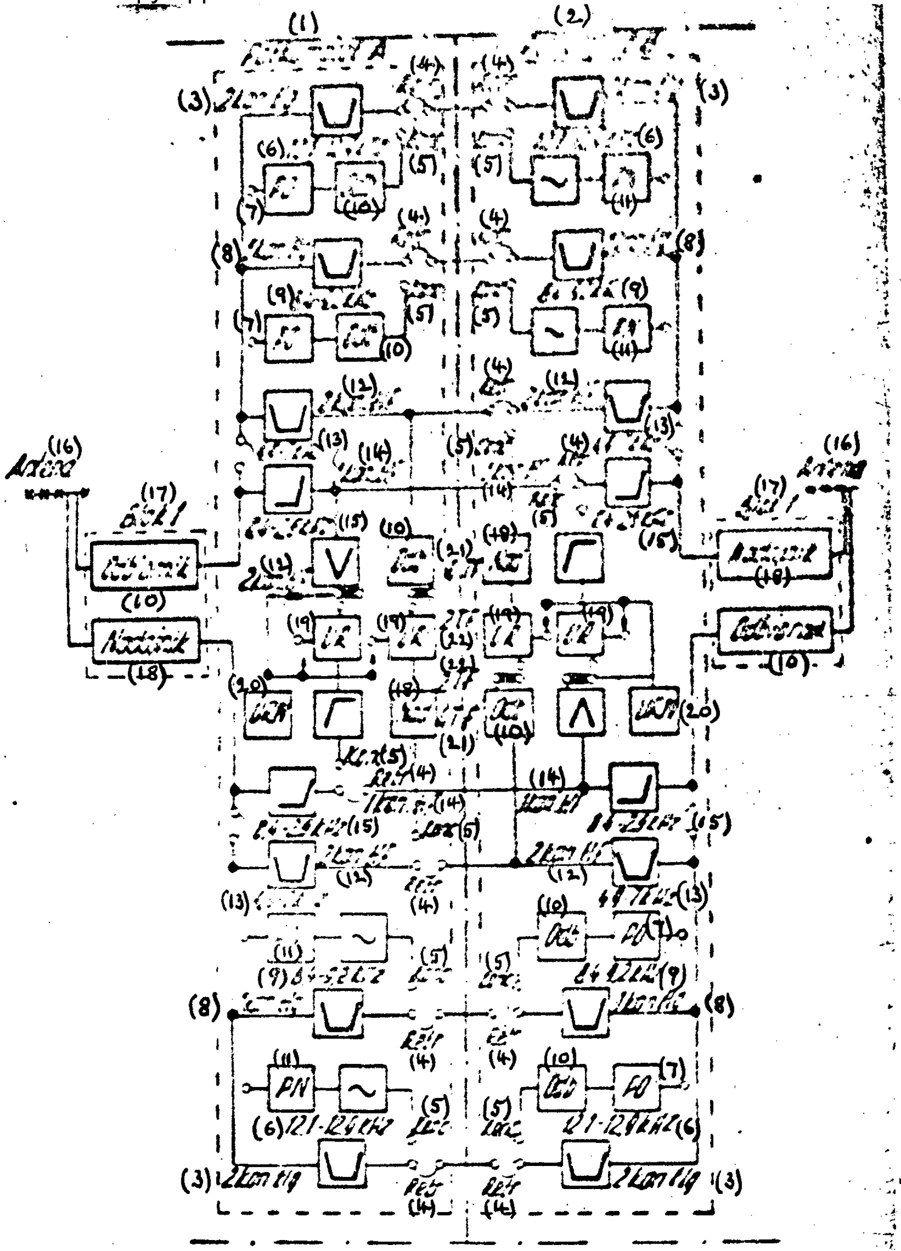


Rys. 13. Schemat blokowy półkompletu przy pracy stacji w **charakterze** końcowej z zewnętrznym zwielokrotnieniem

Figure 13: Block diagram of half-set during the operation of the station as a terminal station with external multiplexing.

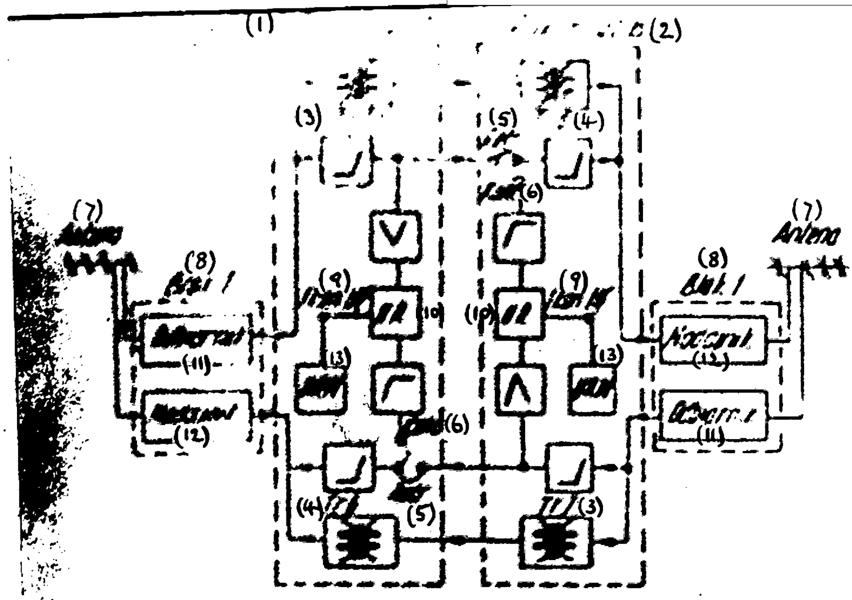
KEY: (1) Block 2
(2) Amplitude limiter
(3) L.F.Filter, 0.4-2.5 kc/s
(4) 1st Telephone Channel
(5) Hybrid junction unit
(6) Block 1
(7) Aerial
(8) Receiver
(9) Transmission
(10) External multiplexing channel
(11) Reception
(12) Wide-band transformer Tr6
(13) Wide-band transformer Tr7
(14) Transmitter (kHz = kc/s)



Rys. 14. Schemat blokowy stacji przy pracy w charakterze pośredniej

Figure 14: Block diagram of Station during operation as repeater station

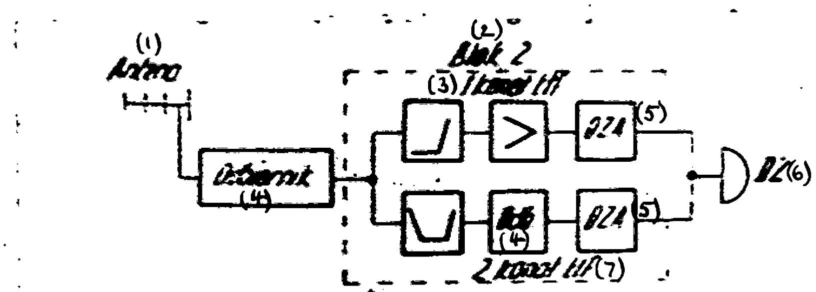
KEY:
(1) Half-set A
(2) Half-set B
(3) 2nd Telegraph Channel
(4) Repeating
(5) Terminal
(6) 12.1-12.9 kc/s
(7) Receiving relay
(8) 1st Telegraph Channel
(9) 8.4-9.2 kc/s
(10) Receiver
(11) Transmitting relay
(12) 2nd Telephone Channel
(13) 4.9-7 kc/s
(14) 1st Telephone Channel
(15) 0.4-2.5 kc/s
(16) Aerial
(17) Block 1
(18) Transmitter
(19) Hybrid junction unit
(20) Talk-call circuit
(21) 4 TF
(22) [meaning of (21) and (22) not clear]



Rys. [illegible] przy zewnętrznym [illegible]

Figure 15: Block diagram of repeater station with external multiplexing

KEY:
- (1) Half-set A
- (2) Half-set B
- (3) Wide-band transformer Tr7
- (4) Wide-band transformer Tr6
- (5) Repetition
- (6) Terminal operation
- (7) Aerial
- (8) Block 1
- (9) 1st Telephone Channel
- (10) Hybrid junction unit
- (11) Receiver
- (12) Transmitter
- (13) Talk-call circuit



Rys. 16. Schemat blokowy pracy półkompletu podczas dyżurnego odbioru

Figure 16: Block diagram showing operation of half-set during stand-by reception

KEY:
- (1) Aerial
- (2) Block 2
- (3) 1st Telephone Channel
- (4) Receiver
- (5) Audio calling signal receiver
- (6) Bell
- (7) 2nd Telephone Channel

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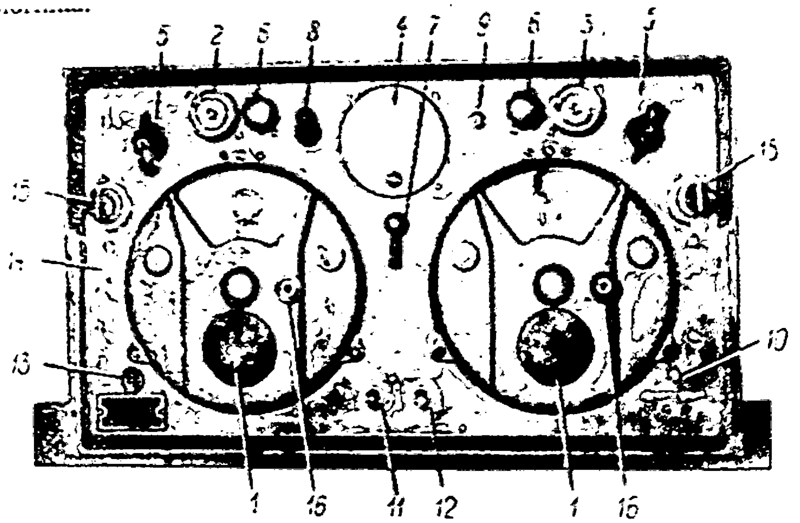

Rys. 17 Blok nadawczo-odbiorczy (blok 1)

Figure 17: Transceiver unit (Block 1)

KEY: (1) Tuning knobs
(2) Transmitter output half-connector
(3) Receiver input half-connector
(4) Measuring instrument
(5) Switches
(6) Vibrator converter fuses
(7) Type of supply switch
(8) "Operation - Stand-by" switch
(9) AFC on-off switch
(10) Potentiometer for transmission level adjustment
(11) Dial illumination switch
(12) Calibrator on-off switch
(13) Fine-tuning knob for output circuit of transmitter
(14) Front panel
(15) Bolts securing unit to housing
(16) Dial locking screws

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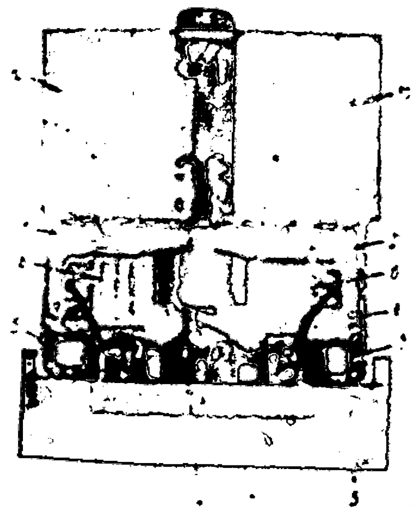
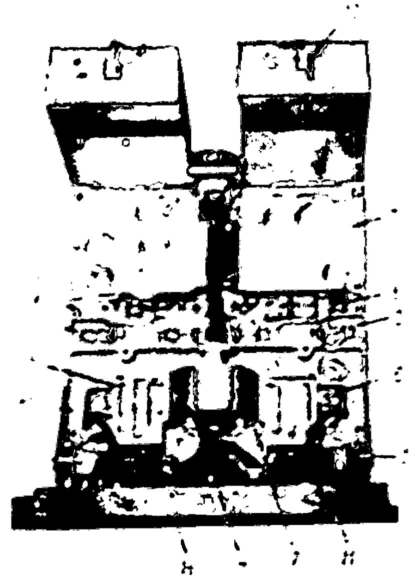


Rys. 18 Widok z góry bloku nadawczo-odbiorczego po zdjęciu obudowy



Rys. 19 Widok z góry bloku nadawczo-odbiorczego po zdjęciu obudowy (przetwornice odchylone).

Figure 18: Transeiver unit viewed from above, with housing removed

KEY:

(1) Transmitter block
(2) HF Amplifier block of receiver
(3) Front panel
(4) Measuring instrument
(5) Measuring instrument switches
(6) Tuning mechanisms
(7) Type of power supply switch
(8) Chassis
(9) Half-connector Sz-1-1A
(10) Vibrator converter of transmitter
(11) Vibrator converter of receiver

Figure 19: Transceiver unit viewed from above with housing removed (converters tilted back)

KEY:

(1) Transmitter block
(2) HF Amplifier block of receiver
(3) IF Amplifier block of receiver
(4) Measuring instrument
(5) Instrument switches
(6) Tuning mechanisms
(7) Type of power supply switch
(8) Anti-interference filters
(9) Half-connector Sz-1-1A
(10) Chassis
(11) Front panel
(12) Vibrator converter of transmitter
(13) Vibrator converter of receiver
(14) "Operation - Stand-by" switch

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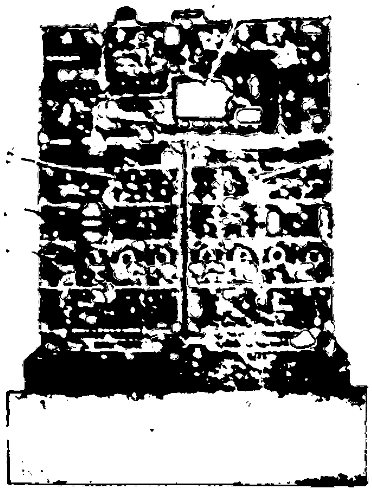


Figure 20: View from below of transceiver unit with housing removed (screening covers removed)

(1) Transmitter block

(2) HF Amplifier block of receiver

(3) IF Amplifier block of receiver

(4) HF circuits

(5) Trimming capacitor for correcting transmitter frequency

(6) Trimming capacitor for correcting receiver frequency

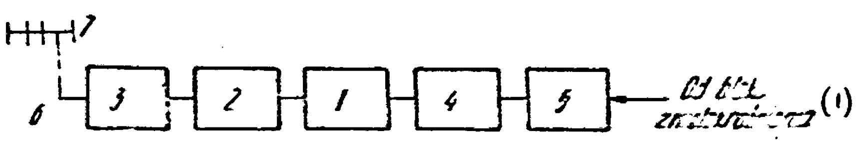
(7) Sz-1-1A half-connector for Station power supply

(8) Front panel

(9) Sz-1-1B half-connector

(10) Potentiometer of the AFC circuit

(11) Output transformer



Rys. 21. Schemat blokowy nadajnika:
1 — generator wzbudzający (L-3); 2 — separator (L-2); 3 — [illegible] (L-1); 4 — modulator częstotliwości (L-4); 5 — [illegible] (L-5); 6 — kabel antenowy; 7 — antena

Figure 21: Block diagram of transmitter

(1) Master oscillator (L-3)

(2) Separator [buffer amplifier] (L-2)

(3) Power amplifier (L-1)

(4) Frequency modulator (L-4)

(5) Modulation amplifier of transmitter (L-5)

(6) Aerial feeder cable

(7) Aerial

KEY: (1) From multiplexing block

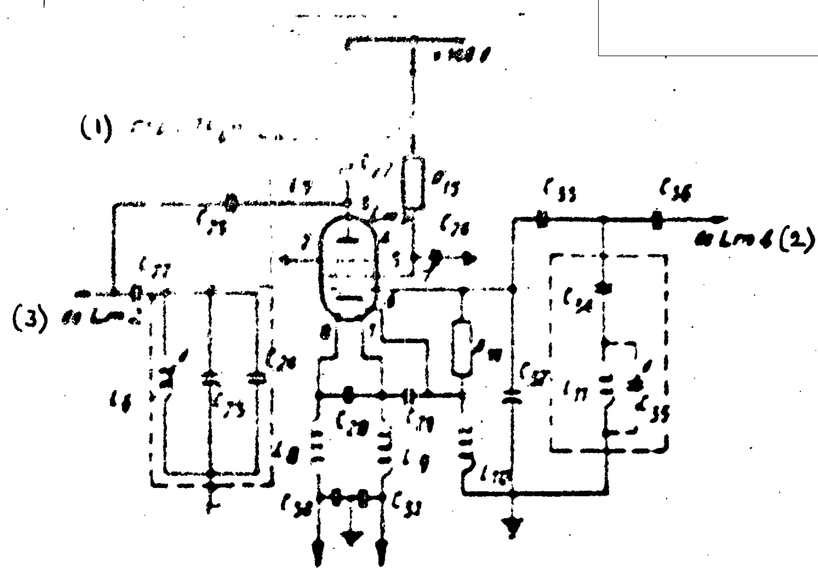
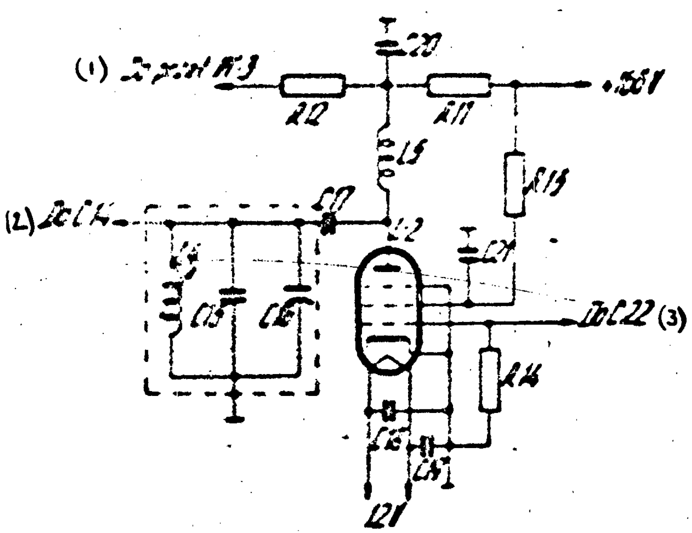


Figure 22: Circuit diagram of the master oscillator

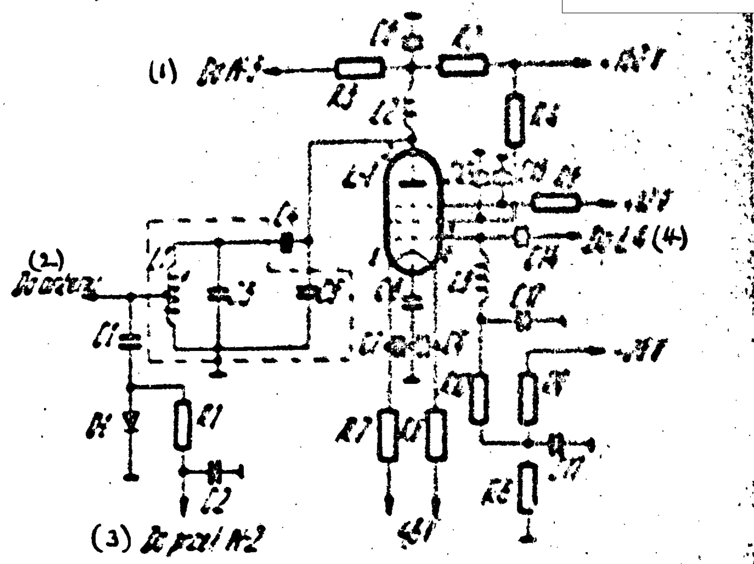
KEY: (1) To switch W-3 (2) To valve 4
(3) To valve 2



Rys. 23. Schemat separatora

Figure 23: Diagram of separator

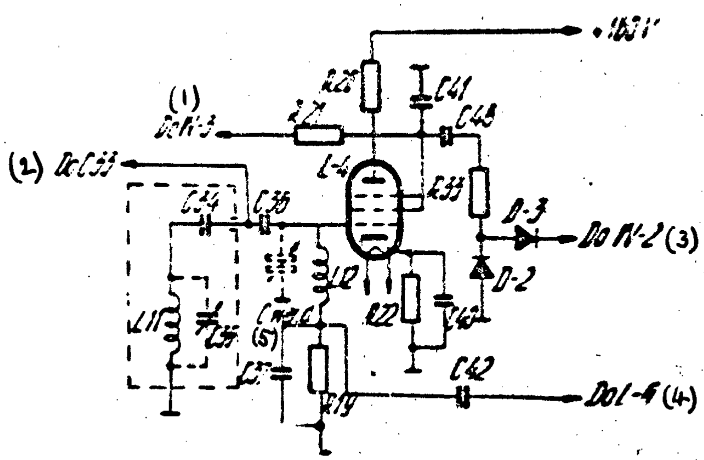
KEY: (1) To switch W-3 (2) To C14
(3) To C22



Rys. 24. Schemat wzmacniacza mocy

Figure 24: Circuit diagram of power amplifier

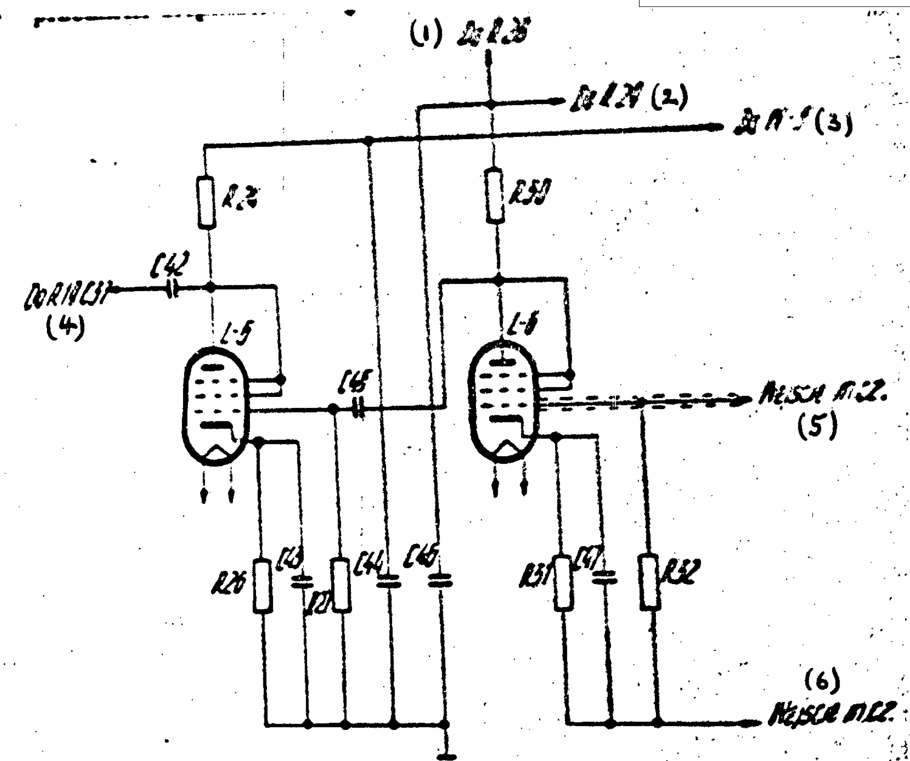
KEY: (1) To W-3 (2) To aerial
(3) To switch W-2 (4) To L-4



Rys. 25. Schemat modulatora częstotliwości

Figure 25: Circuit diagram of frequency modulator

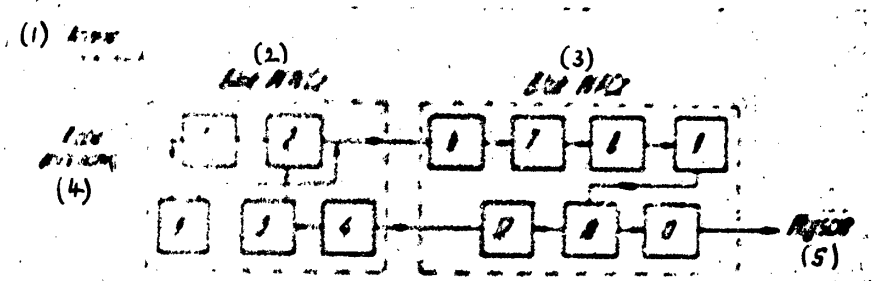
KEY: (1) To W-3 (2) To C33
(3) To W-2 (4) To L-5
(5) Dynamic input capacitance C_{wd}



Rys. 26. Schemat wzmacniacza modulacyjnego

Figure 26: Circuit diagram of modulation amplifier

KEY: (1) To R28
(2) To R24
(3) To W-5
(4) To R19 C37
(5) and (6) LF input

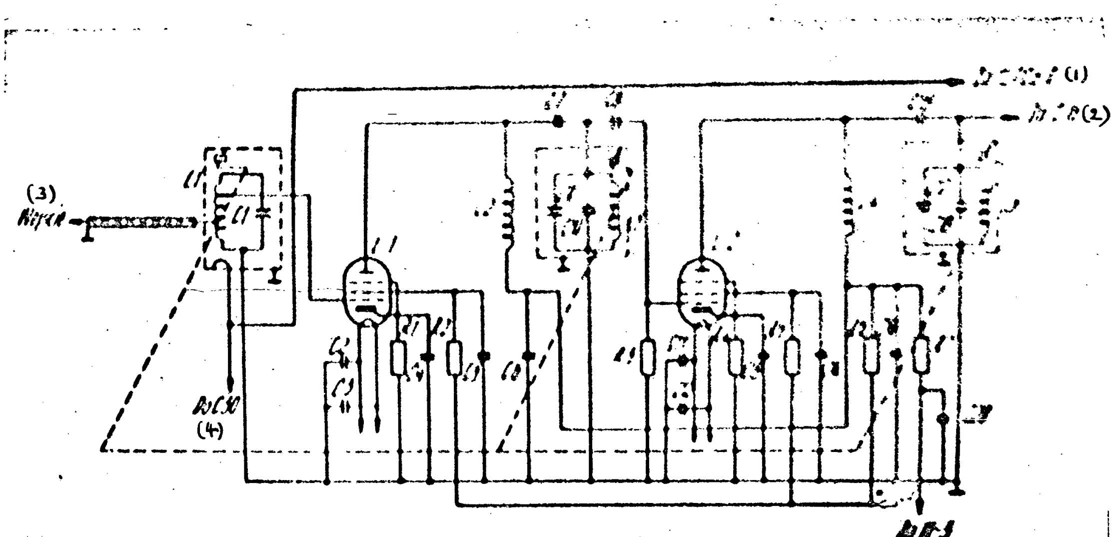


Rys. 27 Schemat blokowy odbiornika

Figure 27: Block diagram of receiver

KEY: (1) Aerial
(2) HF Amplifier block
(3) IF Amplifier block
(4) Aerial cable
(5) Output

50X1-HUM

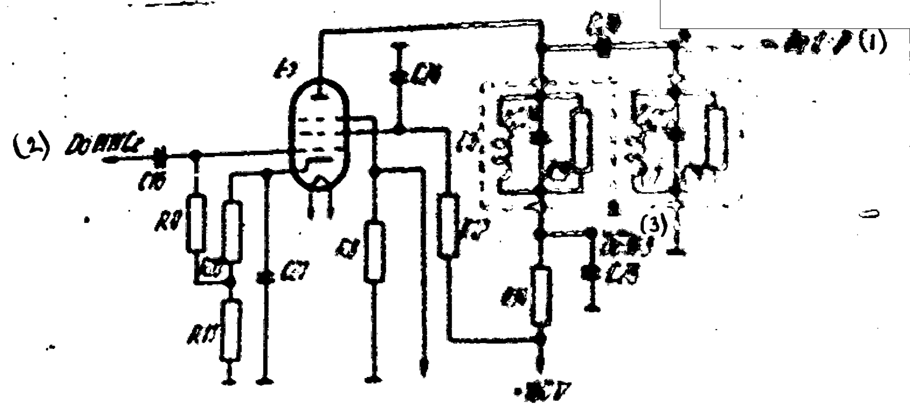


Rys. 28. Schemat wzmacniacza wielkiej częstotliwości

Figure 28: Circuit diagram of HF Amplifier

KEY: (1) To 1st IF Amplifier
(2) To C16
(3) Input
(4) To C30
(5) To W-5[?]

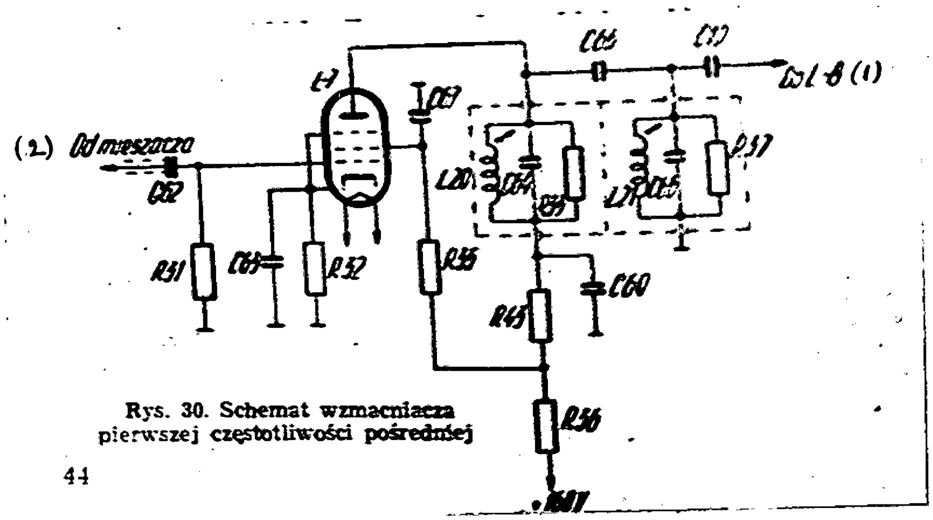
SECRET



Rys. 29 Schemat mieszacza

Figure 29: Circuit diagram of mixer

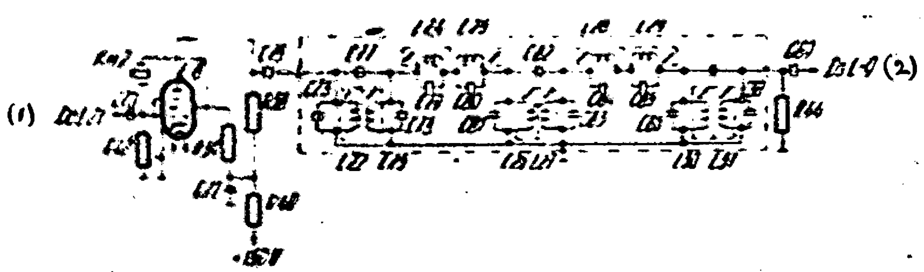
KEY: (1) To L-7 (2) To HF Amplifier
(3) To W-3[?]



Rys. 30. Schemat wzmacniacza pierwszej częstotliwości pośredniej

Figure 30: Circuit diagram of first IF Amplifier

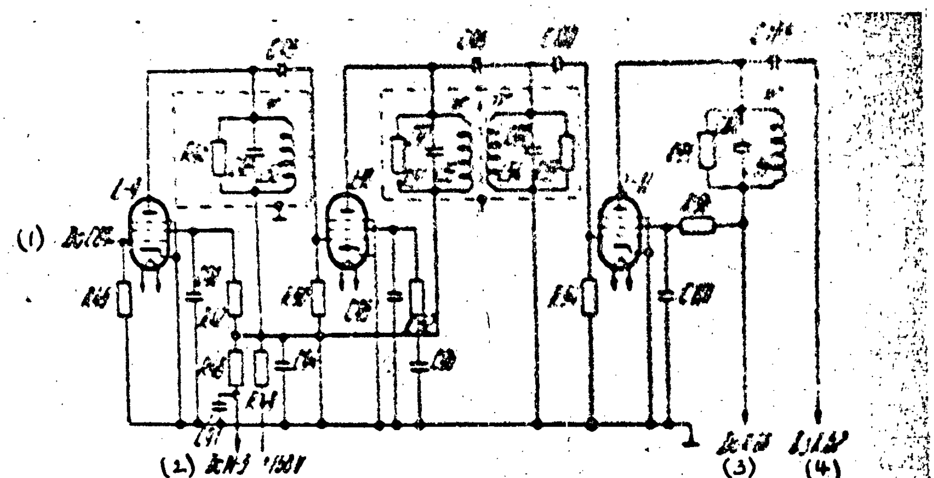
KEY: (1) To L-8 (2) From mixer



Rys. 31. Schemat układu drugiej przemiany częstotliwości

Figure 31: Diagram of the second frequency conversion circuit

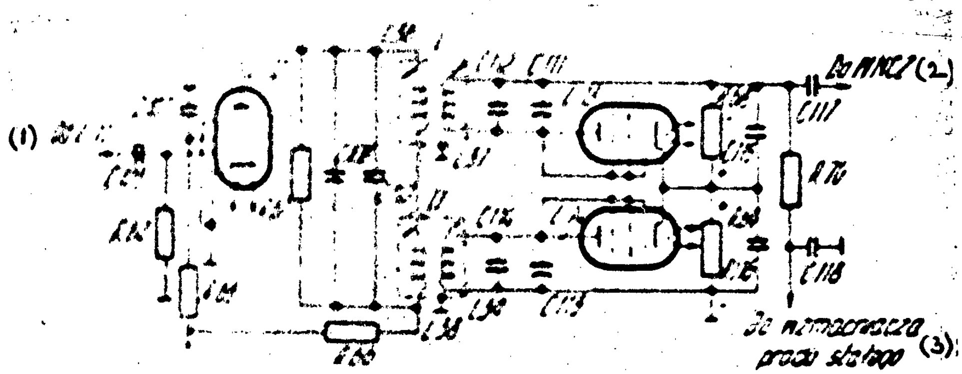
KEY: (1) To L-21[?] (2) To L-9



Rys. 32. Schemat wzmacniacza drugiej częstotliwości pośredniej

Figure 32: Circuit diagram of second IF Amplifier

KEY: (1) To C89 (3) To R66
(2) To W-3 (4) To R62



Rys. 33. Schemat ogranicznika amplitudy i detektora częstotliwości

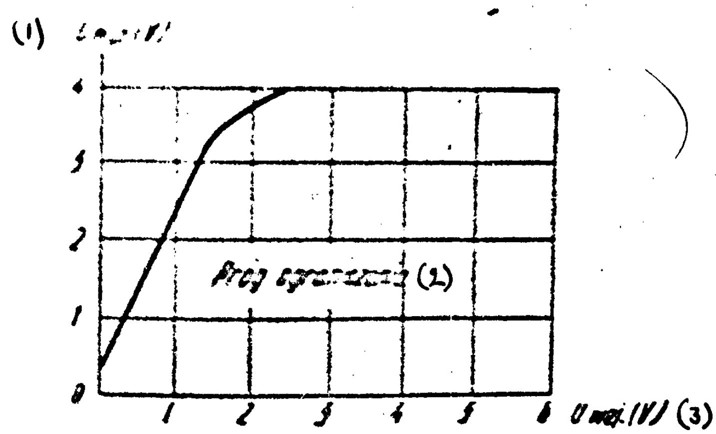
Figure 33: Circuit diagram of amplitude limiter and frequency detector

KEY: (1) To L-11 (2) To LF Amplifier
(3) To D.C. Amplifier

50X1-HUM

SECRET

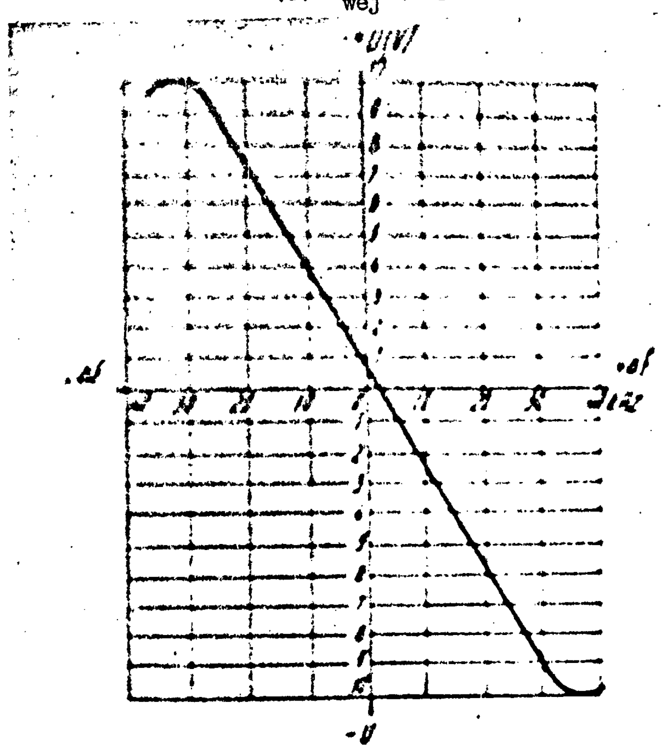
50X1-HUM



Rys. 34. Charakterystyka ogranicznika

Figure 34: Characteristic of the amplitude limiter

KEY: (1) U_{wyj} (output voltage) (2) Limiting threshold (3) U_{wej} (input voltage)



Rys. 35 Charakterystyka detektora częstotliwości

Figure 35: Characteristic of the frequency detector (kHz = kc/s)

50X1-HUM

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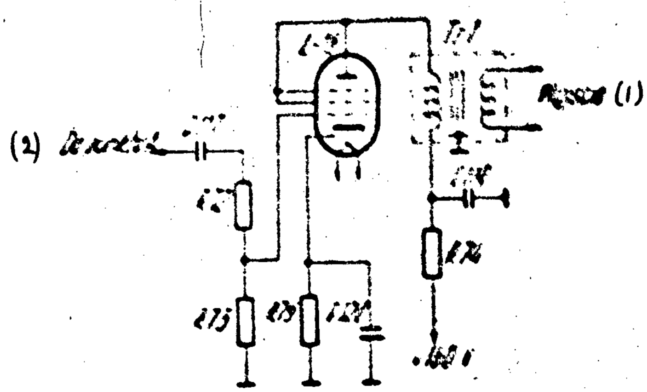
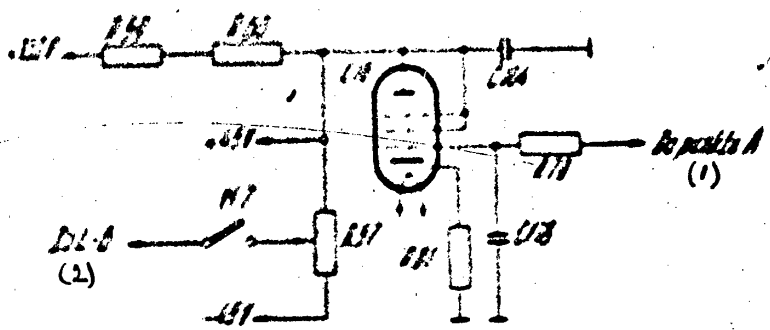


Rys. 36. Schemat wzmacniacza małej częstotliwości

<u>Figure 36</u>: Circuit diagram of LF Amplifier

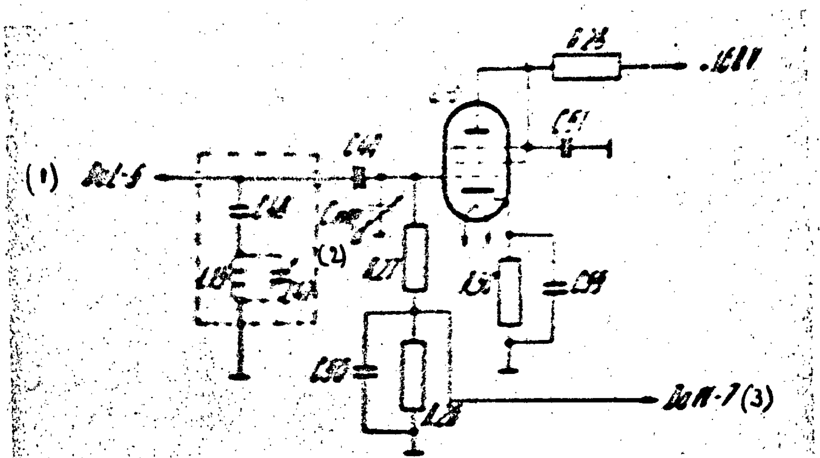
KEY: (1) Output (2) To point 'A'



Rys. 37. Schemat wzmacniacza prądu stałego

<u>Figure 37</u>: Circuit diagram of DC Amplifier

KEY: (1) To point 'A' (2) To L-6



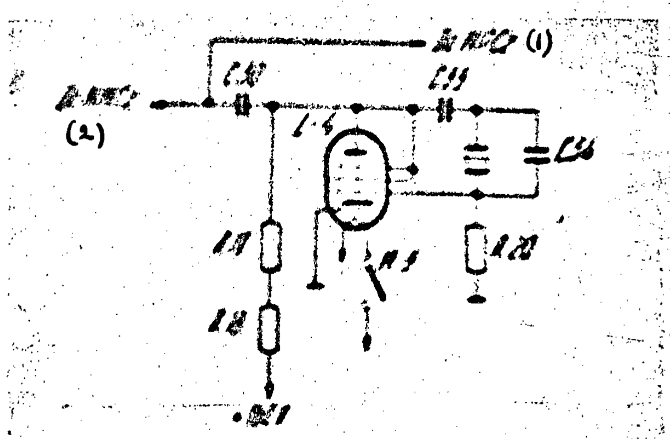
Rys. 38. Schemat układu podstrajania częstotliwości

__Figure 38:__ Circuit diagram of the Automatic Frequency Control

KEY: (1) To L-5

(2) Dynamic input capacitance C_{wd}

(3) To W-7



Rys. 39. Schemat kalibratora kwarcowego

__Figure 39:__ Circuit diagram of quartz calibrator

KEY: (1) To IF Amplifier

(2) To HF Amplifier

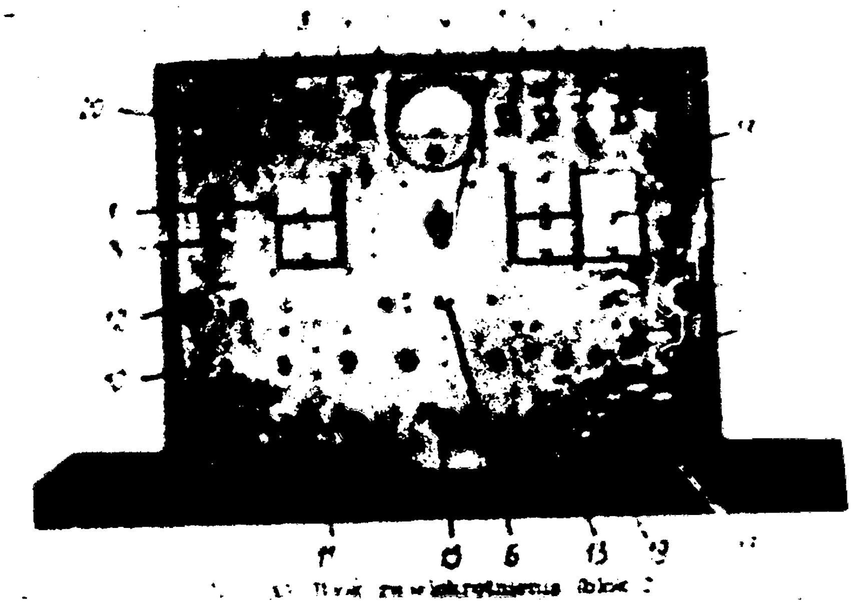


Figure 40: Multiplexing unit (Block 2)

(1) Audio calling signal receiver OZA. of the telephone channels

(2) Transmitting and receiving relays of the telegraphic channels

(3) Handset socket

(4) Measuring instrument

(5) Step-by-step switch of measuring instrument

(6) On-off switch of instrument

(7) Talking keys of telephone channels

(8) Telephone channel test key

(9) Calling key

(10) "Terminal - Repeater" switches of the telephone channels

(11) Telephone channel type of operation switches

(12) Bolts securing unit to housing

(13) Type of power supply switches of the telegraphic channels

(14) Telegraph channel type of operation switches

(15) Station type of operation switch

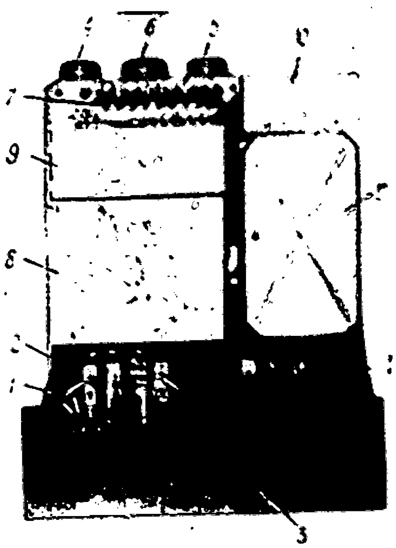
(16) Telegraphic channel test keys

(17) Telegraphic channel polarity switch

(18) Front panel

(19) Vibrator converter fuse

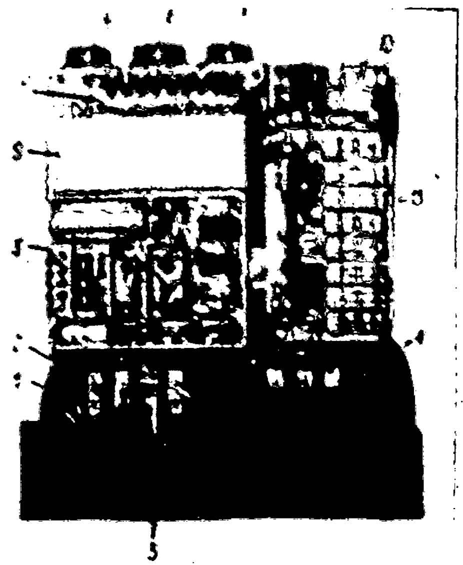
(20) Housing



Rys. 41. Widok z góry bloku zwielokrotnienia po zdjęciu obudowy:

Figure 41: Multiplexing unit viewed from above, with housing removed

(1) Flexible cables connecting panel with chassis
(2) Chassis
(3) Front panel
(4) Half-connector Sz-2
(5) Half-connector Sz-3
(6) Half-connector Sz-1-2
(7) Anti-interference filters
(8) Vibrator converter
(9) LF filters
(10) Calling signal converter
(11) Relay cover



Rys. 42. Widok z góry bloku zwielokrotnienia po zdjęciu obudowy (od-

Figure 42: Multiplexing unit viewed from above, with housing removed (vibrator converter tilted back)

(1) Flexible cables connecting panel with chassis
(2) Chassis
(3) Front panel
(4) Half-connector Sz-2
(5) Half-connector Sz-3
(6) Half-connector Sz-1-2
(7) Anti-interference filters
(8) Vibrator converter
(9) LF filters
(10) Calling signal converter
(11) Relay assembly

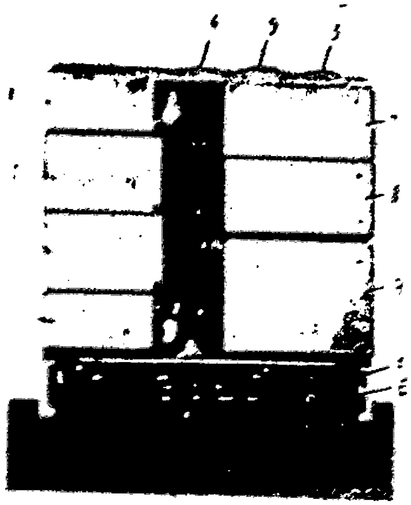


Figure 43: Multiplexing unit viewed from below, with housing removed

(1) Chassis

(2) Front panel

(3) Half-connector Sz-2

(4) Half-connector Sz-3

(5) Half-connector Sz-1-2

(6) Switches

(7) LF Amplifier of first Telephone Channel

(8) LF Amplifier of second Telephone Channel

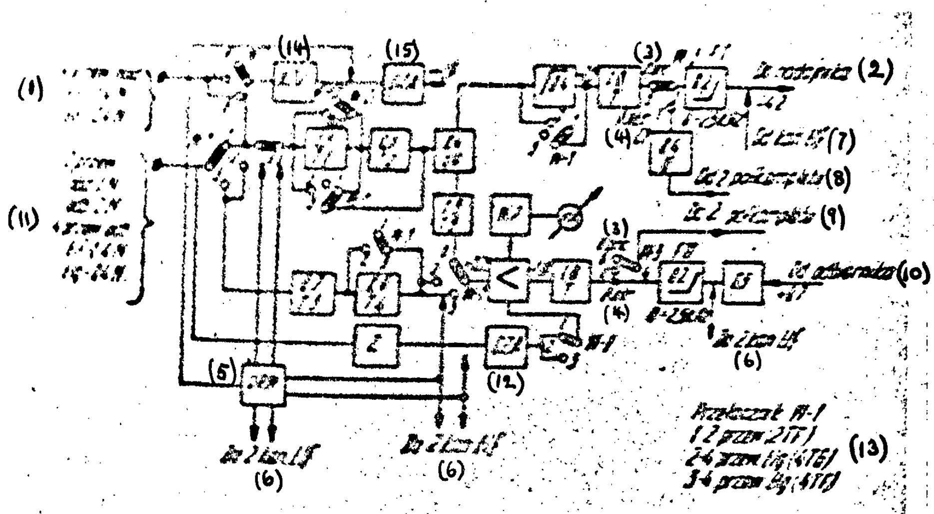
(9) Audio calling signal generator, modulator, and demodulator of the second Telephone Channel, and sub-carrier frequency oscillator

(10) Band-pass filters of the second Telegraph Channel

(11) Receiver and oscillator of the second Telegraph Channel

(12) Receiver and oscillator of the first Telegraph Channel

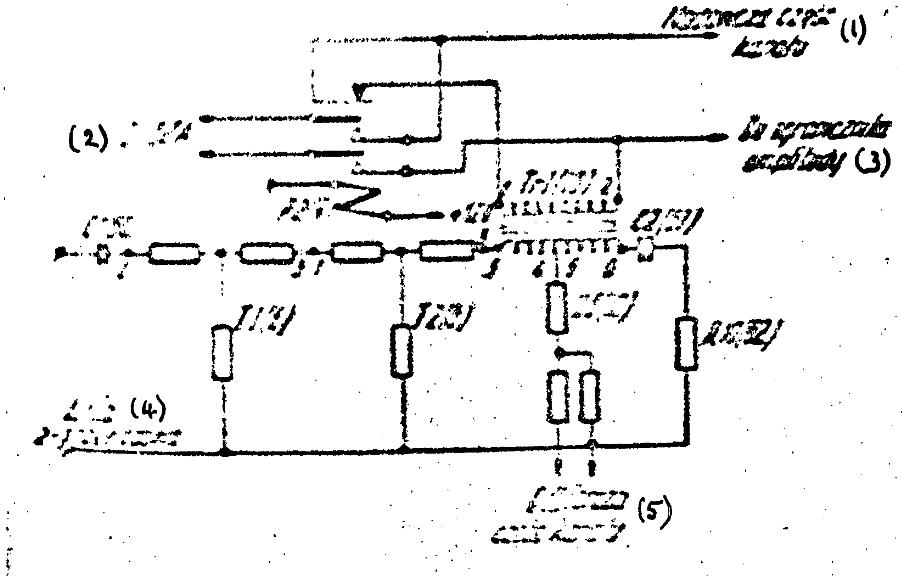
(13) Band-pass filters of the first Telegraph Channel



Rys. 44. Schemat blokowy pierwszego kanału telefonicznego

Figure 44: Block diagram of first telephone channel

KEY:
- (1) 4-wire transmission: telephone 1.4 N, telephone 2.4 N
- (2) To transmitter
- (3) Terminal
- (4) Repeater
- (5) Talk-call circuit
- (6) To 2nd Telephone Channel
- (7) From telephone channel
- (8) From 2nd Half-set
- (9) To 2nd Half-set
- (10) From receiver
- (11) 2-wire: transmission 1 N, reception 2 N; 4-wire reception: telephone 1.4 N, telegraph 2.4 N
- (12) Audio calling signal receiver
- (13) Switch W-1: 1-2 lead (2nd Telephone Channel), 2-4 telegraph lead (4th Telegraph Channel); 3-4 telegraph lead (4th Telephone Channel)
- (14) Magneto calling signal receiver
- (15) Audio calling signal generator

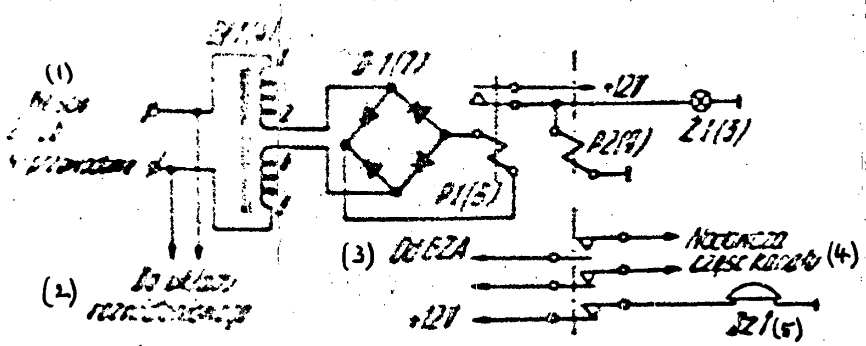


Rys. 45. Uproszczony schemat układu rozwidleniowego

Figure 45: Simplified circuit diagram of hybrid junction unit

KEY: (1) Transmitting portion of channel
(2) To audio calling signal generator GZA
(3) To amplitude limiter
(4) 2-wire line
(5) Receiving portion of channel

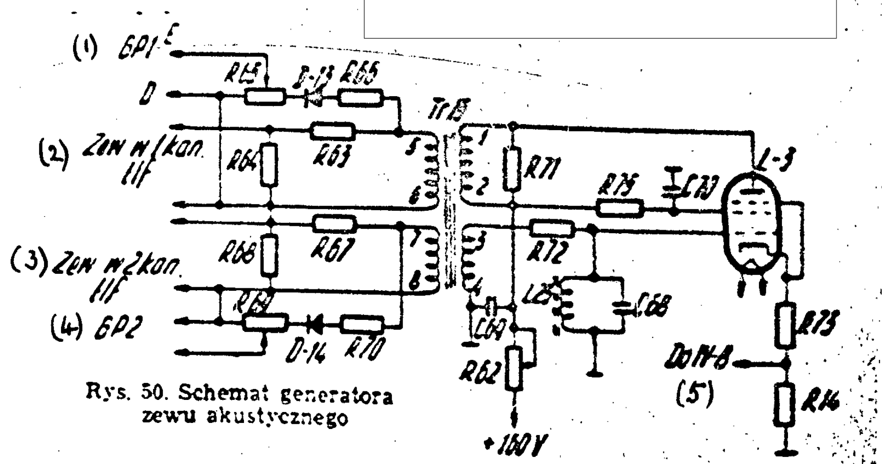
[Figures 46, 47 and 48 - missing]



Rys. 49. Schemat odbiornika zewu induktorowego

Figure 49: Circuit diagram of magneto calling signal receiver

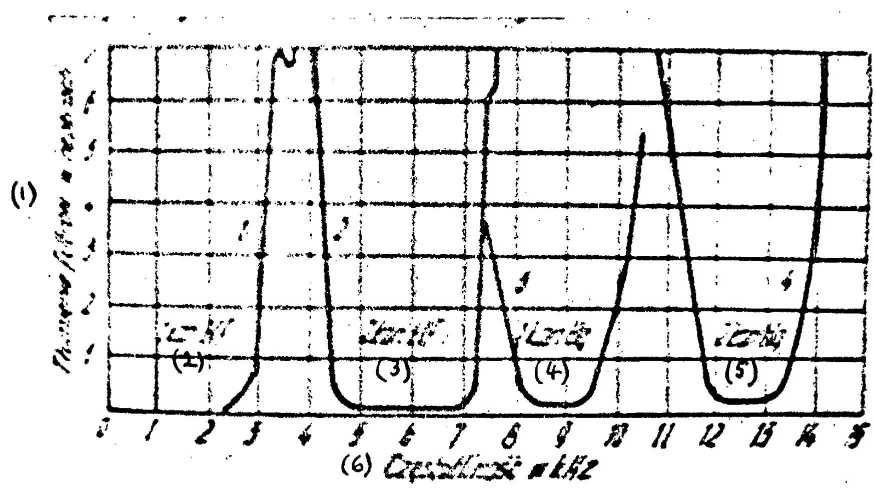
KEY: (1) 2-wire or 4-wire input
(2) To hybrid junction unit
(3) From audio calling signal generator
(4) Transmitting portion of channel
(5) Bell Dz 1



Rys. 50. Schemat generatora zewu akustycznego

Figure 50: Circuit diagram of audio calling signal generator

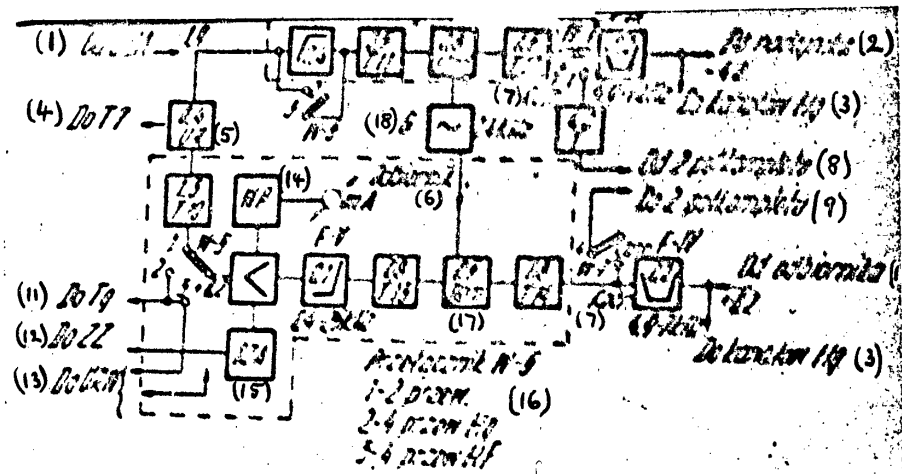
KEY: (1) Audio calling signal generator GP1
(2) Call in 1st telephone channel
(3) Call in 2nd telephone channel
(4) Audio calling signal generator GP2
(5) To W-8



Rys. 51. Charakterystyka tłumienia filtrów

Figure 51: Filter attenuation characteristics

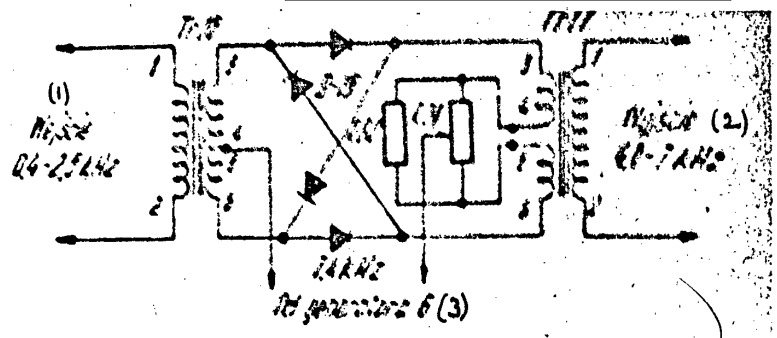
KEY: (1) Filter attenuation in nepers
(2) 1st telephone channel
(3) 2nd telephone channel
(4) 1st telegraph channel
(5) 2nd telegraph channel
(6) Frequency in kc/s



Rys. 52 Schemat blokowy drugiego kanału telefonicznego

Figure 52: Block diagram of second telephone channel

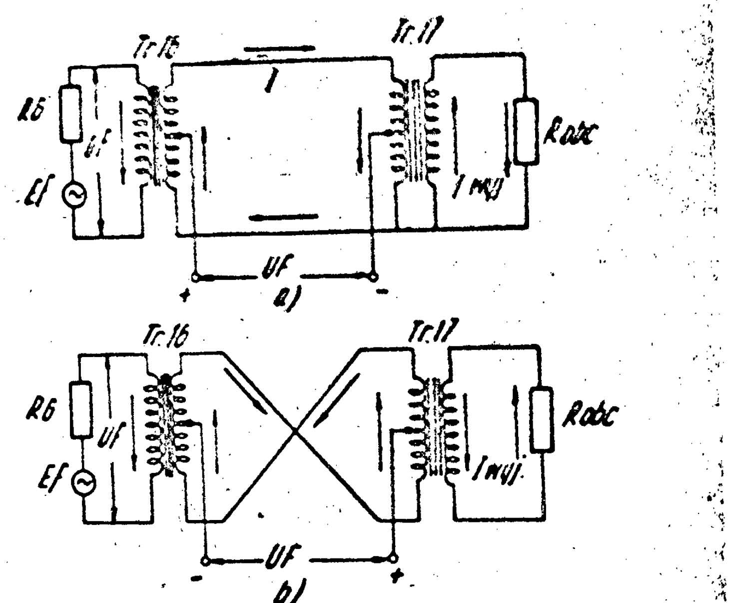
KEY:
(1) From audio calling signal generator
(2) To transmitter
(3) To telegraph channels
(4) To T7
(5) Hybrid junction unit
(6) Receiver
(7) Repeating
(8) From 2nd half-set
(9) To 2nd half-set
(10) From receiver
(11) To Tg [telegraph instrument terminals?]
(12) To ZZ (terminals)
(13) To talk-call circuit
(14) Level indicator
(15) Audio calling signal receiver
(16) Switch W-5: 1-2 line; 2-4 telegraph line
3-4 telephone line
(17) Demodulator
(18) Local oscillator



Rys. 53. Schemat modulatora

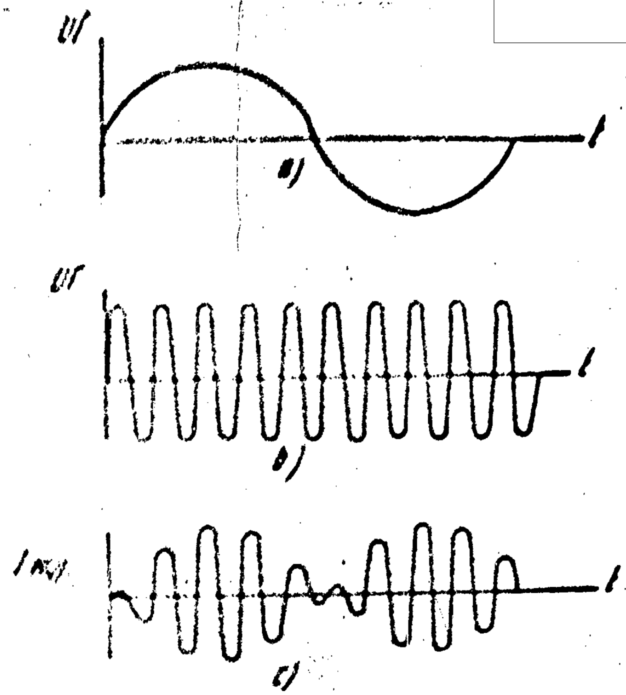
Figure 53: Circuit diagram of modulator

KEY: (1) Input, 0.4-2.5 kc/s
(2) Output, 4.9-7 kc/s
(3) 7.4 kc/s from oscillator G



Rys. 54. Schematy wyjaśniające zasadę pracy modulatora kołowego

Figure 54: Diagrams explaining the principle of operation of a ring-type modulator



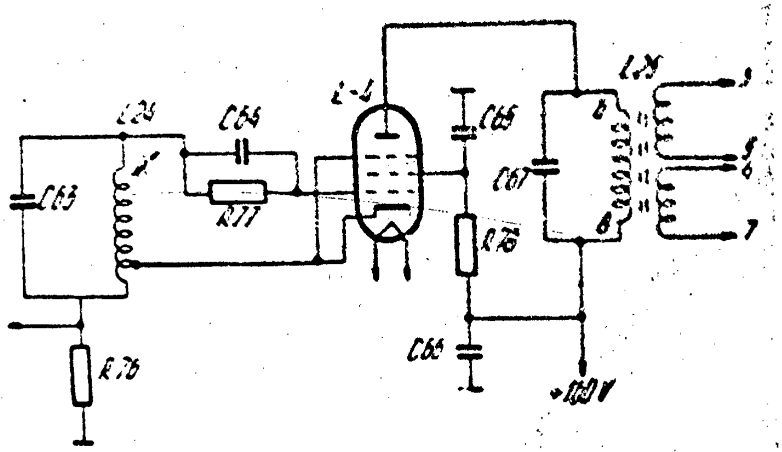
Rys. 55 Wykres napięć i prądów:

Figure 55: Voltage and current graph

(a) Modulating voltage

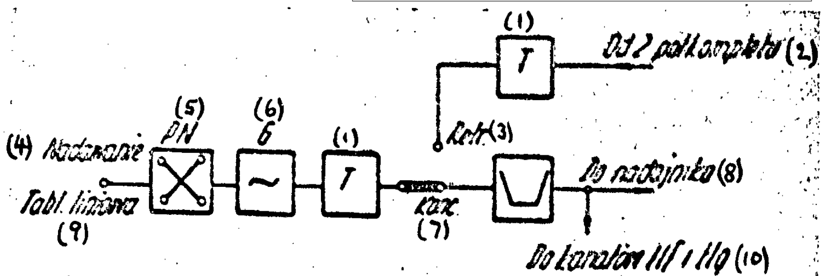
(b) Voltage of a frequency of 7.4 kc/s

(c) Amplitude modulated current



Rys. 56. Schemat generatora częstotliwości podnośnej

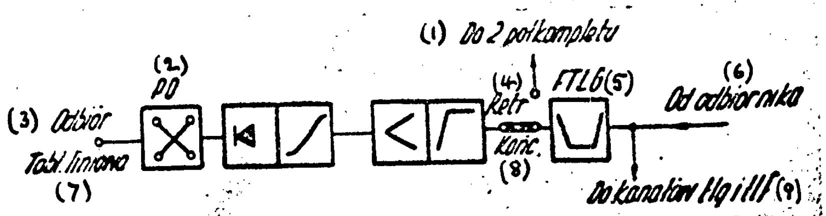
Figure 56: Circuit diagram of sub-carrier frequency generator



Rys. 57. Schemat blokowy nadajnika kanału telegraficznego

Figure 57: Block diagram of telegraphic channel transmitter

KEY:
(1) Matching attenuator
(2) From 2nd half-set
(3) Repetition
(4) Transmission
(5) Transmitting relays
(6) Ultrasonic frequency generator G
(7) Terminal (operation)
(8) To transmitter
(9) Line panel
(10) To telephone and telegraph channels



Rys. 58. Schemat blokowy kanału telegraficznego

Figure 58: Block diagram of telegraph channel

KEY:
(1) To 2nd half-set
(2) Receiving relays
(3) Reception
(4) Repetition
(5) Receiving filter
(6) From receiver
(7) Line panel
(8) Terminal (operation)
(9) To telegraph and telephone channels

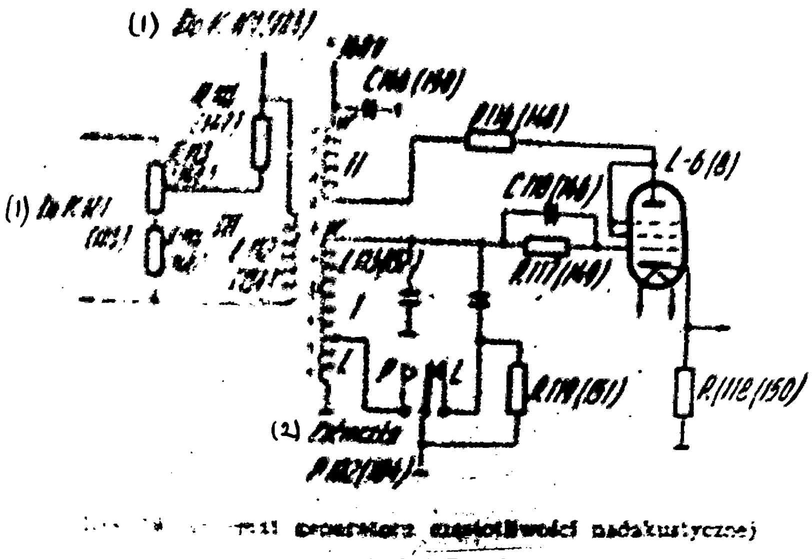


Figure 59: Circuit diagram of ultrasonic frequency generator

KEY: (1) To K 101 (103)

(2) Relay arm (P = right-hand contact, L = left-hand contact)

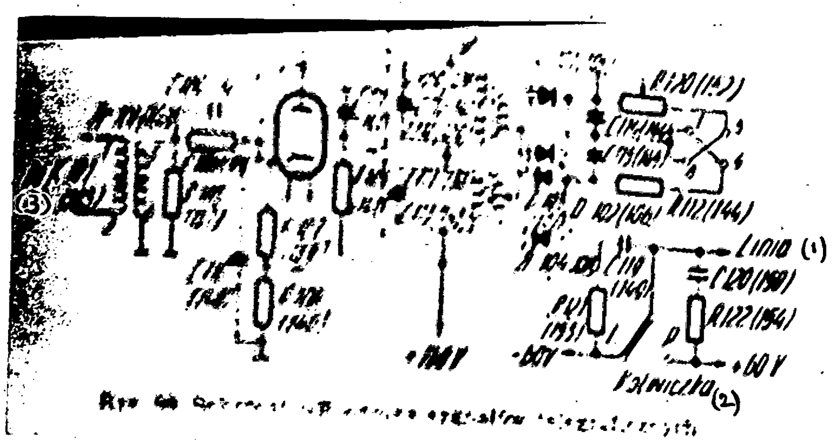


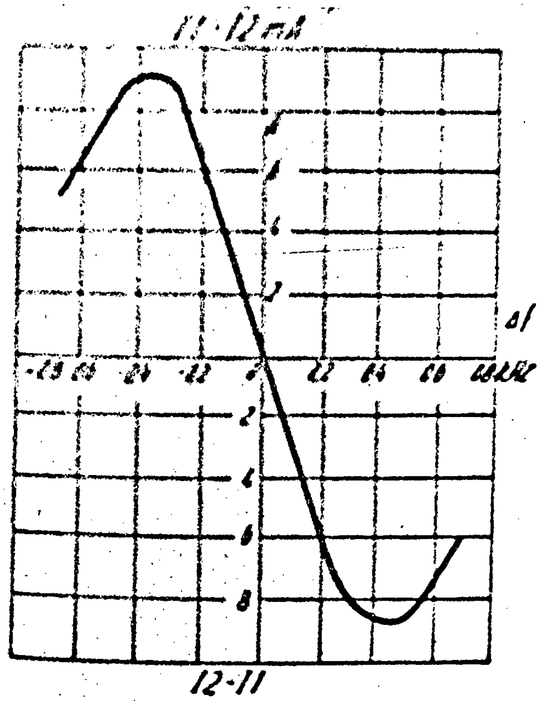
Figure 60: Circuit diagram of telegraph signal receiver

KEY: (1) Line

(2) Relay arm (P = right-hand contact, L = left-hand contact)

(3) To K101 (103)

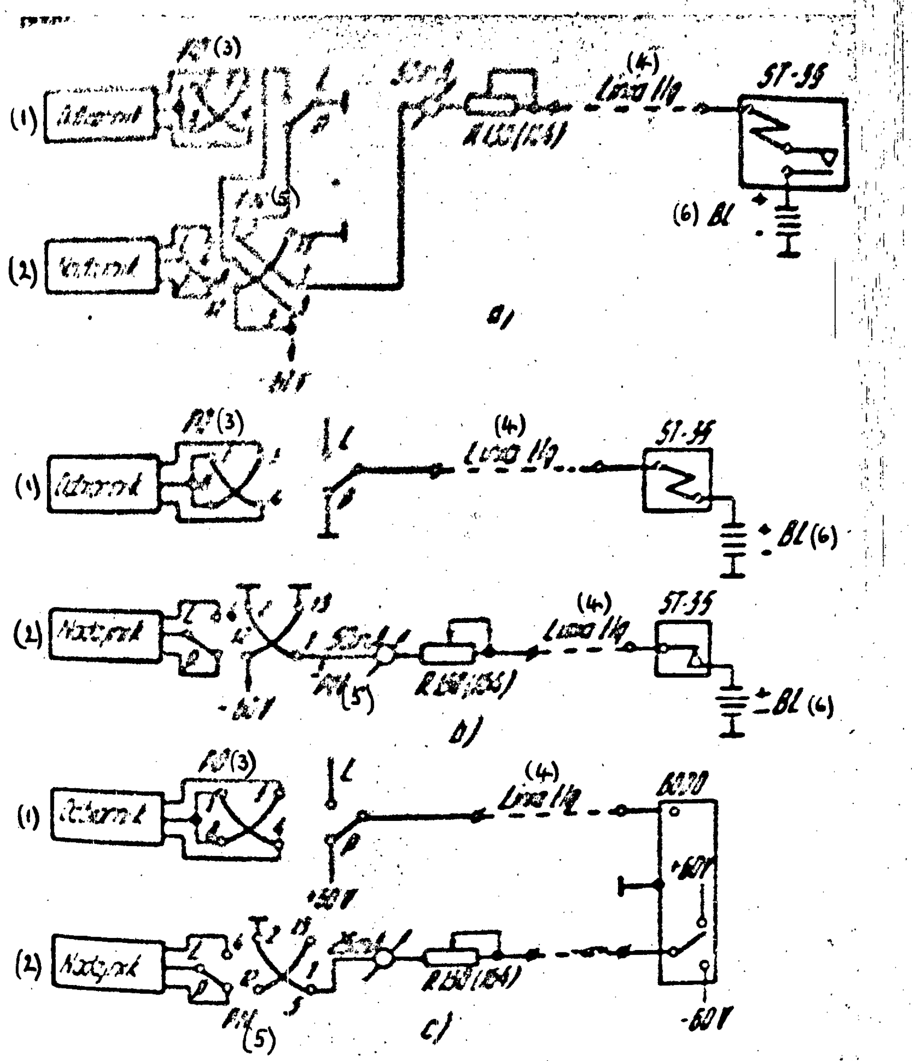
50X1-HUM



Rys. 61. Charakterystyka częstotliwościowa odbiornika kanału telegraficznego

Figure 61: Frequency characteristic of the telegraph channel receiver

50X1-HUM



Rys. 62. Schemat włączenia kanałów telegraficznych:

Figure 62: Diagram showing connection of telegraph channels

(a) Operation of ST-35 sets with common earth path

(b) Operation of ST-35 sets with separate directions of transmission and reception

(c) Operation of Baudot set

KEY: (1) Receiver

(2) Transmitter

(3) Receiving relays

(4) Telegraph line

(5) Transmitting relays

(6) Line batteries /?/; L = left-hand, P = right-hand

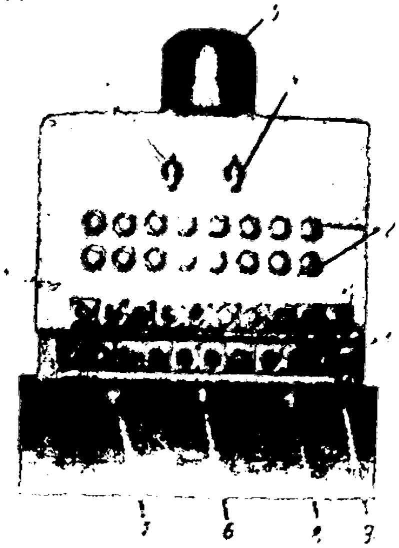
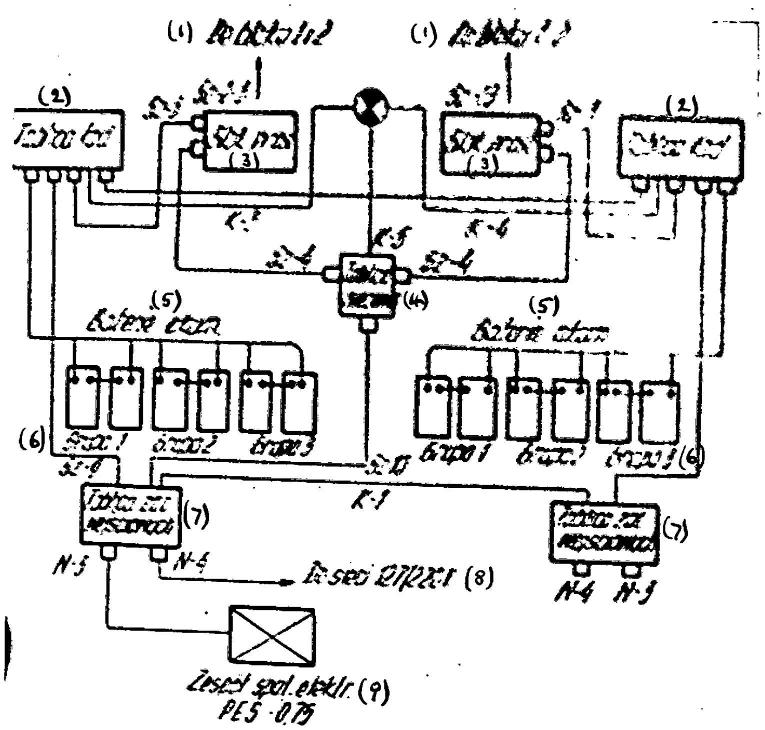


Figure 63: Line panel

(1) Terminals for connecting the wire lines
(2) Fuses
(3) Strip for writing down code names
(4) Line transformer switches
(5) Bell
(6) Half-connector Sz-5[?]
(7) Half-connector Sz-6
(8) Half-connector Sz-7
(9) "Earth" terminal



Rys. 64. Schemat blokowy zasilania stacji

Figure 64: Block diagram of Station power supply

KEY:
(1) To blocks 1 & 2
(2) Charging panel
(3) Rectifier block
(4) Mains panel
(5) Batteries
(6) Group 1 - Group 2 - Group 3
(7) Input terminal panel.
(8) To 127/220 V Mains
(9) Mobile generator PES-0.75

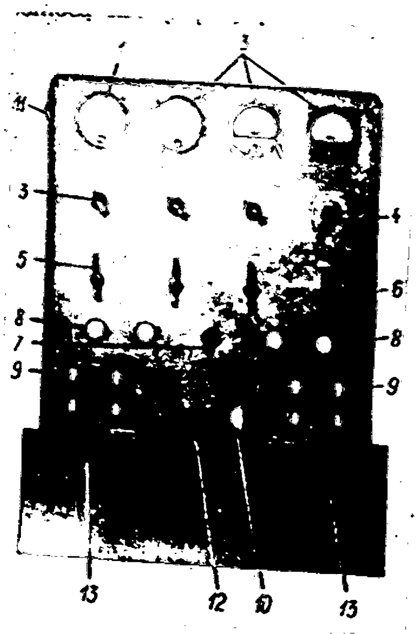
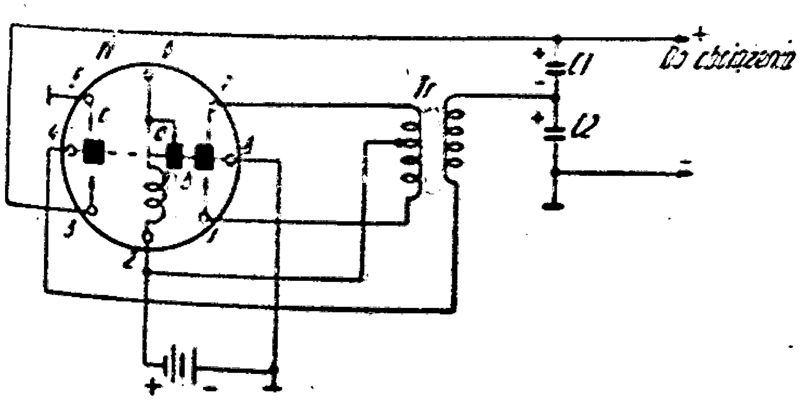


Figure 65: Charging Panel

(1) Voltmeter
(2) Ammeters
(3) Generator field rheostat
(4) Rheostats in the battery charging circuits
(5) Generator voltage on-off switch
(6) Battery group switches
(7) Voltmeter switch
(8) Pilot lamps
(9) Fuses
(10) Reverse current relay
(11) 12 V voltage socket
(12) Flap
(13) Flap catches



Rys. 66. Uproszczony schemat przetwornicy wibratorowej

Figure 66: Simplified circuit diagram of vibrator converter

/"Do Obciazenia" = "to load"/

50X1-HUM

SECRET

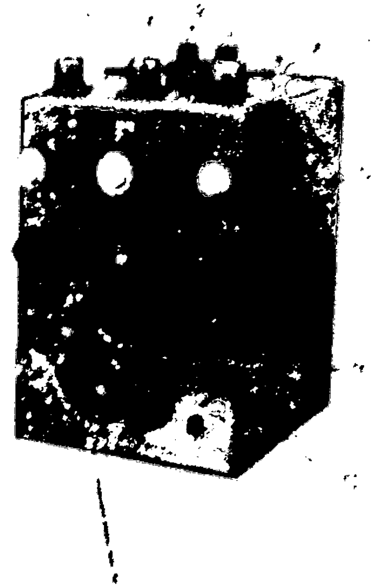
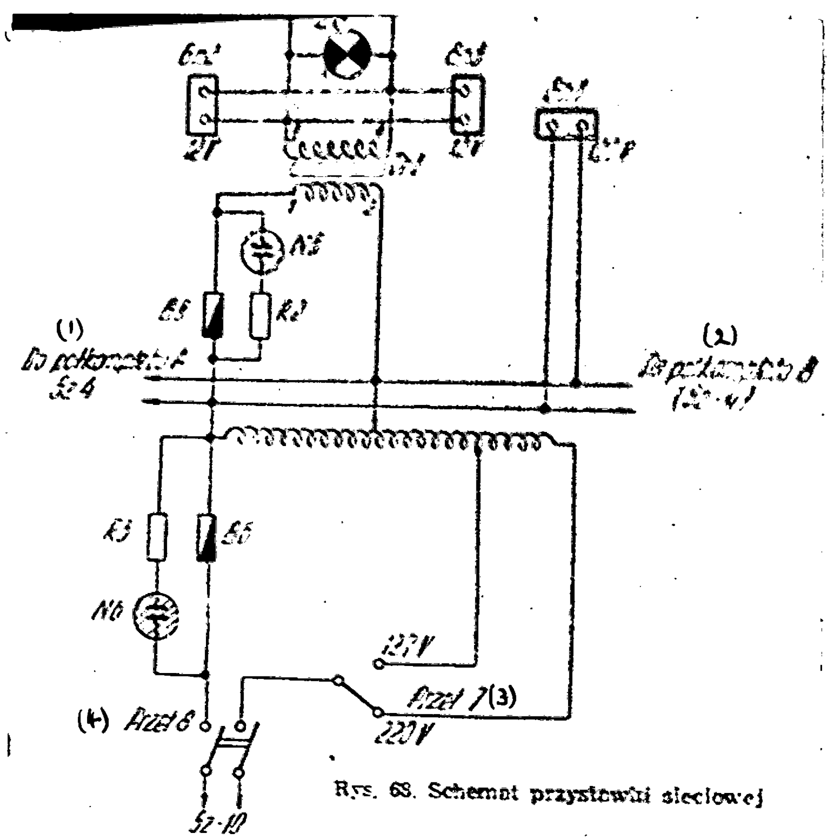


Figure 67: Mains attachment

(1) Transformer knob
(2) Mains on-off switch
(3) Fuses
(4) Pilot lamps
(5) Half-connector Sz-10
(6) Half-connector Sz-4
(7) Half-connector Sz-4
(8) "Earth" terminal
(9) 12 V terminal
(10) 127/220 V switch
(11) Switch locking clip
(12) Housing



Rys. 68. Schemat przystawki sieciowej

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Figure 68: Circuit diagram of mains attachment

KEY: (1) To half-set A
(2) To half-set B
(3) Switch 7
(4) Switch 8

/Gn = socket/

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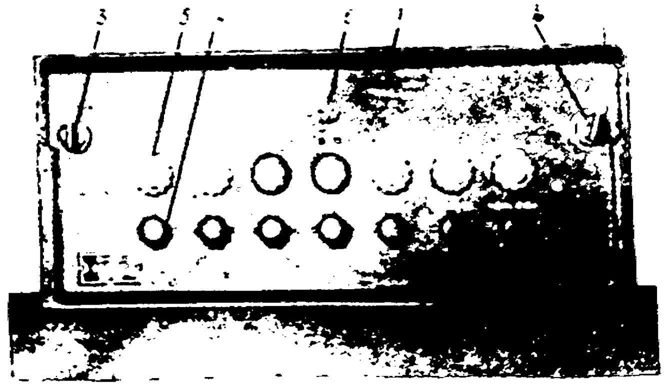
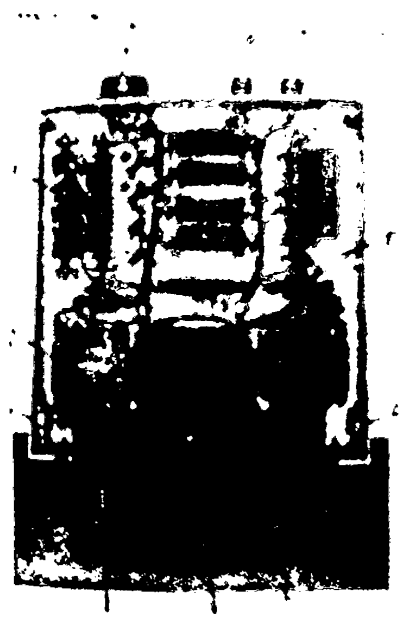


Rys. 69. Blok prostowników (blok 3):

Figure 69: Rectifier unit (Block 3)

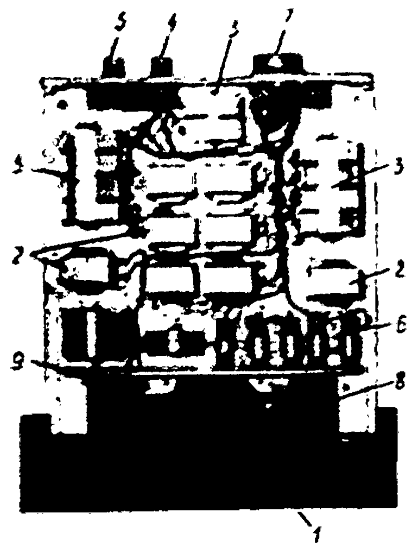
(1) Front panel
(2) Housing with openings
(3) Bolts securing unit to housing
(4) Fuses
(5) Pilot lamps
(6) Potentiometer of the d.c. amplifier



Rys. 70. Widok z góry bloku prostowników po zdjęciu obudowy:

Figure 70: Rectifier block viewed from above, with housing removed

(1) Front panel
(2) Transformers
(3) Selenium rectifiers
(4) Sz-3 half-connector
(5) Sz-4 half-connector
(6) Pilot lamps
(7) Sz-1-3 half-connector
(8) Bolt securing block to housing
(9) IF Amplifier potentiometer
(10) Chassis



Rys. 71. Widok z dołu bloku prostowników po zdjęciu obudowy:

Figure 71: Rectifier block viewed from below, with housing removed

(1) Front panel
(2) Chokes
(3) Paper capacitors
(4) Sz-3 half-connector
(5) Sz-4 half-connector
(6) Electrolytic capacitors
(7) Sz-1-3 half-connector
(8) Fuses
(9) Chassis

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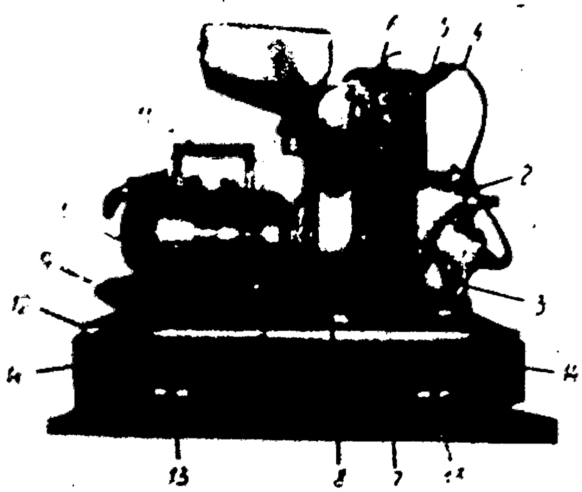
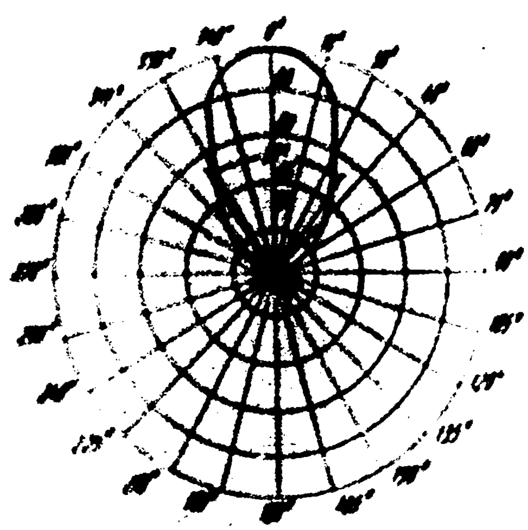


Rys. 72 Zespół spalinowo-elektryczny

Figure 72: Mobile petrol-driven generator

(1) GSK-1500 Generator
(2) 2SD Engine
(3) M-22 "KATEK" Magneto
(4) Screened HT lead
(5) NA-11-10B sparking plug
(6) Decompressor
(7) Silencer in screen
(8) Fan housing
(9) Exhaust pipe
(10) Fuel tank
(11) Anti-interference filters
(12) Base
(13) Securing lugs
(14) Fasteners holding cover



Rys. 73 Pozioma charakterystyka promieniowania anteny pionowej

Figure 73: Horizontal radiation pattern of vertical aerial

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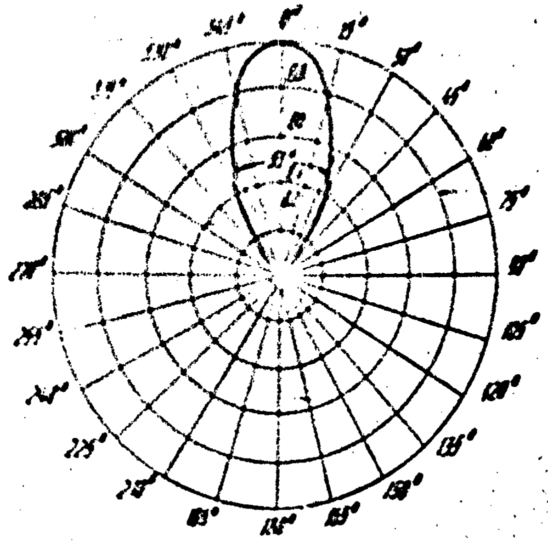
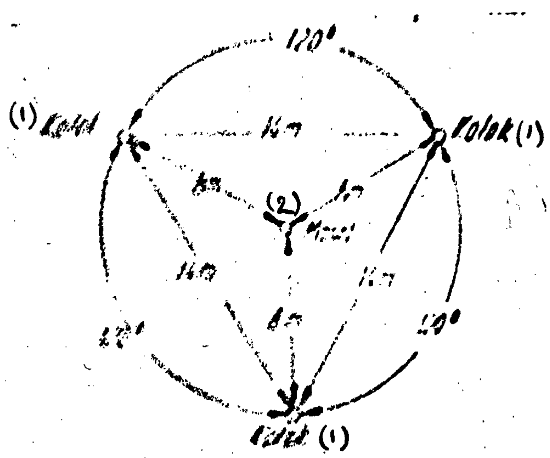


Rys. 74. Pozioma charakterystyka promieniowania anteny poziomej

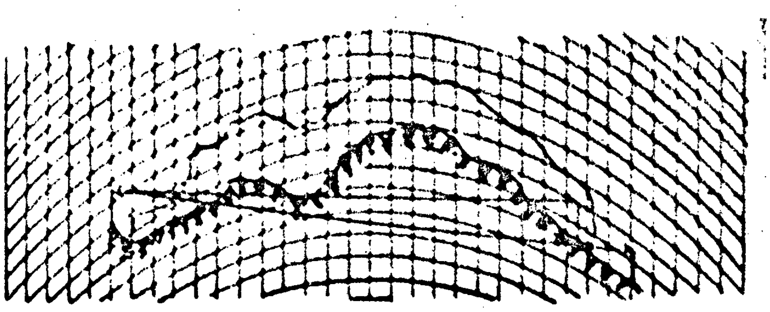
Figure 74: Horizontal radiation pattern of horizontal aerial



[illegible]

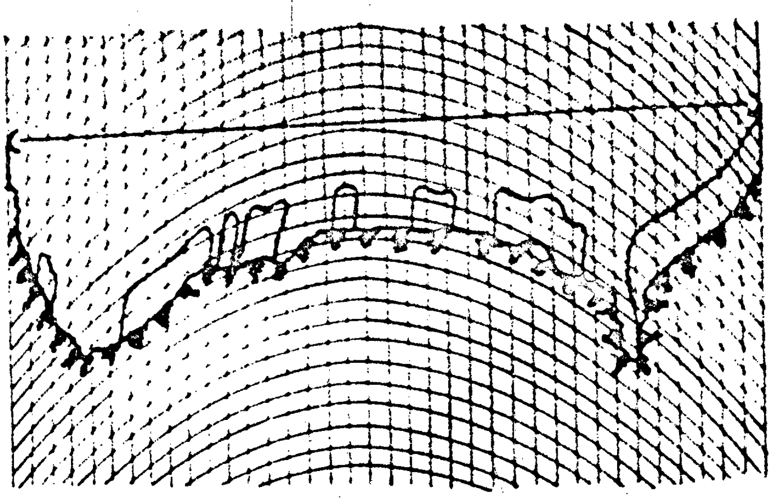
Figure 75: Location of guy-rope pegs

KEY: (1) Peg (2) Mast



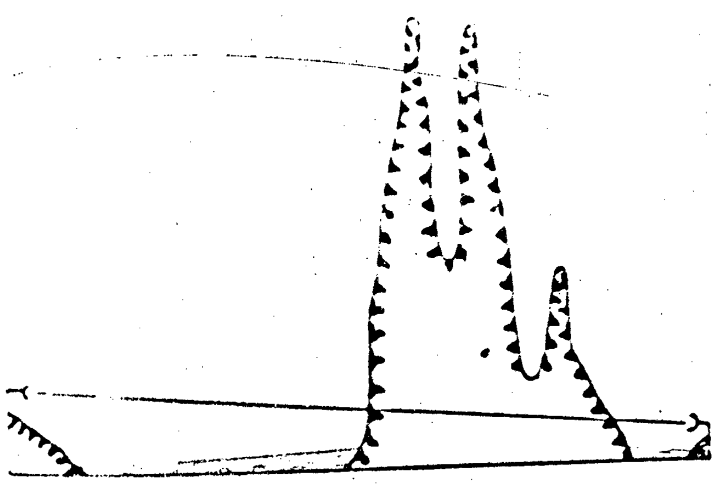
Rys. 76.

Figure 76



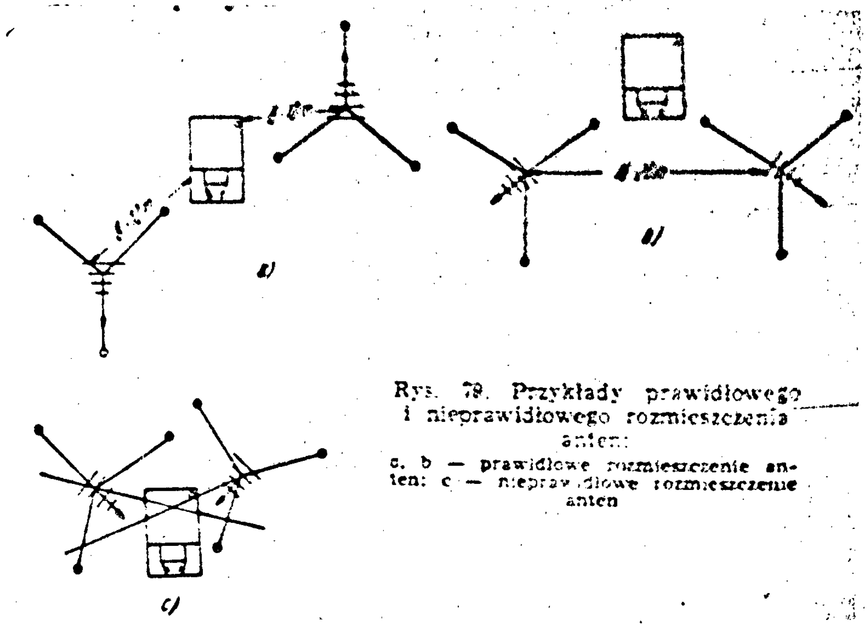
Rys. 77.

Figure 77



Rys. 78

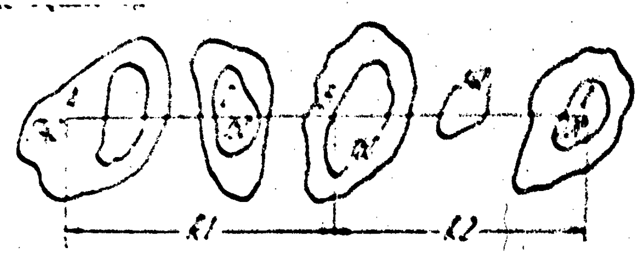
Figure 78



Rys. 79. Przykłady prawidłowego i nieprawidłowego rozmieszczenia anten:
a, b — prawidłowe rozmieszczenie anten; c — nieprawidłowe rozmieszczenie anten

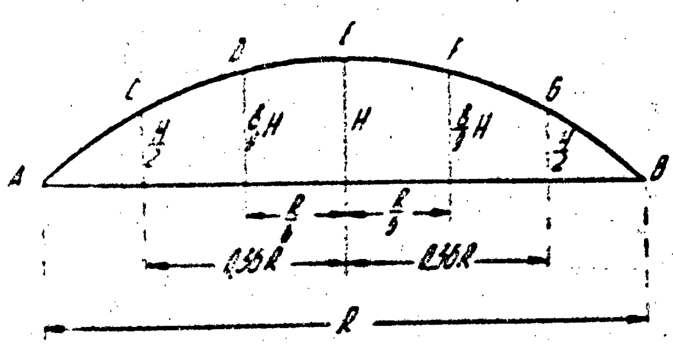
<u>Figure 79</u>: Examples of correct and incorrect placing of aerials

(a) and (b) Correct location of aerials (c) incorrect location of aerials



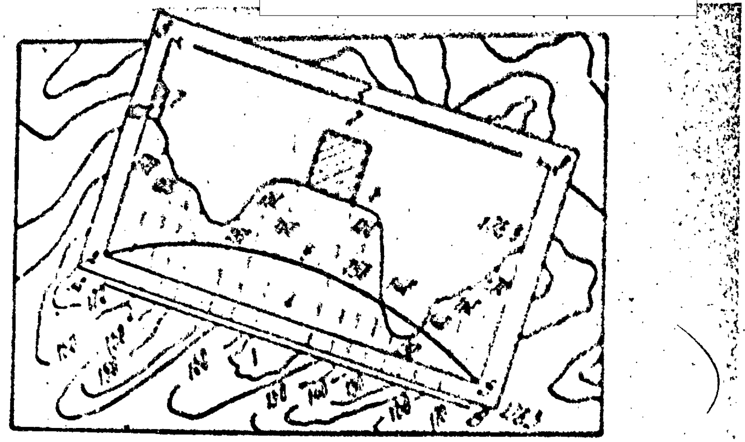
Rys. 80. Orientacyjna metoda sprawdzania bezpośredniej widzialności

<u>Figure 80</u>: Example of a method of checking for line-of-sight



Rys. 81. Sposób wyznaczania punktów pomocniczych dla wykreślenia łuku krzywizny ziemi

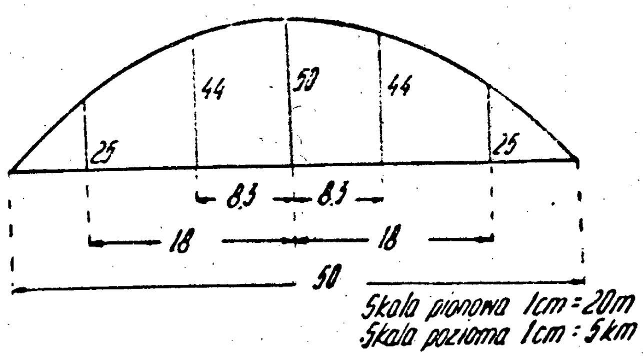
<u>Figure 81</u>: Method of plotting auxiliary points for drawing the arc of the curvature of the earth



Rys. 82. Sposób wykreślania profilu trasy w wypadku braku specjalnych blankietów:

Figure 82: Method of drawing the profile of the route in the absence of special tracing forms

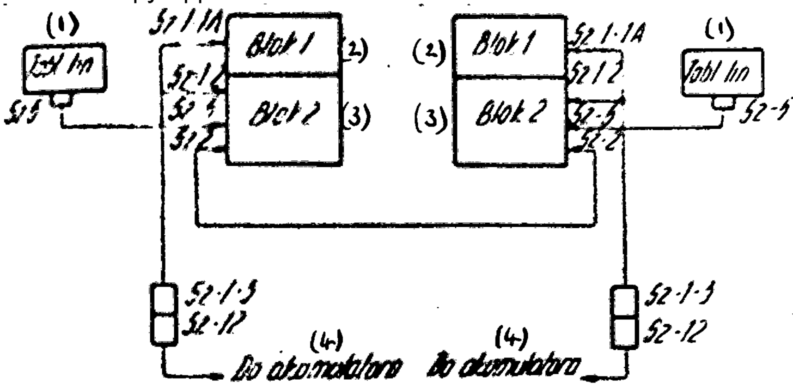
(1) Map
(2) Straight line connecting the location points of the Stations (A-B)
(3) Sheet on which the profile is traced
(4) Straight line connecting points A and B on the sheet
(5) Arc of the curvature of the earth
(6) Line of the profile of the route
(7) Local features (forest, buildings)
(8) Points of location of the aerials
(9) Line-of-sight



Rys. 83. Przykład wykreślania łuku krzywizny ziemi

Figure 83: Example of plotting the arc of the curvature of the earth

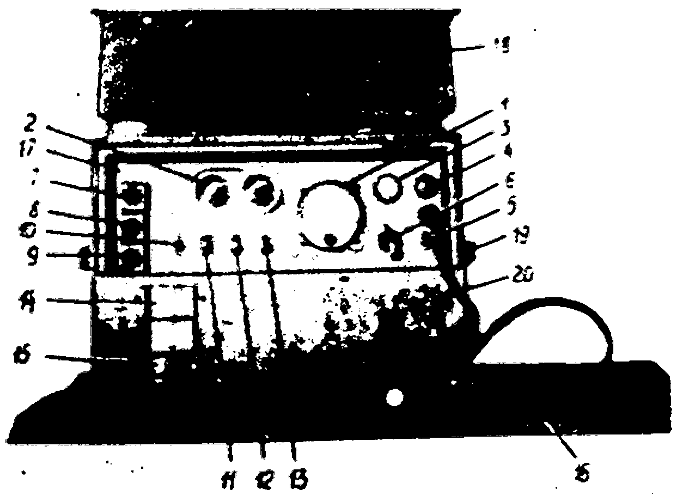
Vertical scale: 1 cm = 20 m
Horizontal scale: 1 cm = 5 kms



Rys. 84. Schemat połączenia dwóch kompletów wynośnych przy pracy retranslacyjnej

Figure 84: Diagram showing connections of two remote control sets during repeater operation

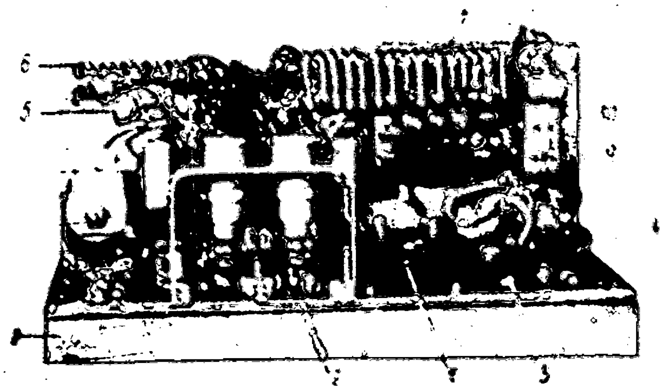
KEY: (1) Line Panel (2) Block 1 (3) Block 2 (4) To batteries



Rys. 85. Przyrząd do regulacji kanałów telegraficznych i przekaźników (widok z przodu).

Figure 85: Instrument for adjusting the telegraphic channels and relays (front view)

(1) Instrument
(2) Ballast lamps (barretters)
(3) Pilot lamp
(4) Fuse of the vibrator converter
(5) Instrument on-off switch
(6) Pulse length adjustment potentiometer
(7) "Transmission" terminal
(8) "Earth" terminal
(9) "Reception" terminal
(10) Line current test press-switch
(11) Key No. 12
(12) Key No. 13
(13) Key No. K.../?/
(14) Pulse transmitter relay
(15) Base for relay being tested
(16) Power supply plug
(17) Front panel
(18) Front panel cover
(19) Cover locks
(20) Housing



Rys. 86. Przyrząd do regulacji kanałów telegraficznych i przekaźników (widok z góry po zdjęciu obudowy)

Figure 86: Instrument for adjusting the telegraphic channels and relays (view from above, with housing removed)

(1) Instrument

(2) Ballast lamps

(3) Pilot lamp holder

(4) Fuse of the vibrator converter

(5) Frequency adjustment potentiometer

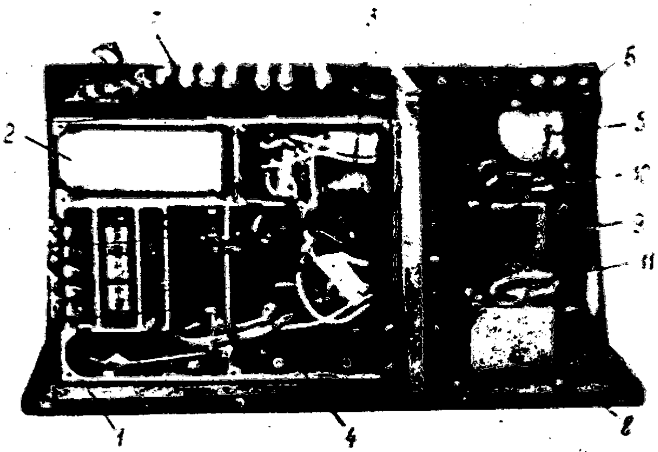
(6) Duct capacitors

(7) Strip with resistors

(8) Front panel

(9) Chassis

(10) RKM /?/ relay



Rys. 87. Przyrząd do regulacji kanałów telegraficznych i przekaźników (widok z dołu po zdjęciu obudowy):

Figure 87: Instrument for adjusting the telegraphic channels and relays (view from below, with housing removed)

(1) Vibrator converter (screening cover removed)

(2) Vibrator of the converter

(3) Transformer

(4) Electrolytic capacitors

(5) Frequency adjustment potentiometer

(6) Duct capacitors

(7) Strip with resistors

(8) Front panel

(9) Chassis

(10) Base of the pulse transmitter relay

(11) Base for relay being tested

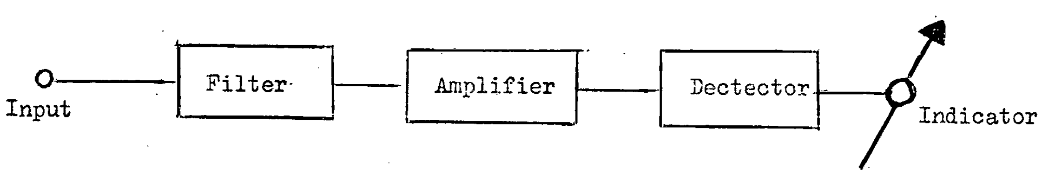


Figure 88: Block diagram of psophometer

Appendix 1

Safety Regulations

1. The commander of the station is responsible for the observance of safety regulations during the work on the station.

2. Persons who are not part of the duty personnel are not allowed to remain inside the truck without the permission of the station commander.

3. When replacing fuses, the circuit concerned should first be de-energised by switching off the respective sources of supply. When replacing fuses in the battery charging circuits, the batteries being charged should first be disconnected.

4. When repairing or checking the blocks removed from the rack, when checking the power supply circuits, and during other work involving high voltage circuits, there should be at least two persons present inside the truck so that one can come to the aid of the other in case of need.

5. When connecting the cable N-4 to a.c. mains it is necessary to wear rubber gloves, and to work in presence of another person, who can render assistance in case of need.

6. It is absolutely forbidden to connect the a.c. mains to the station, and to use it without prior earthing of the motor vehicle.

7. When preparing the battery electrolyte, and when charging the batteries, the regulations given in the "Service manual for cadmium-nickel batteries" should be strictly observed.

8. The petrol engine tank should be filled with the fuel mixture only when the engine is switched off. When preparing the fuel mixture it is forbidden to use a fire or to smoke.

9. When the engine is running, it is forbidden to remove from it the protective covers.

10. It is forbidden to lower the mast without using the hoist.

11. The technical condition of the guy-ropes, the locking hooks, and the circles on the rings should be checked before starting the erection of the mast.

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/Appendix 2

Appendix 2

METHOD OF INSPECTION AND TECHNICAL CONTROL OF THE R-401 RADIO-RELAY STATION

Contents of Appendix 2.

/ Chapter I

CHAPTER I

General Information

1. Introduction

1. The radio-relay station is fed from two 5NKN-45 12-volt batteries, or from single-phase A.C. mains, 127/220 V.

2. The level of interference in the telephonic channels, originating from the power supply, should not exceed:

- in the case of battery power supply: 1.5 mV per octave;
- in the case of A.C. mains supply: 0.8 mV per octave.

3. The power drawn from the battery by one half-set should not exceed:

- during listening: 35 W;
- during duplex operation (using multiplexing equipment): 75 W.

4. The radio-relay set should continue to operate normally if the battery voltage falls to 11 V, or if the mains voltage drops by 10 per cent., of the nominal value.

5. The power of the transmitter at an aerial equivalent resistance of 75 ohms should not be less than 2 W, while if the battery voltage falls to 11 V, or the mains voltage by 10 per cent., this power must not be less than 1 W.

6. The combined error in calibration and setting of the frequency of the transmitter at a temperature of +20°C. $\pm$5°C., must not exceed $\pm$6 kc/s.

7. The total deviation of the frequency of the exciter resulting from a variation in the battery voltage from 11 to 13 V, or in the mains voltage by 10 per cent., and the heating of the transmitter during 15 minutes, should not exceed $\pm$7.5 kc/s.

8. The variation in the frequency of the transmitter during standard weather conditions should amount to 6-9 kc/s for each telephonic channel, and 3-5 kc/s for each telegraphic channel.

/ 9.

9. The nominal level in the channels at a frequency of 800 kc/s, using own multiplexing devices, is:

- in a single-track system: input 285 mV (-1 N)
  output 105 mV (-2 N).

A variation in the output level within limits of 86 - 129 mV (±0.2 N) is permissible:

- in a double-track system, without translating the call: input and output 520 mV (-0.4 N).

A variation in the output level within limits of 425 - 635 mV (±0.2 N) is permissible:

- in a double-track system, translating the call: input and output 190 mV (-1.4 N).

A variation in the output level within limits of 157 - 233 mV (±0.2 N) is permissible:

- when using external multiplexing equipment: input 1.16 V (+0.4 N), and output 105 mV (-2 N) - for an input impedance of 1000 ohms, and for a deviation which appears during operation in the first channel in the single-track system.

10. The limiter should operate in such a way that the increase in the output level should not exceed +0.4 N (in a telephonic channel and a single-track system) in relation to the nominal value, when the input level changes from 285 mV to 775 mV.

11. The frequency characteristic of each telephonic channel in relation to the level at a frequency of 800 c/s should not fall by more than:

- 0.4 N in the 400 - 500 and 2200 - 2500 c/s frequency band;
- 0.3 N in the 500 - 600 and 1800 - 2200 c/s frequency band;
- 0.2 N in the 600 - 1800 c/s frequency band.

12. The frequency characteristic in the whole 400 - 2500 c/s frequency band should not exceed the level for the frequency of 1000 c/s by more than 0.7 N.

13. The inequality of the frequency characteristic of the channel for external multiplexing, in the 3.5 - 15 kc/s frequency range, should not be greater than ±0.2 N in relation to the level at a frequency of 9 kc/s.

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14. The non-linear distortion factor in the telephonic channels must not exceed:

- in a two-wire system: 10% for the input level of 285 mV;
- in a four-wire system: 4% for the input level of 520 mV.

15. The first intermediate frequency of the receiver is 6.6 mc/s, while the second intermediate frequency of the receiver is equal to 460 kc/s.

16. The receiver sensitivity, at a deviation of 6 kc/s, a nominal output level, and the signal voltage-to-noise ratio of 20:1, should not be less than 2 μV.

17. The output voltage of the receiver is equal to 1.6 ± 0.3 V for: the middle frequency of the range, deviation of 6 kc/s, and modulating voltage frequency of 6.6 kc/s.

18. The attenuation of the image frequency should not be less than:

- 22000 (10 N) for the first I.F.;
- 65000 (11 N) for the second I.F.

19. The attenuation of signals of an intermediate frequency should be not less than 125 dB (11.5 N).

20. Receiver selectivity:

- when detuned by 75 to 300 kc/s, the attenuation should be greater than 10000 (9.2 N);
- when detuned by over 300 kc/s, the attenuation should be greater than 125000 (11.5 N).

21. The combined error in calibration and frequency setting of the receiver at a temperature of $+20^{\circ}C. \pm 5^{\circ}C.$ should not exceed ± 6 kc/s.

22. The combined deviation of the frequency of the first heterodyne of the receiver, caused by: changes in the battery voltage from 13 to 11 V, in the mains voltage by 10%, and heating of the receiver during 15 minutes, should not exceed ± 7 kc/s.

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23. The automatic frequency control system should ensure a 7-fold reduction in frequency detuning if this does not exceed ± 25 kc/s.

24. The thermal frequency factor of the exciter and the first heterodyne of the receiver should not exceed the value $\pm 4 \cdot 10^{-6}$ within the temperature range of from +5 to $+40^{\circ}$C.

2. <u>Conditions of storage</u>

25. The radio-relay equipment should be stored in heated garages, with a relative humidity of 50 -75% and a temperature of +15 to $+20^{\circ}$C. The storage of the radio-relay equipment in premises with a relative humidity in excess of 75% is not permitted.

26. General instructions on the storage of communications equipment are contained in "Regulations governing the handling of communications equipment in the Army", Laczn. 87/59.

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/Chapter II.

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CHAPTER II

Inspection of Radio-relay Station

1. External Inspection

27. The purpose of external inspection is to:

- bring to light any mechanical damage;
- bring to light any shortcomings in maintenance or use;
- carry out repairs or maintenance work in order to remove the discovered shortcomings or deficiencies.

28. External inspection includes:

- checking the housing of the various instruments;
- checking the state of the cables;
- checking the aerials;
- checking the handsets and measuring instruments;
- checking the mobile generators and batteries;
- checking the condition of auxiliary equipment.

29. When assessing the external condition, one should take into account the following points:

- the motor vehicle carrying the relay, the interior of the body-work, all the components of the station and its equipment should be clean, and free from any traces of dust, mud, or other impurities. There should not be any signs of scratches, dents, or damage to the screening shields or insulating covers not should there be any looseness in the mechanical mounting of the individual assemblies of the station;
- the knobs (handwheels) of the equipment should not show any trace of scratches or mechanical damage, and should rotate easily and smoothly, without any play on the shafts;
- the switches should lock clearly and accurately on all the operating positions;

/- the aerials ..

- the aerials of the station, and other elements, which, during operation, are set up away from the motor vehicle, should be particularly carefully checked from the point of view of completeness and condition of maintenance. The guy-ropes and pegs, when packed, should have been carefully dried and protected against corrosion by careful removal of dirt and drying, while the metal parts should have been covered with a thin layer of industrial petroleum jelly.

In their set-up condition, the aerials should also be kept clean, while the guy-ropes should not be tensioned excessively.

During the autumn and winter periods, all the ropes outside the vehicle should be cleared of frost and ice deposits, to prevent them from breaking.

Attention should also be paid to the state of maintenance of the aerial sockets in the aerial and in the HF transceiver block inside the motor vehicle;

- the mains and mobile generator power supply cables should be free from grease or oil. The dirty place should be carefully cleaned with a dry cloth, while the half-connectors should be cleaned from dust and mud.

If the air temperature is -40 to -45° C., the cables should be handled carefully, to prevent their being damaged.

30. The result of the external inspection may be regarded as satisfactory, if none of the above shortcomings have been observed.

31. If the shortcomings and damage make it impossible for the station to be used normally, it should be sent for repair. The procedure for this is laid down in the "Regulations governing the handling of communications equipment in the Army", Part V, Section I.

/ 2. Inspection •

2. Inspection of technical condition

32. The purpose of the inspection of the technical condition is to check the usefulness of the station for operation in genuine operating conditions. An inspection of the technical condition of radio-relay equipment should always be preceded by an external inspection.

33. The inspection of technical condition includes:

- checking the supply voltages and the operation of Block 1;
- checking the HF power of the transmitter;
- checking the modulation of the transmitter;
- checking the operation of the receiver;
- checking the accuracy of calibration and the frequency correction of the receiver;
- checking the accuracy of calibration and the frequency correction of the transmitter;
- checking the automatic frequency control system;
- checking the power supply voltages and the operation of Block 2;
- checking the telephone channels;
- checking the telegraphic channels;
- checking the battery voltage;
- checking the battery charging system;
- checking the a.c. mains supply;
- checking the battery power supply.

The method of carrying out the technical inspection is described in paras. 34 - 52.

34. Checking the supply voltages and the operation of Block 1:

(a) In order to check the supply voltages, one should set the left-hand switch of the measuring instrument (on Block 1) to the following positions:

- "+160 nad." ['nad.' = transmitter];

- "-25 V";
- "+160 odb." ['odb.' = receiver];
- "+12 V";
- "-45 V";

At the rated voltages, the deflection of the instrument pointer should lie within the limits of the black area marked on the scale.

(b) If the instrument readings lie below the marked area, the station is faulty. In this case, one should:

- if the power supply comes from the mains: check the mains voltage. If this voltage shows the rated value (220 V), then the station should be sent to the workshops for checking and possible repairs to the rectifier block;
- if the power is drawn from a battery: check the battery voltage, which should not be less than 11 V. If the voltage is at its rated value (12 V), the station should be sent to the workshops for checking the possible exchange or repair of the vibrator converters. The method of checking the battery voltage is described in Chapter II, para. 48, below.

(c) In order to check the operation of the receiver valves, the left-hand switch of the instrument should be set to "Odbiornik" ["Receiver"], while the right-hand switch should be set successively to all the positions marked with figures, from 1-2 to 16. These figures correspond to the valve numbering, as shown on the circuit diagram.

If the valves are to operate properly, the instrument pointer should lie within the limits of the black area. In position "4", the pointer is deflected only during the operation of the quartz calibrator: for this reason, the switch "APCZ-wyl." ["AFC - Off"] should be set to the position "APCZ".

/ (d) .....

(d) In order to check the operation of the transmitter valves, the left-hand switch is set to the position "Nadajnik" ["Transmitter"] and the switch "Praca - Dyzur" ["Operation - Stand by"] to the position "Praca". The right-hand switch is then set successively to the positions marked with figures from 1 to 6. The instrument pointer should lie within the marked area on the scale.

(e) If one of the valves gives instrument readings below the marked area, the valve should be changed and the reading repeated.

35. Checking the HF power of the transmitter.

In order to check the power, the transmitter should be put on load by means of a dummy aerial (to be found in the technical equipment), and the left-hand switch of the instrument should be set to the position "Antena" ["Aerial"]. One should then switch on the power supply of the station and check whether, at the rated voltage, the instrument pointer will lie within the marked area on the scale. If, at the rated voltage of the power supply, the power is less than nominal, one should adjust the tuning of the output circuit of the transmitter. For this purpose: remove the seal from the shaft of the trimming capacitor located at the left-hand side of the panel "Odwod Wyjsciowy" ["Output Circuit"]. Set the left-hand switch of the instrument to the position "Nad." ["Transmitter"] set the right-hand switch to the figure "1", and turn the capacitor shaft in such a way as to obtain the minimum deflection of the instrument pointer (minimum anode current of the power amplifier valve). Having done this once again check the power. The check should be carried out on three waves of the range (e.g. on wave number 2, 28, 52).

36. Checking the modulation of the transmitter:

In order to chekc the transmitter modulation, set the left-

/ hand

hand switch of the measuring instrument in the transceiver block to the position "Wejscie Nadjnika" ["Transmitter Input"], and set the switch of one of the telephone channel in Block 2 (multiplexing block) to the position "Kanal Radiowy" ["Radio Channel"]. Next, set the call switch to the position "Zew" ["Call"] or "Generator Kontrolny" ["Test Oscillator"]. The instrument pointer should be deflected. The amount of deflection depends on the wave number and is proportional to the amount of frequency deviation. The deviation is set with the help of the knob "Regulacja Poziomu" ["Level Adjustment"], which is located on the right-hand side of the panel, in conformity with the table attached to the panel. An example of such a table is given below.

Table 1

Wave No.	Telephone 1		Telephone 2		Telephone 1		Telephone 2	
	Power		Power		Power		Power	
	Mains	Battery	Mains	Battery	Mains	Battery	Mains	Battery
8	66	62	81	75	40	35	39	35
28	60	58	78	70	35	31	33	32
54	58	52	70	65	33	30	32	39

Thus, for instance, in the case of wave No 28, when the station draws its power from a.c mains and is operating on the first telephone channel, the instrument pointer should indicate 60 divisions. When power is drawn from the battery, and the station is operating on the second telephone channel, the deflection of the instrument pointer should be 70 divisions.

37. Checking receiver operation.

In order to check the operation of the receiver, the first and second telephone channel switch should be set to the position

/ "Kanal Radiowy" .

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"Kanal Radiowy" ["Radio Channel"], and one should check for the presence of noise in the ear-piece of the handset. Next, switch on the quartz calibrator by setting the calibrator switch "Kalibrator - Wylaczono" ["Calibrator - Off"] to the position "Kalibrator", and, turning the "Fala" ["Wave"] knob, set the wave to Nos. 1 or 45 (these waves are marked on the scale with dots). If the receiver is operating normally on these waves, one can hear in the first telephone channel an acoustic tone varying within a few kc/s.

If no tone is audible, take action as described in para. 38.

38. Checking the accuracy of calibration and correction of receiver frequency.

The checking of the accuracy of calibration, and the correction of receiver frequency is carried out in the first telephone channel "Kanal Radiowy", at rated power voltages, and after the warming up of the entire equipment for at least an hour.

The calibration check is carried out after disconnecting the aerial cables from the transmitter and receiver.

One should accurately set on the receiver scale the number of the wave marked with a dot (No. 1 or 45), and then detune the transmitter from the receiver frequency by at least 5 numbers. One should also switch off the AFC (setting the "APCZ-wylacz." switch to the position "wylacz"). The mode of operation switch of the first telephone channel in Block 2 should, for better audibility, be set to the position "4TG".

When the telephone channel test switch, "Kontrola I-II" is set to the position "1", receiver noise can be heard in the handset.

One should next switch on the quartz calibrator (by setting the calibrator switch to the position "Kalibrator" and, when an acoustic tone (up to 2.5 kc/s) can be heard in the first telephone channel, then the calibrating inaccuracy is within permissible limits. In this case, a

/ frequency .....

frequency correction is not required. In the event when no acoustic tone is audible, this indicates either that the calibration is very accurate, or that it is very inaccurate.

To check which of these alternatives is present, one should turn the "Fala" ["Wave"] knob slowly in both directions around the correct position marked with a line. If the turning of the knob to the left and right is accompanied by the appearance of the acoustic tone beginning with the lower frequencies, then the receiver is calibrated correctly and no frequency corrections should be made. If, however, no tone is audible, one should increase the rotation of the knob in both directions, until the tone is obtained. This indicates a considerable detuning of the receiver, and, in this case, it is necessary to carry out the frequency correction. In order to carry out this correction, remove the seal from the knob "Podstrojenie Heterodyny" ["Heterodyne Trimming"], located on the right-hand sidewall, and determine on which side of the wave-number marked with a dot the tone is audible. Carefully set on the scale the wave marked with a dot (Nos. 1 or 45), and turn the knob of the heterodyne trimming capacitor until one obtains a zero beat in the channel. If the beats during the calibration checks were on the side of the lower wave numbers, then the capacitor shaft should be turned to the right, and if they were on the side of the higher numbers, then the shaft should be turned to the left.

One should next check the calibration on the second wave marked with a dot. The accuracy at this point should lie within the permissible limits (acoustic tone). Having completed these actions, reseal the "Heterodyne Trimming" knob.

Note

1. When changing the heterodyne and the fine-tuning circuit valves (L-5 and L-6), it is essential to check the calibration and to carry out frequency correction.

2. Frequency correction may only be carried out by qualified persons authorised by the commanding officer.

39. Checking the calibration accuracy and correcting the frequency

of the transmitter.

In order to check the calibration accuracy and to carry out frequency correction of the transmitter, one should first carry out a careful frequency correction of the receiver.

The check should be carried out as follows: remove the seal (on the left sidewall) from the knob marked "Generator Wzbudzajacy" ["Master Oscillator"], and put both the receiver and the transmitter on load with dummy aerials. The receiver, with the quartz calibrator switched on, should be set to the wave marked with a dot,

On the transmitter scale, set the same wave as in the receiver. If an acoustic tone is heard in the first telephone channel, no correction is necessary. If no tone is audible, check for either of the two eventualities, as in the case of the receiver.

If it is found that the transmitter is detuned, one should carry out the frequency correction. For this purpose, set on the receiver the wave marked with a dot, as in the receiver, and turn the shaft of the master oscillator trimming capacitor until zero beats are heard in the earphone. Next, check the calibration of the transmitter on the other wave marked with a dot: the calibration accuracy at this point should lie within the permissible limits.

Having completed these actions, re-seal the "Master Oscillator" knob.

40. Checking the automatic frequency control.

The operation of the AFC circuit is checked as follows: set on the receiver scale the wave marked with a dot; set the mode of operation switch of the first telephone channel to the position "I". Switch on the quartz calibrator, set the left-hand switch of the measuring instrument to the position "Odbiornik" ["Receiver"], and the right-hand switch to the figure "6" (on the inner circle of numbers). Slowly turn the receiver knob "Fala" ["Wave"], until an acoustic tone close to the zero 50X1

/ beats will ...50X1-HUM

beats will be heard in the earphone. Next, switch on the AFC switch, and, if the pitch of the tone in the earphone remains unchanged, then no AFC adjustment is necessary.

If the AFC is operating correctly, the current of the valve L-6 should not undergo any changes when the AFC is switched on or off. If the current does fluctuate, one should carry out anadjustment of the AFC circuit.

41. Adjustment of the AFC when the station is powered from a battery.

In order to carry out adjustments to the AFC, remove the seal from the knob "AFCz" ["AFC"] located on the left wall of the block, and turn the shaft of this knob (the R [30 ? illegible] potentiometer on the circuit diagram) in such a way as to obtain no fluctuation of the L-6 valve current when switching the AFC on or off, while the pitch of the acoustic tone in the first telephone channel should remain constant. Having done this, re-seal the "AFC" knob.

42. Adjustment of the AFC when the station is powered from a.c. mains.

The adjustment is carried out in exactly the same way as in the case of the battery-powered station, except that one should manipulate the "AFC" knob mounter on the frontal plate of panel 3 (first knob from the bottom).

Note

In order to prevent the AFC adjustment from being disturbed when going over from one source of power to the other, one should first carry out the adjustment as for the battery supply, and then as for the mains supply.

43. Checking the power supply voltages and the operation of the valves in Block 2.

(a) In order to check the supply voltages of Block 2, one should

/ set the .....

set the "TF-TG-Przyrzad" ["Telephony-Telegraphy-Instrument"] switch to the position "TF", and set the instrument switch successively to the positions "12" and "160" on the inner ring of inscriptions.

The instrument pointer should deflect to the right, within the limits of the marked area.

If the instrument reading for the voltage being measured lies below the marked area, proceed as described in Chapter II, section 34.

(b) In order to check the operation of the valves of the telephone channels, set the "TF-TG-Przyrzad" switch to the position "TF" and set the instrument switch successively to positions "L-1", "L-2", "L-3", "L-4". The instrument pointer should deflect within the limits of the right-hand area marked on the scale.

If, for a given valve being checked, the instrument pointer falls below the marked area, the valve should be changed, and the reading repeated.

(c) In order to check the operation of the valves of the telegraphy channels, the "TF-TG-Przyrzad" switch should be set to the position "TG", and the instrument switch should be set successively to the positions marked "L-5", "L-6", "L-7", "L-8". Further proceedings are the same as when checking the valves in the telephone channels.

44. Checking the telephone channels.

By checking the telephone channels is meant the checking of the transmission of a call to the exchange and vice-versa, and operating "self-contained" [na siebie - see full explanation under (b) below].

(a) In order to check the passage of a call and conversation to the exchange, one should first connect the 2-wire telephone lines running from the exchange (or other sequential switch 50X1-HUM

/ device) .....

50X1

device) to the terminals of the first and second channel on the line panel (the appropriate terminals are marked 1-2 and 5-6). The "Kanal Radiowy - Centrala" ["Radio Channel - Exchange"] switch of the appropriate channel (I or II) should then be set to the position "Exchange", and the "Generator Pomiarowy - Wywolanie" ["Measuring Oscillator - Call Signal] switch to the position "Call Signal". The operator should answer from the exchange, and one should test with him the speech quality.

A call from the exchange is taken when the "Radio Channel - Exchange" switch is in the central position. The call is signalled by a bell and by the lighting up of green lamps (under the inscription "Centrala" ["Exchange"], depending on the channel).

Note

Instead of the 2-wire telephone lines from the exchange, one may connect up telephone handsets to the teminals 1-2 and 5-6.

(b) By the phrase "self-contained" operation is meant the operation of a HF transmitter of one half-set with the HF receiver of the other half-set, or the operation of a transmitter with a receiver in one half-set.

During the operation of a transmitter with a receiver of the other half-set, the transmitter should be put on load with a dummy aerial, and the receiver should be joined to the aerial by a feeder cable. The transmitter should then be tuned to the receiver frequency (on any wave) in such a way that the mode of operation switch "Dyzur - Praca" ["Stand by - Operation"] should be set to the position "Stand by". The switch "Oswietlenie - Wylaczone" ["Illumination - Off"] should be set to the position "Illumination", the scale locking knobs should be turned to the left, and the "Fala" ["Wave"] knobs of the transmitter and the receiver in the two different half-sets should be set to the given wave number in

/ such a way .....

such a way that the vertical line of the wave number on the scale should coincide exactly with the line on the view-finder [sic - "wizjer"].

Having set the wave numbers, the scale should be locked by turning the knobs to the right. The switches "TF-4TG-4TF" should be set to the position "2TF", and the "Dyzur - Praca" switch in Block 1 should be set to "Praca".

In order to send a call into the radio channel, the switch "Kanal Radiowy - Centrala" ["Radio Channel - Exchange"] should be set to "Kanal Radiowy", while the switch "Generator Pomiarowy - Wywolanie" ["Measuring Oscillator - Call Signal"] should be tilted to the position "Wywolanie".

A test conversation should then be carried out. Telephone handsets should be connected to the terminals 1-2 and 5-6 on the line panel.

The arrival of a call from the radio channel is signalled by a bell and by the lighting up of red lamps over the inscriptions "Kanal Radiowy" (depending on the channel).

The testing of conversations passing through the telephone channels is carried out with the help of a handset connected to the conversation and calling channel, with the switch "Kontrola I-II" ["Test I-II"] in the position I or II, depending on the channel in which the test is being made. The handset of the conversation and calling circuit should be connected to the terminals marked "MKT" in Block 2.

In the event of operation of the transmitter and receiver in the same half-set, the switches "2TF-4TG-4TF" should be set to the position "4TF", and the handsets should be connected to terminals 3-4 and 7-8 on the line panel. The remaining procedure is the same as in the case of testing of telephone channels during the operation of a transmitter with a receiver in the other half-set.

/ If the call .....

[redacted]

If the call signal and the conversation are not carried by the telephone channels, one should adjust the latter.

Note

When testing the telephone channels, the remaining switches should be set as follows: "Retranslacja - Koncowa" ["Retranslation - Terminal"] should be set to "Koncowa"; the switches "Przelotowa - Koncowa" ["Intermediate - Terminal"] to the position "Koncowa"; the switch "Zwielokrotnienie Wewnetrzne - Zwielokrotnienie Zewnetrzne - Koncowa - Zwielokpotnienie Zewnetrzne Dla Retranslacji" ["Internal Multiplexing - External Multiplexing - Terminal - External Multiplexing for retranslation"] into the position "Internal Multiplexing".

45. The adjustment of telephone channels.

The adjustment of the telephone channels consists of adjustment of the transmission measuring level and of the reception measuring level.

(a) In order to adjust the transmission measuring level in the I telephone channel, the switch of the measuring instrument in Block 2, "TF-TG-Przyrzad" ["Telephone-Telegraph-Instrument"] should be set to the position "TF", and the knob of the measuring instrument should be set to "Generator Pomiarowy I" ["Measuring Oscillator I"]. The switch "Generator Pomiarowy - Wywolanie" ["Measuring Oscillator - Call Signal"] should be set to "Generator Pomiarowy" and, by turning the potentiometer shaft of this oscillator, set the instrument pointer to the figure 50. On the (transceiver) Block 1, set the left-hand switch of the measuring instrument to the position "Wejscie I" ["Input I"], and on Block 2 set the position of the switch "Kanal Radiowy - Centrala" ["Radio Channel - Exchange"] to "Kanal Radiowy I". The shaft of the "Ustawienie Poziomu" ["Level Setting"] potentiometer in Block 1 should then be rotated in such a manner as to secure that the deflection of the instrument pointer agrees with the table of deviations, attached to the panel of the given half-set. During this adjustment,

/ a bell .....

[redacted]

a bell should be ringing on the transmission side.

In order to adjust the transmission measuring level in the II telephone channel, the knob of the measuring instrument should be set to the position "Generator Pomiarowy II" ["Measuring Oscillator II"], and the switch "Kanal Pomiarowy II - Centrala" ["Measuring Channel II Exchange"] to the position "Kanal Radiowy II" ["Radio Channel II"]. One should no longer carry out adjustments of the frequency deviation by means of the "Ustawienie Poziomu" ["Level Setting"] potentiometer, or the "Generator Pomiarowy" potentiometer in Block 2.

(b) In order to adjust the reception measuring level in the I telephone channel, the knob of the measuring instrument in Block 2 should be set to the position "Poziom I" ["Level I"]. (U_1), and the switch "Kanal Radiowy - Centrala" should be set to "Kanal Radiowy". Next, turning the shaft of the potentiometer "I", set the deflection of the instrument pointer to the figure "50". A bell should ring during the reception of the measuring level.

In order to adjust the reception measuring level in the II telephone channel, the knob of the measuring instrument should be set to the position "Poziom II" (U_2), and the adjustment made with potentiometer "II", similarly as in the first telephone channel.

46. Testing the telegraphic channels.

In order to test the telegraphic channels, one should make the following reconnections: set the switch of the "TF-TG-Przyrzad" measuring instrument in Block 2 to the position "TG"; set the "Bodo - Simpleks ST-35" switches to the position "Bodo" ["Baudot"]. Set the "Kontrola - Praca" ["Testing - Operation"] switches to the positions "9.1" and "12.8". When the measuring instrument switch is set in the positions "8.5-9.1" (for the first telegraphic channel), and "12.2-12.8" (for the second telegraphic channel), the pointer should deflect to the

/ right .....

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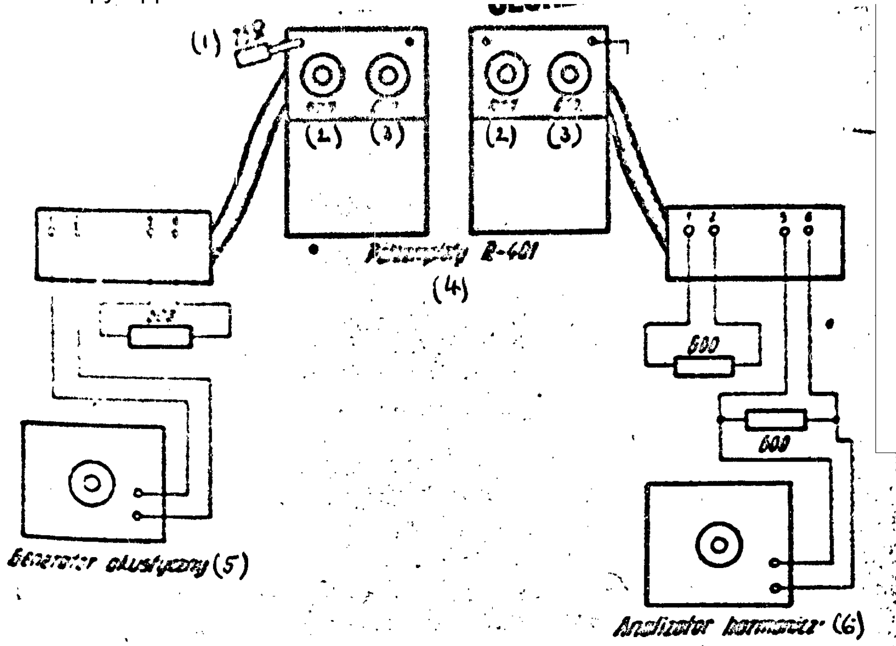
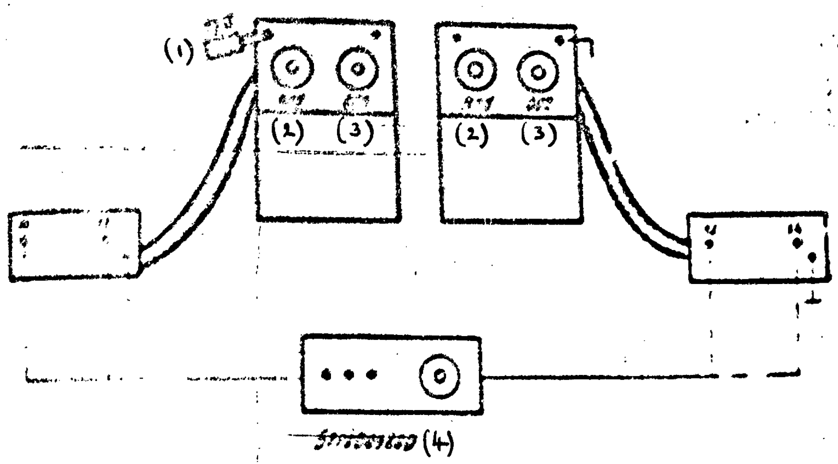


Rys. 15

Figure 15

KEY: (1) Dummy aerial, 75 ohms; (2) Transmitter; (3) Receiver; (4) R-401 Half-sets; (5) Acoustic generator; (6) Harmonic analyser.



Rys. 16

Figure 16

KEY: (1) Dummy aerial, 75 ohms; (2) Transmitter; (3) Receiver; (4) Stroboscope.

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right, into the marked area. The "Kontrola - Praca" switches should be set in turn to the position "8.5" and "12.2" and, at the same settings of the measuring instrument switch, the pointer should deflect to the left, into the marked area.

Finally, one should check the deviation of the transmitter frequency obtained from each telegraphic channel. For this purpose, the left-hand switch of the measuring instrument in Block 1 should be set to the position "Wejscie Nadajnika" ["Transmitter Input"], while the "Kontrola Praca" ["Testing - Operation"] switches in Block 2 should be successively set to "Praca". The instrument pointer in Block 1 should deflect in accordance with the frequency deviation table attached to the panel of the half-set concerned.

Note

The switches located on the right-hand side of Block 2 should be set in the following positions: the switches "Akumulatory - Wylaczone - Siec" ["Battery - Off - Mains"] should be in the "Battery" or "Mains" position, depending on the source of supply. The switches "Retranslacja - Koncowa" ["Retranslation - Terminal"] should be in the positiion "Koncowa", and the switches "Normalnie - Odwrotnie" ["Normal - Reverse"] in the position "Normalnie".

47. Adjustment of telegraphic channels.

The adjustment of telegraphic channels is carried out with the help of an instrument for adjusting telegraphic relays and channels, which forms part of the technical equipment of the radio-relay station.

In order to adjust the telegraphic channels, the instrument terminal "Nadawanie" ["Transmission"] should be connected to the terminal "11" (when adjusting the first telegraphic channel) or "13" (when adjusting the second telegraphic channel), located on the line panel. The instrument terminal "Odbior" ["Reception"] should be similarly connected to the terminals "12" or "14", and the instrument terminal "Z" ("Earth") should be connected to the "Earth" of the line panel. The switches "Bodo-Simpleks - ST-35" and "Kontrola - Praca" of the channels being

/ adjusted .....

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adjusted should be set to the positions "Bodo" ["Baudot"] and "Praca" ["Operation"]. The switch on the instrument, "Impulsy Dwubiegunowe - Impulsy Jednobiegunowe" ["Bi-polar pulses - Uni-polar pulses"] should be set to "Bi-polar pulses". The switch "Wysylanie - Neutralne - Proba Kanalu" ["Sending - Neutral - Channel Test"] should be set to "Channel Test", and the switch "Proba Kanalu - Kontrola" ["Channel Test - Checking"] to the position "Checking".

The instrument should then be connected to the power supply. For this purpose, the cord with the jack should be connected to the 12 V d.c. socket (paying attention to the voltage polarity), and the switch on the instrument set to "Wlaczone" ["On"]. The knob "Reg. Czasu Trwania Impulsu" ["Pulse Duration Adjustment"], located on the instrument, should be turned in such a way as to make the instrument pointer oscillate around the zero reading. This will indicate that the duration of the emitted positive and negative pulses is approximately equal.

-The switch "Proba Kanalu - Kontrola" ["Channel Test - Checking"] should then be set to the position "Channel Test". The standard telegraphic pulses will then be fed to the transmitting side of the telegraphic channel, while from the receiving side, the pulses will be fed to the measuring instrument circuit.

In order to adjust the line current in the telegraphic channels, one should depress the press-switch "Prad Liniowy" ["Line Current"] on the adjusting instrument, while the testing instrument switch in Block 2 should be set to "Prad Liniowy I" or "Prad Liniowy II", depending on the channel being adjusted. Turning the "Prad Liniowy" knob in Block 2, set the instrument pointer to the figure "25". Having made this adjustment, turn the shaft of the potentiometer "Reg. Czasu Trwania Imp" ["Pulse Duration Adjustment"] (of the first and second telegraphic channel), so as to make the pointer of the milliammeter on the adjusting instrument

/ oscillate around .....

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oscillate around the zero reading.

48. Checking the battery voltage.

Three groups of batteries are provided to supply the power for each half-set. Each group consists of two batteries type 5NKN-45. In order to check the voltage of a particular battery, the switch "Agregat -I-II-III" ["Mobile Generator I, II, III"] on the charging panel should be set to the position "I", "II", or "III", depending on the group the voltage of which is to be measured. The voltage is shown by the left-hand instrument on the charging panel, and should read 12 V, and not be less than 11 V. If the voltage is less than 11 V, the group concerned should be put on charge with the help of a petrol-drive generator, type PES-0.75.

49. Checking the battery charging.

In order to check the charging of a group of batteries, the PES-0.75 petrol-driven generator should be placed at a distance of 15 to 20 metres from the vehicle, and be connected by an "N-3" cable to the half-connector on the input panel labelled "12-27 V". The battery case covers should be taken off, and the battery vent plugs removed. The "Wylaczone - Wlaczone" ["Off - On"] switch on the charging panel should be set to "On", and the "AGR. I-II-III" switch should be set to "AGR." ["Mobile Generator"]. Having started up the generator by turning the knob "Agregat Prad - Wzbudzenia" ["Mobile Generator - Exciting Current"], the voltage should be set within the limits of 18 - 20 V, on the voltmeter (left-hand instrument). Depending on the group being charged, the switch "Ladowanie - Wylaczone - Rozladowanie" ["Charge - Off - Discharge"] should be set to "Charge", and the "Prad Ladowania" ["Charging Current"] knob on the instrument of the group being charged should be set to a current of 11.25 A.

If a current of this value cannot be attained, the charging panel and the mobile generator should be checked in the workshops. Any blown fuses on the charging panel should be replaced on the spot.

/ Note .....

Note

Only two groups of batteries may be charged simultaneously from one mobile generator.

50. Checking the power from an a.c. mains supply.

If the station is powered from the mains with a voltage of 220 V, the switch "127 V - 220 V" on the mains panel should be set to the position "220 V". Having connected the mains through a cable to the socket outlet on the mains panel labelled "127 - 220 V", the switch on the mains panel should be set to the "Wlaczone" ["On"] position, and the voltage 127 V should be set on the voltmeter by means of the auto-transformer knob.

The switch "Siec - Wylaczone - Akumulatory" ["Mains - Off - Battery"] in Block 1 should be set to the position "Mains". The "Akumulatory - Wylaczone - Siec" switches in the telegraphic channels of Block 2 should also be set to the position "Mains". It is then possible to test the voltage in Blocks 1 and 2.

Note

Before connecting up the mains voltage, the vehicle should be earthed.

51. Checking the power from batteries.

One half-set is powered by one group of batteries. In order to test this supply, the switch "Siec - Wylaczone - Akumulatory" in Blocks 1 and 2 should be set to the position "Battery", and the "Ladowanie - Wylaczone - Rozladowanie" ["Charge - Off - Discharge"] switch on the charging panel should be set to "Discharge".

52. The radio-relay station may be regarded as technically efficient when the readings listed in paras. 34 - 51 above have not exceeded the permissible limits laid down for the relay station.

3. Inspection of state of completeness

53. The purpose of this inspection is to check the quantity and quality of the technical equipment of the radio-relay station.

/ 54. .....

54. The inspection should include:

- a check of the quality and state of maintenance of all the component parts of the set;
- a comparison of the actual number of items with the number listed in the equipment log-book.

55. The result of the inspection is regarded as favourable when the number of items composing the set corresponds to the list, and their quality is satisfactory.

4. <u>Inspection of the state of technical and operating documents</u>

56. The purpose of this inspection is to check up on the correctness of upkeep and state of maintenance of technical and operating documents.

57. The inspection should cover:

- checking the existence and state of maintenance of operating manuals, diagrams, and equipment log-books;
- checking the correctness, care, and accuracy of keeping up entries in the equipment log-books, their content, and method of making corrections.

58. The inspection of documents may be regarded as completed favourably when no document shortages have been found, nor have there been any shortcomings in the upkeep of equipment log-books.

5. <u>Inspection of storage conditions</u>

59. The purpose of this inspection is to check on the observance of the principles and conditions of storage of radio-relay equipment.

60. During the inspection, one should confirm whether the storage and protection conditions conform to paras. 25 and 26 above.

61. The results of the inspection of storage conditions may be regarded as satisfactory when no shortcomings have been found in the storage or protection of the radio-relay equipment.

/ Chapter III .....

CHAPTER III

Technical Control of the Radio-Relay Station

62. Technical control is carried out in order to establish whether the radio-relay station is fulfilling the basic technical requirements, and to assess its combat readiness.

63. Technical control includes the actions covered by inspections, and the following measurements:

- the power drawn from the batteries and from the a.c. mains;
- HF power of the transmitter;
- receiver sensitivity;
- receiver AFC;
- telephone channel levels;
- cross-talk attenuation of telephone channels;
- distortion of telegraphic channels;
- resistance of the mains circuit insulation in relation to the earth potential of the radio-relay station.

1. Measurement of energy drawn from batteries

64. The supply of energy from the batteries should conform to point 12 of the TW /?/, according to which the power drawn by one half-set when standing by should not exceed 35 W (3 A), with the transmitter switched off, and 75 W (6.3 A) with the transmitter switched on, when the battery voltage is 12 V.

The batteries are mounted in a case, and are inter-connected as shown in the circuit diagram in Figure 1.

65. In order to measure the power drawn, one should open the battery case, disconnect the end of the positive lead from the battery being tested, and connect up the positive terminal of the ammeter to the positive terminal

/ of the battery. ...

of the battery. The negative terminal of the ammeter should be connected to the lead which has been disconnected from the battery. Simultaneously, the positive terminal of a voltmeter should be connected to the positive terminal of the battery, and the negative terminal of the voltmeter should be connected to the negative terminal of the battery. The lay-out is shown in Figure 2. The power supply from the battery to the half-set should then be switched on as described in paragraph 51, Chapter II.

66. Having read off the current and voltage values, the power being drawn should be calculated from the formula:

$$P = V \cdot I$$

where: P = power consumed, in Watts;

V = battery voltage, in Volts;

I = current drawn, in Amperes.

67. The following instruments should be used for the measurements:

- a d.c. ammeter, with a measurement range not less than 10 A, and an accuracy not less than 1.5%;
- a d.c. voltmeter, with a measurement range not less than 15 V, and an accuracy not less than 1.5%.

68. The measurement should be made very carefully, to prevent the short-circuiting of any of the batteries. After taking the measurement the case should be closed.

69. The results of the measurements should be entered in Table 1.

Table 1.

No.	Factory No. of radio-relay half-set.	Standing by			Operating			Temp. °C.	Humidity %
		U in V	I in A	P in W	U in V	I in A	P in W		

Note: The measurements should be taken with the vehicle and transmitter and receiver scale illumination switched off.

2. Measurement of energy drawn from a.c. mains

70. The power drawn from the a.c. mains by one half-set standing by (transmitter switched off) should not exceed 65 W (0.3 A), and with the transmitter switched on, 150 W (0.7 A), when the mains voltage is 220 V. The power drawn from the a.c. mains by two half-sets on full load (the vehicle and the transmitter and receiver scale illumination switched on, and a call being sent out) should not exceed 340 W.

The permissible power to be drawn from the a.c. mains is defined in the user instructions of the R-401 radio-relay station; it is not defined in the TW /? - cf. paragraph 64 above: this appears to refer to some general signals instructions7.

71. In order to measure the power being consumed, one should make the following connections: the mains cable-end leading to the half-connector should be connected to the input panel of the vehicle labelled "127 - 220". At the other end of the cable, one of the wires should be connected direct to one of the terminals of the 220 V mains panel, and the other wire to one terminal of an ammeter. The other terminal of the ammeter should be connected to the second terminal on the mains panel.

Simultaneously, a voltmeter should be connected in parallel across the mains terminals.

A simplified lay-out of the connections is shown in Figure 3.

One should then switch on the power to the half-set being measured, as described in Chapter II, paragraph 50, above.

Having read off the current and the voltage values, the power consumed should be calculated according to the formula:

$$P = U : I$$

where: P = power consumed, in Watts,

U = mains voltage, in Volts;

I = current drawn, in Amperes.

/ The results .

The results obtained from the readings should be entered in Table 1.

The following instruments should be used for the tests:

- an a.c. ammeter, with a measurement range not less than 2 A, and an accuracy not less than 1.5%;
- an a.c. voltmeter, with a measurement range not less than 300 V and an accuracy not less than 1.5%.

3. <u>Measurement of the HF power of the transmitter</u>

72. The value of the HF power of the transmitter is defined in points 16 and 17 of the WT. At normal supply voltages (127 V a.c., measured with a voltmeter at the mains panel inside the vehicle, and 12 V d.c. from the batteries, measured with a voltmeter at the charging panel), the power should be not less than 2 W.

The power measurement may be carried out:

- with the help of an HF power meter;
- with the help of a milliammeter with a thermo-couple and a non-inductive resistor of a value of 75 ohms.

(a) Measurement with the help of an HF meter:

In order to carry out this measurement, the power meter should be connected to the transmitter output socket by means of a short length of co-axial cable (20 - 30 cms), with a wave impedance of 75 ohms. The cable length should be terminated at both ends by co-axial half-connectors.

If no such connectors are available, the connection should be made by means of a similar length of cable, connecting its inner wire to the centres of the power meter and the transmitter half-connectors, while the screening sheath should be connected to the "earth" of the meter and transmitter half-connector.

A simplified lay-out of the measuring circuit is shown in Figure 4.

/ The input ....

The input impedance of the meter should be 75 ohms; the power is read off direct from the meter scale, in Watts.

If the input impedance of the meter is lower, and is 50 ohms, then a non-inductive resistor of a value of 25 ohms should be connected in series to the power meter (to the central wire of the half-connector) while the cable screen should be connected to the "earth" of the meter. A simplified lay-out of this arrangement is shown in Figure 5.

The read-off power should be calculated from the formula:

$$P = 1.5\ P_{dz}$$

where: P = true power of the transmitter;

P_{dz} = number of divisions on the power meter scale.

(b) Measurement with the help of a milliammeter:

A simplified lay-out of the measurement circuit is shown in Figure 6. The connection should be made by means of a short length of co-axial cable of a wave impedance of 75 ohms, the diameter of its cores being not less than 0.8 - 1.0 mms.

The connections should be kept as short as possible.

The measurement should be made with a milliammeter with a thermo-couple, with a measurement range not less than 200 mA, and an accuracy not less than ±5%. The power should be calculated from the formula:

$$P = I^2 \cdot R$$

where: P = power in Watts;

I = measured current, in Amperes,

R = 75-ohm resistor.

During the measurement, the supply voltages should be at the rated level.

In principle, the measurement should be made with the milliammeter. The results of the measurement should be entered in Table 2.

/Table 2.

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Table 2

No.	Factory No. of half-set of the radio-relay	Wave No.	I in A	R in ohms	P in W	Temp. °C.	Humidity %

4. Checking the calibration of the transmitter

73. The calibration error and the re-setting of the transmitter frequency is described in point 18 of the WT, according to which the error should not exceed ± 6 kc/s at a temperature of $+20^{\circ}C. \pm 5^{\circ}C.$

In order to check the transmitter calibration, one should use an interference wavemeter, quartz-stabilised, with an accuracy not less than $+1 \ . \pm 10^{-3}$.

In order to make this measurement, the transmitter should be set to the wavelength the accuracy of which is to be checked. The transmitter should then be put on load with a dummy aerial (75 ohms), and should be lightly coupled (by means of a wire loop) with the interference wavemeter, as shown in Figure 7, where:

G.SZ. = wide-band oscillator

G.W. = narrow-band oscillator

fx = frequency being measured

fsz = wide-band oscillator frequency

fw = narrow-band oscillator frequency

S1 = earphones

/Falomierz = Wavemeter; Polkomplet radiolinii = Half-set/

The principle of measurement on this type of wavemeter is as follows: the frequency being measured, fx, is fed to the input of the wavemeter, while the wide-band oscillator G.SZ. of the wavemeter is set in such a way as to obtain a zero beat in the earphones.

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This gives an approximate indication of the frequency of the transmitter being tested.

Next, one should disconnect the measured frequency fx, and connect up the narrow-band oscillator GW, setting it to zero beat with the frequency of the wide-band oscillator. One must next determine what multiple of the wide-band generator frequency fsz (and therefore of the measured frequency fx) is the narrow-band oscillator frequency fw.

For this purpose, one should divide the approximate frequency fsz by the frequency fw. The quotient n obtained from the division is the required multiple, which should be a whole number. If the quotient is a fraction, one should take the nearest whole number.

In order to determine accurately the frequency being measured, the indicated frequency fw of the narrow-band oscillator should be multiplied by the calculated multiple n. For example:

$$fsz = 69.8 \text{ Mc/s}$$

$$fw = 3172 \text{ kc/s}$$

$$n = \frac{fsz}{fw} = \frac{69800}{3172} = 22.04$$

If we take n = 22, therefore the measured frequency fx is:

$$fx = 22 \cdot fw = 22 \cdot 3172 = 69{,}784 \text{ Mc/s}.$$

In certain cases this multiple is already calculated and shown on the instrument scale; if this is so, then it is not necessary to calculate the multiple.

Knowing the nominal frequency of the transmitter, corresponding to the wavelength being measured, it is possible to determine the frequency deviation from the relationship fn - fx. Thus:

$$fn = 69{,}975 \text{ Mc/s}$$

$$fx = 69{,}971 \text{ Mc/s}$$

$$fn - fx = 4 \text{ kc/s } [sic]$$

where: fn = nominal frequency.

/The nominal .....

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The nominal frequency of the radio-relay, corresponding to the wave-length being measured, is calculated from the equation:

$$fn\ (Mc/s) = 66 + 75\ (N-1)\ .\ 10^{-3}$$

where: N = number of the wave. For instance, for wave No. N =26:

$$fn = 66 + 75\ .\ 25\ .\ 10^{-3} = 67{,}875\ Mc/s$$

If the calibration and frequency resetting error, at a temperature of $+20^{\circ}C \pm 5^{\circ}C$, exceeds ± 7 kc/s, the radio-relay station should be returned to the workshops for calibration correction.

Before beginning the measurement, the narrow-band oscillator should be calibrated in the range of the frequency measured, with the help of a quartz oscillator located in the wavemeter.

In view of the fact that the measurement is fairly complicated, before beginning the measurement one should acquaint oneself with the wavemeter operating instructions, which should be carefully adhered to.

The measurement way be made with the wavemeter-oscillator taken from the "WILGA" measuring kit.

The results obtained should be entered in Table 3.

Table 3.

No.	Factory No. of half-set	Wave No.	fw Mc/s	fx Mc/s	fn-fx kc/s	Temp. °C.	Humidity %

5. Checking the calibration of the receiver

74. The error in calibration and in the resetting of the frequency of the receiver is defined in paragraph 29 of the WT. According to this, the error should not exceed ± 6 kc/s at a temperature of $+20^{\circ}C \pm 5^{\circ}C$.

In order to make the measurement, one should connect up to the interference wavemeter the input of the receiver, from which, thanks to the reverse radiation /promieniowanie wsteczne/ of the heterodyne, a signal is fed to the wavemeter input.

/ The wavemeter ...

The wavemeter should be set to a frequency lower by 6.6 Mc/s from the frequency of the heterodyne.

The connection should be made by means of a co-axial cable, as shown in Figure 8. If a co-axial cable is not available, the connection may be made by means of a short conductor.

The transmitter should be switched off (with the "Dyzur - Praca" ["Stand by - Operation"] switch in the position "Stand by"). The receiver AFC should be switched off (the "APCz - Wylaczone" switch in the position "Wylaczone" ["Off"]), and the quartz calibrator should also be switched off (the "Kalibrator - Wylaczone" switch in the "Wylaczone" ["Off"] position).

The wave of which the frequency is to be measured should be accurately set on the receiver scale, and the receiver frequency deviation should be measured similarly as in the case of the receiver (paragraph 73).

In the event when the sensitivity of the wavemeter is too weak, and it is not possible to obtain a beat of its frequency with the frequency of the receiver, originating from the reverse radiation of the heterodyne, the transceiver block should be taken out of the housing of the half-set. One should then connect up the supply voltage by means of extension cables, remove the plate screening the resonance circuits located at the bottom of the transceiver block (see the wiring diagram of the HF amplifier circuits) and couple the wavemeter, by means of a co-axial cable (or a conductor) to the capacitor C44 (20pF), as shown in Figure 9. The coupling should be minimal, so as not to influence the frequency of the heterodyne through the anode circuit of the heterodyne, L12, C43. In order to obtain a minimal coupling, the co-axial cable (or insulated conductor) should be placed at a certain distance from the capacitor C44, and then moved further from it, so that a beat can still be obtained in the earphones of the wavemeter.

/ Since the ....

Since the heterodyne is operating at a frequency 6.6 Mc/s lower than the frequency of the transmitter oscillator, one should set on the wavemeter a frequency 6.6 Mc/s lower than the frequency set on the receiver scale.

The measurement of the deviation of the receiver frequency should be carried out in the same way as for the transmitter (paragraph 73). The readings obtained from the measurements should be entered in Table 3.

6. Checking receiver sensitivity

75. The receiver sensitivity is laid down in paragraph 25 of the WT, according to which the sensitivity, at a frequency deviation of 6 kc/s at the nominal output level and a signal-to-noise ratio of 20:1, should not be worse than 2 μ V in the entire frequency range in both telephone channels.

In order to make this measurement, one should connect to the receiver input the output of the HF oscillator, with an output resistance of 75 ohms, using a co-axial cable, as shown in Figure 10.

The oscillator should make it possible to carry out a smooth regulation of the output voltage from 1 μ V, and should be tunable within a frequency range corresponding to that of the R-401 radio-relay station, i.e. within a range of 66 to 70 Mc/s.

This measurement may be made by means of the wavemeter-oscillator taken from the "WILGA" measuring kit.

The switches "2TF - 4TG - 4TF" in Block 2 should be set to "2TF", and the transmitter should be switched off (the "Praca - Dyzur" ["Operation - Stand by"] switch in the position "Stand by").

A 600-ohm resistor should be connected to the terminals 1-2 of the first telephone channel (or 5-6 of the second telephone channel) on the line panel. Parallel with it, one should connect a thermionic voltmeter, capable of measurements from 1 mV to 1 V, with an accuracy not less than ±5%.

✓ Selecting ...

Selecting any wave, one should feed to the input of the receiver from the HF oscillator a signal of a deviation of 6 kc/s. One should then accurately tune the oscillator frequency to the receiver frequency, at a maximum deflection of the thermionic voltmeter pointer.

Using potentiometer "I" or "II" in Block 2 (for the first or second channel respectively), adjust the level in such a way that the voltmeter will indicate 105 mV.

Next, switch off the HF oscillator and measure with the voltmeter the receiver noise level. Switch on the oscillator once more, without carrier wave modulation, and, using the knob for the smooth adjustment of the output voltage of the oscillator, set the voltage in such a way that the noise level Us, measured with the voltmeter, is 20 times smaller from the Usz noise level measured without the oscillator carrier wave.

The oscillator voltage, in microvolts, at which the signal-to-noise ratio is 20, will correspond to the receiver sensitivity.

In the event of using HF oscillators of an output impedance of 50 ohms, one should connect up to the oscillator, in series, a non-inductive resistor of 25 ohms, as shown in Figure 11.

The measurement should be made in the same way as in the case of using an oscillator with an output impedance of 75 ohms. The true sensitivity of the receiver is then calculated from the formula:

$$Ug_{rz} = \frac{Ug}{1.5}$$

where: Ug = oscillator voltage read off from the scale of the smooth adjustment of the output voltage, at a signal-to-noise ratio of 20:1.

Before be nning the measurement, one should carefully study the instructions for use of the HF oscillator. The measurement results should be entered in Table 4.

/Table 4.

Table 4

No.	Factory No. of half-set	Wave No.	Usz mV	Us mV	Ug_{rz}	$\frac{Us}{Usz}$	Temp. °C.	Humidity %

7. Checking the automatic frequency control of the receiver

76. The range of the receiver AFC is described in paragraph 36, according to which this control should ensure the reduction of the receiver frequency detuning in relation to the signal frequency by not less than 7 times, at a detuning not exceeding $\pm$25 kc/s.

In order to carry out this measurement, the transceiver block should be removed from the half-set housing. Connect up the supply voltage by means of extension cables, determine /? - okreslic, perhaps misprint for 'odkrecic' - unscrew/ the screening plate of the discriminator circuits (see the wiring diagram of the IF amplifier systems) and connect up the thermionic voltmeter to the points A - B, as shown in Figure 12. The voltmeter should be capable of measuring d.c. voltages from 1 V, and should have an accuracy not less than 1.5%.

The HF oscillator should be connected to the receiver input (as shown in Figure 10), making it possible to take readings of the frequency deviation of up to 25 kc/s from the rated frequency of the oscillator. In the absence of such an oscillator, connect up the interference wavemeter used for testing the HF transmitter and receiver.

The measurement may be made with the wavemeter-oscillator from the "WILGA" measuring kit.

Switch off the quartz calibrator and the AFC (the switches "Kalibrator - Wylaczone" and "APCZ - Wylaczone" should be set to the "Wylaczone" /"Off"/ position). Switch off the transmitter (set the switch

/ from "Praca -

from "Praca /"Operation"/ to "Dyzur" /"Stand by"/). Set any wave number on the receiver scale and, using the HF oscillator, tune up to the receiver frequency, so that the pointer of the thermionic voltmeter, connected up at points A - B, will deflect to zero.

Next, detune by means of the oscillator by 25 kc/s (in either direction), and note the value of the voltage U_1 measured with the voltmeter at points A - B. Switch on the AFC (setting the "APCz - Wylaczone" switch to "APCz" /"AFC"/), and note the value of the voltage ΔU_2.

$$d = \frac{\Delta U_1}{\Delta U_2}$$

where: U_1 = value of voltage at the discriminator output, when detuned from the nominal frequency by 25 kc/s measured without AFC;

U_2 = voltage value at the same degree of detuning, measured with the AFC switched on.

This value should not be less than 7.

The results of the measurements should be entered in Table 5.

Table 5.

No.	Factory No. of half-set	Wave No.	U_1 V	U_2 V	$\frac{U_1}{U_2}$	Temp. °C.	Humidity %

8. Checking the levels in the telephone channels

77. The value of the levels of the telephone channels is defined in paragraph 21 of WT. With a two-wire connection, the relative levels should be:

- input: 285 mV (-1 N);
- output: 105 mV (-2 N);

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while it is permissible to tolerate variations in the output level within limits of 86 - 129 mV ($\pm$0.2 N). With a four-wire connection, without the translation of the magneto call, the appropriate levels should be:

- input: 520 mV (-0.4 N);
- output: 520 mV (-0.4 N);

while it is permissible to tolerate variations in the output level within limits of 425 - 635 mV ($\pm$0.2 N).

With a four-wire connection, with the translation of the magneto call, the appropriate levels should be:

- input: 190 mV (-1.4 N);
- output: 190 mV (-1.4 N);

while it is permissible to tolerate variations in the output level within limits of 157 - 233 mV ($\pm$0.2 N).

78. In order to carry out the measurement of levels with a two-wire connection, the switches "2TF - 4TG - 4TF" in Block 2 should be set to the position "2TF". The transmitter and receiver of the two half-sets should be tuned to the same wavelength, and should be put on load with dummy aerials.

Connect up to the terminals 1 - 2 of the first telephone channel (or 5 - 6 of the second telephone channel) an acoustic generator of an output resistance of 600 ohms, from which should be supplied a level of 285 mV, of a frequency of 800 c/s.

The accuracy of the generator should not be less than $\pm$5%.

Connect up a 600-ohm resistor to the terminals 1 - 2 (or 5 - 6) on the line panel of the second half-set. In parallel with it, connect up a thermionic voltmeter capable of measuring acoustic voltages from 100 mV to 700 mV, with an accuracy not less than $\pm$5%.

The voltage should be 105 mV, with permissible variation between 86 - 129 mV.

A simplified lay-out of the connections is shown in Figure 13.

Note: In order to prevent the bell from ringing during the measurement, one should remove the calling relay from the reception channel being tested.

/ 79.

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79. In order to carry out the measurement of levels with a four-wire connection, without translation of the magneto call, the switches "2TF - 4TG - 4TF" in Block 2 should be switched to the position "4TG". Connect up an acoustic generator to terminals 3 - 4 of the first telephone channel (or 7 - 8 of the second telephone channel) on the line panel of one half-set, and feed a level of 520 mV of a frequency of 800 c/s.

The output level should be measured on terminals 1 - 2 (or 5 - 6) on the line panel of the second half-set, the level should be 520 mV, with a permissible variation within limits of 425 - 635 mV.

The lay-out of the connections to the line panels is shown in Figure 14.

80. In order to carry out the measurement of levels with a four-wire connection, with the translation of the magneto call, the switches "2TF - 4TG - 4TF" in Block 2 should be set to the position "4TF", and the measurement made as in the case of a four-wire connection without the translation of the magneto call.

The input should be fed with a level of 190 mV, with a frequency of 800 c/s. The output level should be 190 mV, with a permissible variation between 157 - 233 mV.

The results obtained from the three readings should be entered in Table 6.

Table 6.

No.	Factory No. of half-set	Wave No.	Type of oper.	Channel I		Channel II		Temp. °C.	Humidity %
				Uwej mV	Uwyj mV	Uwej mV	Uwyj mV		

/Uwej = input voltage; Uwyj = output voltage/

/9.

9. <u>Checking the cross-talk attenuation in telephone channels.</u>

81. The extent of the cross-talk attenuation is laid down in the general requirements of WT, sec. D and E, according to which the absolute level of intelligible cross-talk in both telephone channels without retranslation should not be greater than 0.7 mV (-7 N).

The absolute level of unintelligible cross-talk in both the telephone channels without retranslation should not be greater than 5.2 mV (-5 N).

In order to carry out this measurement, the switches "2TF - 4TG - 4TF" in Block 2 should be set to "2TF". Connect a /acoustic/ generator of an output impedance of 600 ohms to terminals 1 - 2 of the first telephone channel on the line panel of one half-set, and connect a 600-ohm resistor to terminals 5 - 6 of the same half set, as shown in Figure 15.

On the line panel of the second half-set, connect a 600-ohm resistor to terminals 1 - 2, and, parallel with this resistor, connect to terminals 5 - 6 a harmonic analyser, or a selective level indicator, capable of measuring voltages from 0.1 mV, at a frequency of 400 - 3000 c/s.

Before making these connections, the transmitters and receivers of both the half sets should be put on load with dummy aerials. One should also set the normal frequency deviation at nominal input and output levels, in accordance with the table affixed to the panel of the half-set, as described in paragraph 36.

Feed a level of 285 mV from the acoustic generator, and carry out the measurement of the level on terminals 5 - 6 of the second half-set using the harmonic analyser. The measurement should be made on several frequencies, in the 400 - 2500 c/s band.

Before making the measurements, one should study the operating instructions of the harmonic analyser (or selective level indicator).

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/ In the absence..

In the absence of such an analyser, one may connect a thermionic voltmeter, capable of measurements from 0.1 mV, and of an accuracy not less than ±5%.

The results of the measurements should be entered in Table 7.

Table 7.

No.	Factory No. of half-set	Modulation frequency c/s	Uwej I (II) mV	Uwyj II (I) mV	Temp. °C.	Humidity %

10. Checking the distortion of telegraphic channels

82. The distortions of telegraphic channels are defined in paragraph 35 of the WT.

The error in the setting of telegraphic channels to the minimum distortion by means of the instrument for adjusting telegraphic channels and relays should not exceed 10%. This condition should [also] apply to any RP-4 relays fulfilling the technical requirements.

The transmitter and receiver should be put on load with dummy aerials and the power should be switched on.

The measurement of the distortion should be done with a stroboscope, the transmitting section of which should be connected to terminals 11 of the first telegraphic channel on the line panel of one half-set. The receiving section should be connected to terminal 12 (or 14) of the other half-set, as shown in Figure 16. In addition, the switches "Bodo - Simpleks St-35" and "Kontrola - Praca" of the appropriate channel should be set to "Bodo" ["Baudot"] and "Praca" ["Operation"].

The measurement should be made in accordance with the stroboscope instructions. In the absence of a stroboscope, one should use the instrument for adjusting telegraphic channels and relays, and the measurement should be made as detailed in paragraph 47.

/The results ...

The results of the measurements should be entered in Table 8.

Table 8

No.	Factory Nos. of half-sets	Wave No.	Distortion %		Temp. °C	Humidity %
			Chan. I	Chan. II		

11. Checking the resistance of the mains circuit insulation in relation to the earth potential of the radio-relay station.

83. The resistance of the mains circuit insulation in relation to the earth potential of the radio-relay station should not be less than 500 kilohms at an ambient temperature of 20°C ±5°C and a relative humidity of 95% ±3%.

In normal conditions of use, i.e. at an ambient temperature of 20°C ±5°C, and a relative humidity of 65 - 75%, this resistance should not be less than 2 megohms.

In order to carry out this measurement, one should use an inductor megger producing a voltage not less than 500 V, which is connected into the circuit as shown in Figure 17.

Disconnect the mains cable from the motor vehicle; connect one terminal of the megger to one of the two knife contacts of the cable connector on the wall of the vehicle labelled "127-220", or to the mains socket inside the vehicle. The second megger terminal should be connected to the vehicle frame. Turn the handle of the megger and read off the value of the insulation resistance. The readings obtained should be entered in Table 9.

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/Table 9

Table 9

No.	Factory No. of half-set	Insulation resistance in megohms	Temp. °C	Humidity %

84. The radio-relay station may be regarded as technically efficient if all the parameters measured fulfil the conditions laid down in Chapter I of the present "Method of Inspection".

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CHAPTER IV

Final Remarks

85. The results of technical inspections are entered in the signals equipment inspection books, kept up in accordance with para. 365 of Signals Regulations 87/59.

86. Having completed the technical control on the basis of the results of the measurements entered in Tables 1 - 9, one draws up a Certificate ["Protokol"] as indicated in the pro-forma below.

87. The inspections (carried out in full) and technical controls are also recorded in the equipment log-book.

[redacted]

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/ Pro-forma .....

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Pro-forma of Certificate

CERTIFICATE No. ....

concerning the completion of technical control of the R-401 radio-relay set, drawn up on 19 , at (name of unit), by a Commission consisting of:

Chairman:

Members :

appointed by virtue of Order No. issued by (state authority) on 19 .

The Commission, composed as above, has carried out a control of (number) of R-401 radio-relay stations.

The control included:

1. An inspection of the radio-relay station
2. The measurement of the following parameters:

- energy drawn from batteries;
- energy drawn from the mains;
- HF power of transmitter;
- calibration of HF transmitter;
- calibration of HF receiver;
- receiver sensitivity;
- receiver AFC;
- levels in telephone channels;
- cross-talk attenuation in telephone channels;
- distortion in telegraphic channels;
- resistance of mains circuit insulation in relation to the earth potential of the radio-relay station;
- measuring circuits;

ring .....

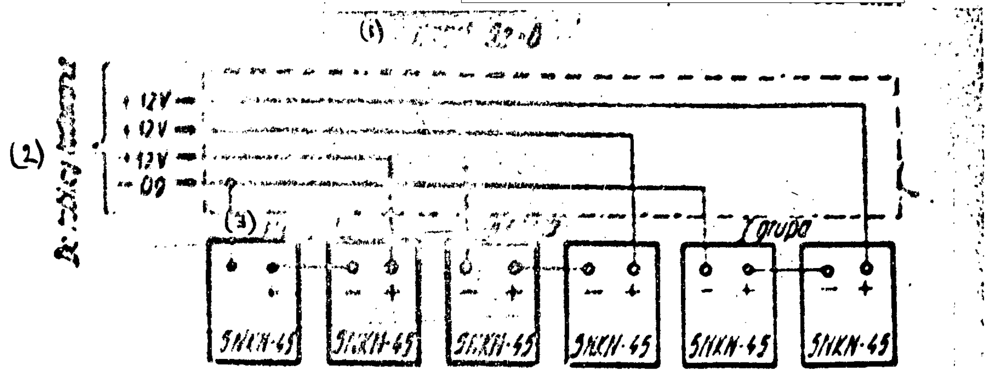
- measuring instruments used;
- short description of measurements carried out;
- tables of results obtained.

Final Conclusions

The Certificate should end with final conclusions. These should state how many radio-relay stations have fulfilled the technical requirements. Give factory numbers of the relay stations which have failed to come up to the WT standard. Give an assessment of the technical condition of the radio-relay stations examined, and the state of their maintenance and operational capabilities under actual operating conditions. Give recommendations for the removal of shortcomings and faults which have come to light.

Signatures of Commission:

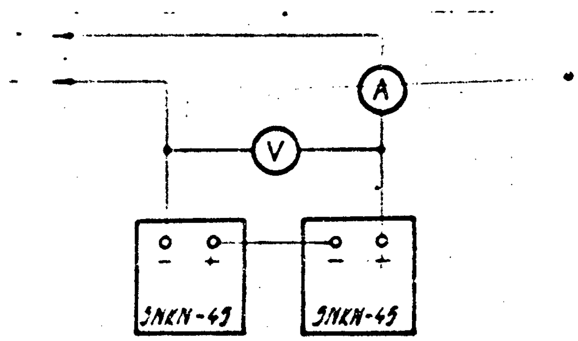
[redacted]



Rys. 1

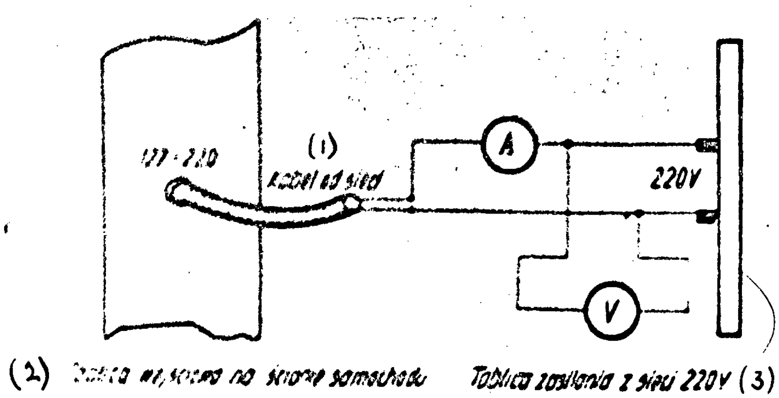
Figure 1

KEY: (1) Sz-8 cable; (2) To charging panel; (3) Group III - Group II - Group I.



Rys. 2

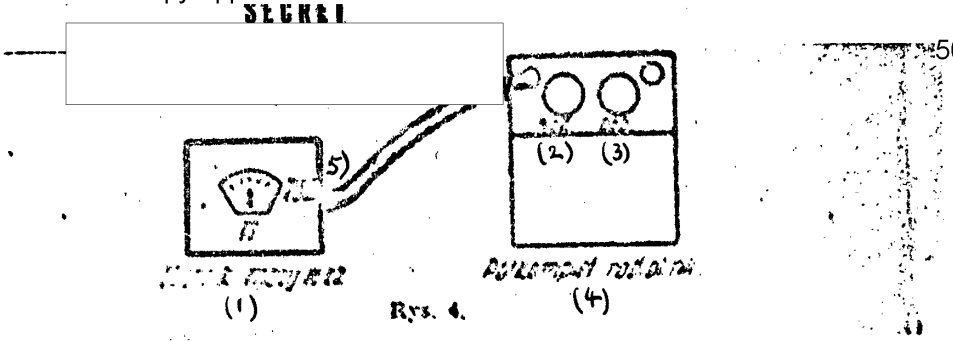
Figure 2



Rys. 3

Figure 3

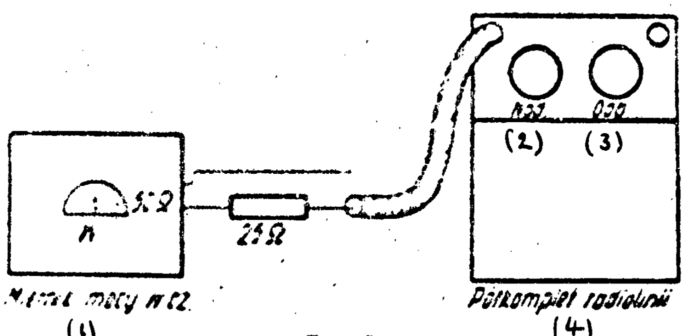
KEY: (1) Cable from mains; (2) Input panel on cabin wall of truck; (3) 220 V mains supply panel.



Rys. 4.

Figure 4

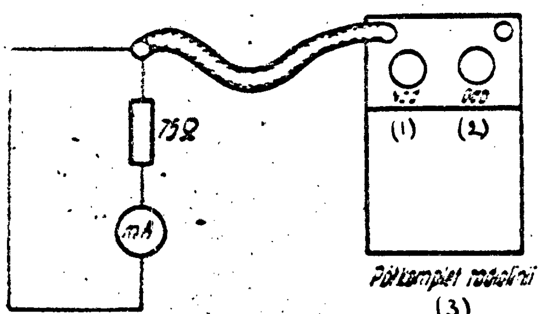
KEY: (1) HF power meter; (2) Transmitter; (3) Receiver; (4) Half-set of radio relay; (5) 75 ohms.



Rys. 5

Figure 5

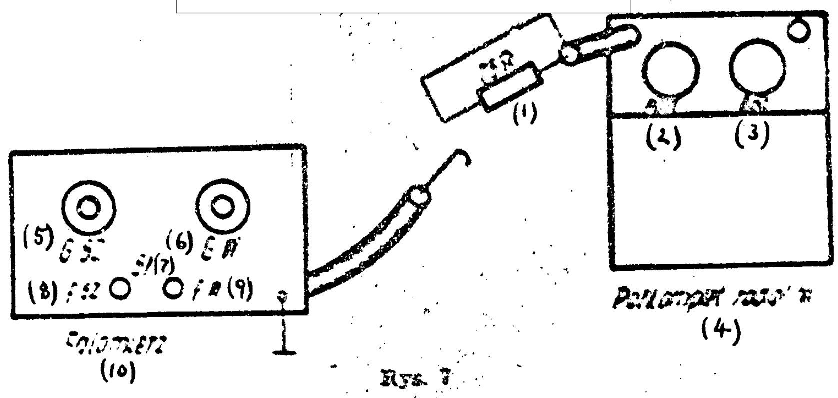
KEY: (1) HF power meter; (2) Transmitter; (3) Receiver; (4) Half-set of radio relay.



Rys. 6

Figure 6

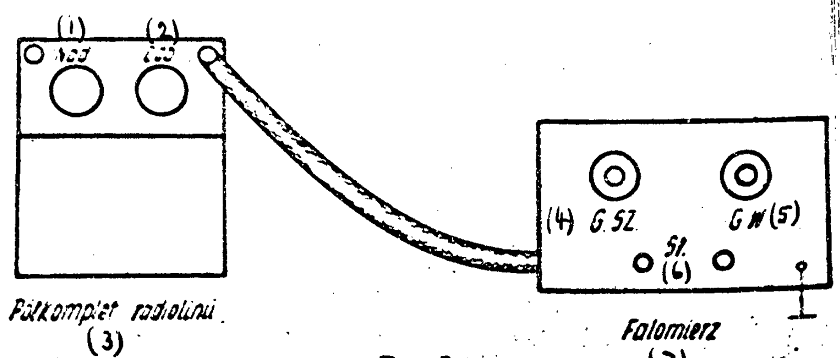
KEY: (1) Transmitter; (2) Receiver; (3) Half-set of radio relay.



Rys. 7

Figure 7

KEY: (1) Dummy aerial, 75 ohms; (2) Transmitter; (3) Receiver; (4) Half-set of radio relay; (5) Wide-band oscillator; (6) Narrow-band oscillator; (7) Earphones; (8) Wide-band oscillator frequency; (9) Narrow-band oscillator frequency; (10) Wavemeter.



Rys. 8

Figure 8

KEY: (1) Transmitter; (2) Receiver; (3) Half-set of radio relay; (4) Wide-band oscillator; (5) Narrow-band oscillator; (6) Earphones; (7) Wavemeter.

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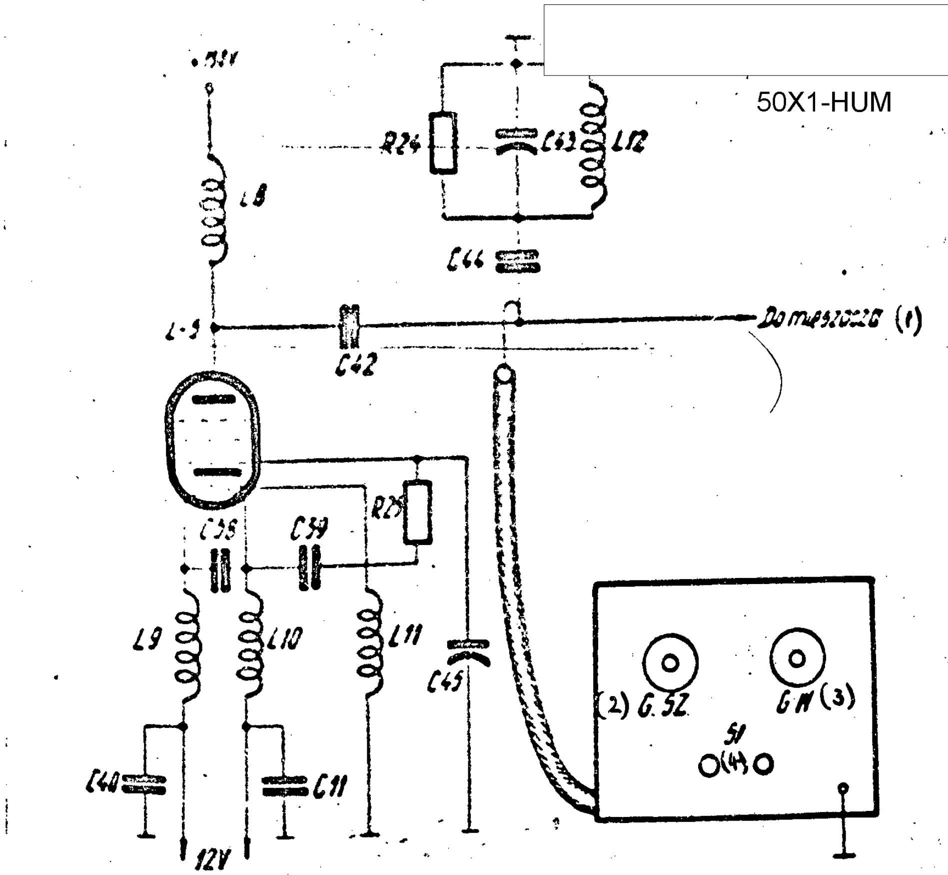
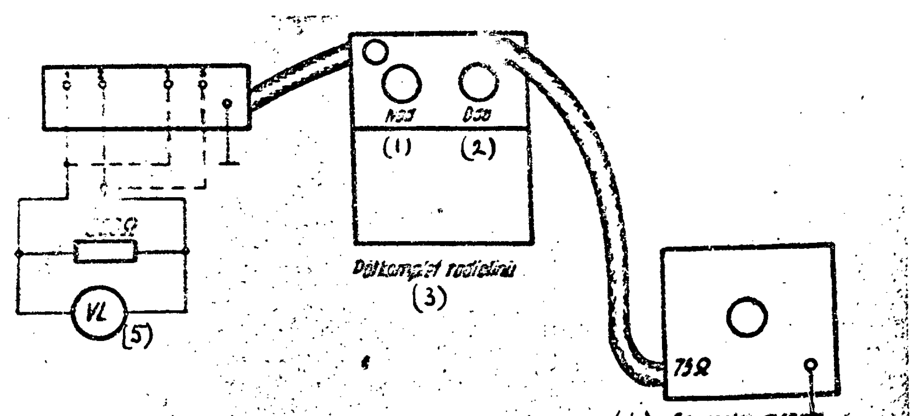


Rys. 9

Figure 9

KEY: (1) To mixer; (2) Wide-band oscillator; (3) Narrow-band oscillator; (4) Earphones.



Rys. 10

Figure 10

KEY: (1) Transmitter; (2) Receiver; (3) Half-set of radio relay; (4) HF oscillator; (5) Thermionic voltmeter.

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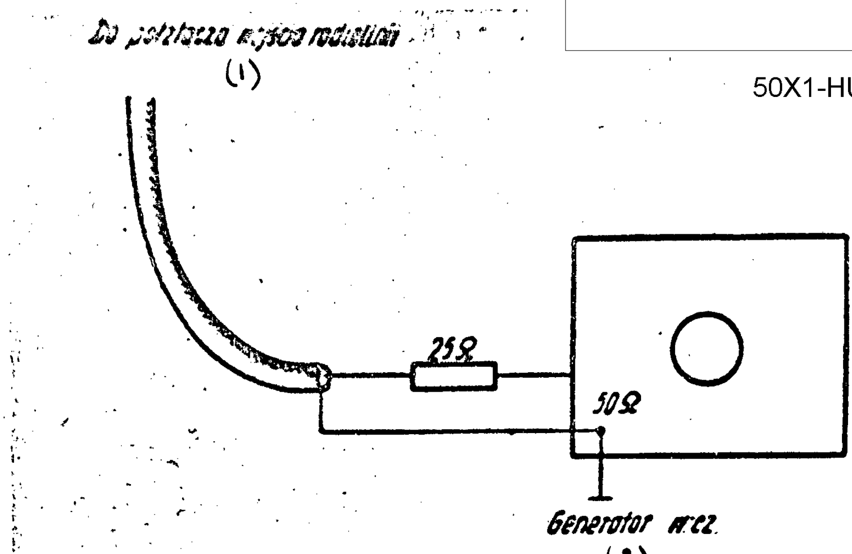
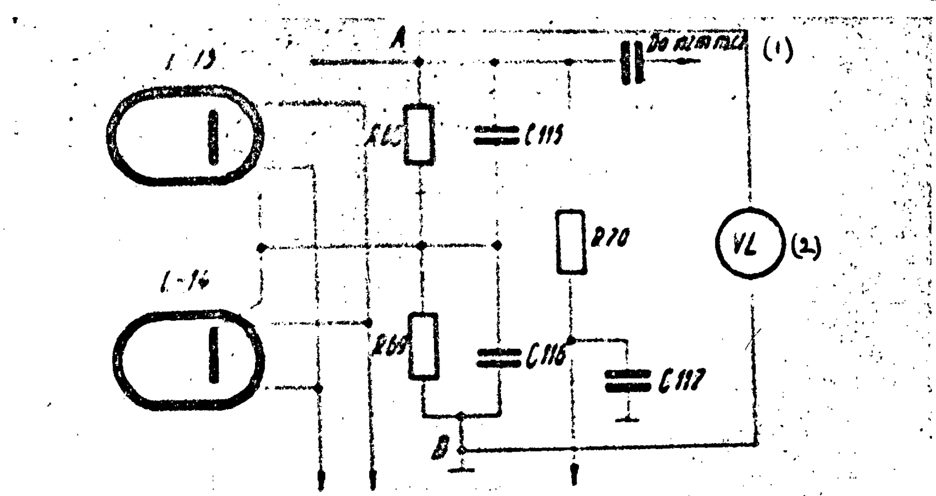


Rys. 11

Figure 11

KEY: (1) To input half-connector of radio relay; (2) HF oscillator.



Rys. 12

Figure 12

KEY: (1) To LF amplifier; (2) Thermionic voltmeter.

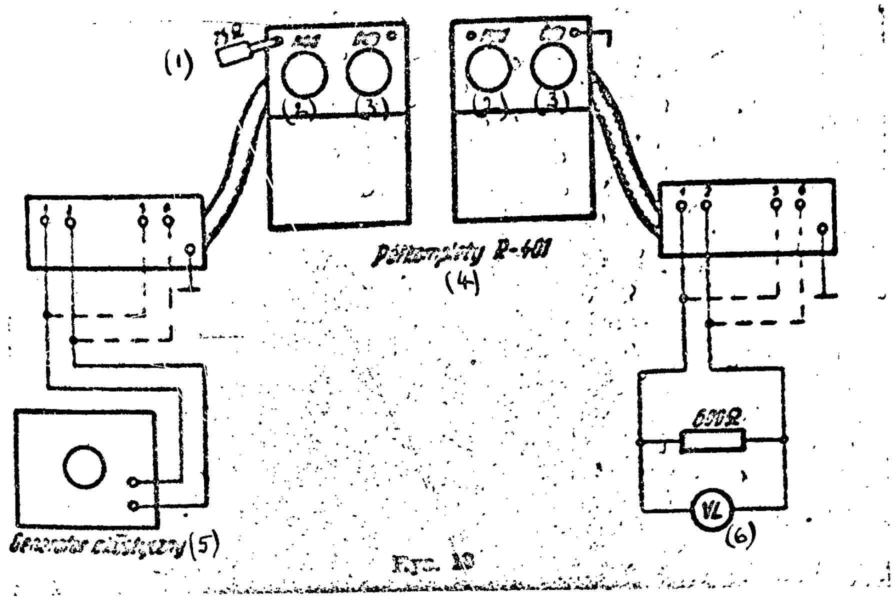
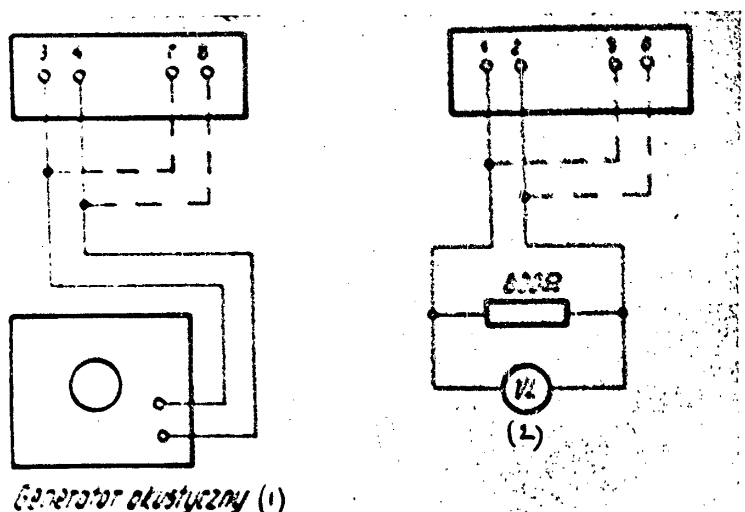


Figure 13

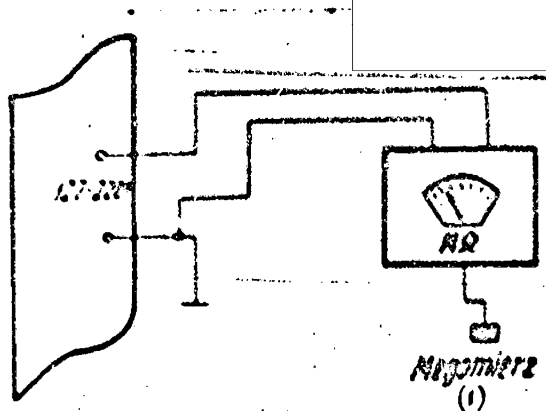
KEY: (1) Dummy aerial, 75 ohms; (2) Transmitter; (3) Receiver; (4) R-401 Half-sets; (5) Acoustic generator; (6) Thermionic voltmeter.



Rys. 14

Figure 14

KEY: (1) Acoustic generator; (2) Thermionic voltmeter.



Rys. 17

Figure 17
KEY: (1) Megger; (2) Input panel on cabin wall of truck.

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