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1. A 110-page English translation of a Russian-language manual, entitled Type "R-670" First Class Radio Receiving Equipment, Description and Instructions [redacted] 50X1-HUM

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TYPE "R-670" FIRST CLASS RADIO RECEIVING EQUIPMENT

Description and Instructions

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I. Application and Tactical-Technical Data of the Receiver

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1. General Information

The first-class, type "R-670" short-wave radio receiver ensures audible reception of telephone and telegraph radio transmissions in the frequency range of 1.5 to 25.5 Mc (200-11.75 m) and is intended for ships, coastal radio centers and other military and naval installations.

Provisions are made for combined telephone and telegraph reception with two or three diversity antennas, and for reception over the wire line.

If an auxiliary terminal equipment is available the receiver can operate in conjunction with the teletype (for either frequency or amplitude modulation), undulator or facsimile, as well as in multiplex and multiple telegraph mode.

High precision of calibration and high frequency stability of the receiver, as well as its high sensitivity and selectivity, ensure search-free communication.

High selectivity of the IF and audio-frequency channels of the receiver and the presence of pulse-interference limiter ensure noise-proof reception.

2. Description of the Receiver and its Basic Technical Data

The fundamental circuit peculiarity of this first-class short-wave superheterodyne receiver is its crystal stabilized frequency of the first local oscillator for operation on continuous coverage of the whole frequency range.

The receiver operates on the principle of double conversion of frequency; the first local oscillator is crystal stabilized, so that the first IF varies, and changes on each receiver's subrange within the limits from 1.5 to 3.5 Mc (the frequency of the first local oscillator is switched-over simultaneously with the switching-over of the subranges).

The frequency of the second local oscillator changes continuously in such a manner that the second IF is always maintained at 215 Mc.

A. Circuits

The receiver comprises: two-circuit preselector, one radio frequency amplification stage, first converter with separate local oscillator, one amplification stage of the first IF with a two-section bandpass filter, second frequency converter with a separate local oscillator, three amplification stages of the second IF with two high-discrimination filters, detector, three audio-frequency amplification stages with variable bandpasses, third local oscillator, high-performance automatic sensitivity control (ASC) with two tubes, two-way pulse interference limiter of the audio frequency channel, crystal calibrator, and a neon type plate-voltage regulator of the second local oscillator.

The block diagram of the receiver is shown on figure 10.

Note: 1. During operation on the first subrange the receiver performs only one frequency conversion, thus the first IF amplifier becomes an amplifier for the radio frequency.

Crystal frequency-stabilization of the first local oscillator is utilized on all subranges, except for the first one.

B. Technical Data for Receiver

The receiver operates in a continuous frequency range from 1.5 to 25.5 Mc (200-11.75 M).

The whole frequency range of the receiver is divided into 12 subranges as follows:

Subrange	I	1.5-3.5 Mc	Subrange	VII	13.5-15.5	Mc
"	II	3.5-5.5 "	"	VIII	15.5-17.5	"
"	III	5.5-7.5 "	"	IX	17.5-19.5	"
"	IV	7.5-9.5 "	"	X	19.5-21.5	"
"	V	9.5-11.5 "	"	XI	21.5-23.5	"
"	VI	11.5-13.5 "	"	XII	23.5-25.5	"

Change from one subrange to another is done with the aid of a drum-type switch. The frequency overlap on each end of subrange is not less than 25 kc, except for the subrange II where the overlap is effected by the adjacent subranges.

Input of the Receiver. The input circuit of the receiver is designed to operate with four types of antennas:

a) balanced antennas terminating with a feeder line having characteristic impedance in a range of 60-400 ohms (or any balanced antennas having impedance equivalent of indicated range).

b) Asymmetrical antennas terminating with a feeder line having characteristic impedance in a range of 60-400 ohms (or any asymmetrical antennas having impedance equivalent of indicated range).

c) "Slanting beam" antenna having capacitance in a range of 100-300 μμF and resistance of the order of 100 ohms.

d) Pole antennas with capacitance of 50 μμF and greater.

For operation with other antennas having impedance different from indicated in paragraphs a,b,c, and d, a provision is made for matching the input circuit of the receiver.

To decrease the mismatch of the receiver input while operating with balanced antennas having equivalent resistance of 200 ohms, an antenna balancing transformer is used.

Output of the Receiver. The receiver comprises:

a) outlet for one low-resistance telephone headgear type TA-4 (provision is made for two low-resistance telephones); rated voltage of a single telephone headgear is 1.5 v.

b) outlet for operation with a 600-ohm transmission line; the power in such line not less than 0.5 w.

c) dc outlet of automatic sensitivity control (ASC) intended for combined operation of the receiver with diversity antennas. The ASC outlet can also be used for half-duplex operation of the receiver.

d) outlet of second IF from the buffer stage of the ASC; voltage at the IF output is not less than 0.1 v for a capacitive load of 50 μμF if the voltage at the input is greater than 3 μv.

The half-duplex system outlet to the transmitter control desk or the radio-operator post (PRO) is located on the socket "vykhod" ("output") mounted on the back wall of the housing.

Sensitivity of the Receiver. Sensitivity of the receiver operating in telegraph mode for signal-to-noises ratio of 3 to 1, for IF bandpass of 3 Kc and for audio-frequency bandpass of 2.5 Kc is not less than 1.5 μv relative to the antenna equivalent of 100 ohms.

Sensitivity of the receiver operating in telephone mode under the above mentioned conditions and for frequency modulation of 1,000 cps and for percentage modulation of 30% is not less than 4 μv. Exception being the second subrange in the region of 4-4 Mc where under the same conditions the telegraph reception sensitivity is not less than 2 uv and the telephone reception sensitivity is not less than 6.5 μv.

Selectivity of the Receiver. For the second IF the receiver has four selective bandpasses with nominal values of "12", "6", "3" and "1" Kc. Actual values for the mentioned bandpasses are as follows: for the bandpass "12" the actual value is not less than 11Kc for attenuation factor of 2 and not greater than 30 Kc for attenuation factor of 1,000; for the bandpass "6" the actual value is

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not less than 5 Kc for attenuation factor of 2 and not greater than 20 Kc for attenuation factor of 1,000; for the bandpass "3" the actual value is not less than 2.4 Kc for attenuation factor of 2 and not greater than 12 Kc for attenuation factor of 1,000; for the bandpass "1" the actual value is o.7-1.5 Kc and not greater than 6.5 Kc for attenuation factor of 1,000.

At audio frequency the receiver has three selective bandpasses with nominal values of "5", "2.5" and "0.3" Kc. When the receiver operates on/a 600-ohm line, then the "5" Kc bandpass is limited by frequencies not greater than 200 cps and not less than 4,000 cps for attenuation factor of 2 and not greater than 6,500 cps for attenuation factor of 10; the "2.5" bandpass is limited by frequencies of not greater than 200 cps and not less than 2,000ccps for attenuation factor of 2 and not greater than 4,000 cps for attenuation factor of 10; the "0.3" bandpass is a sound-frequency filter with middle frequency of 900-1,100 cps and a bandpass of 200-350 cps for attenuation factor of 2 and not greater than 800 cps for attenuation factor of 10.

Nonuniformity frequency-response factor of the receiver when operating on 600-ohm line at percentage modulation of 30% in the range of 200-4,000 cps is not greater than 2 (for IF bandpass of "12" Kc and for audio-frequency bandpass "5" Kc).

Sensitivity attenuation for image channels of the first and second conversion is not less than 3,000 times.

Sensitivity attenuation for the first and second IF is not less than 7,000 times.

Automatic Sensitivity Control. When the ASC is in operation during either telephone or telegraph reception, the output voltage may increase by a factor not greater than 2 even if the input voltage increases by a factor of 1,000.

Amplitude Characteristic. The amplitude characteristic of the receiver when operating on 600-ohm line is practically linear up to 4 v when operating with a single headgear.

Nonlinear Distortions. Non-linear distorsion factor of the receiver when operating with 600-ohm line at a maximum power of 0.5 v in telephone mode, at modulation frequency of 1,000 cps and at percentage modulation of 30%, or under similar conditions of operation with the telephone headgear, does not exceed 8%.

AC Background Noises. The ac background noises at the receiver output do not exceed 0.4% of the nominal output voltage.

Leakage of the Local Oscillator Voltage into the Antenna Circuit. Leakage of the first, second and third local oscillator voltages and their harmonics, as measured at the receiver output loaded on antenna equivalent of 100 ohms, does not exceed 10 uv (10 fixed points are permissible with a level up to 40 µv).

Internal Combined Noises. Certain points of the receiver range are tested for the combined internal noises caused by the beats of harmonics 1, 2 and 3 of the local oscillators (see the receiver pamphlet).

Their level does not exceed the level of telegraph sensitivity. (Presence of 2 points with a level up to 30 µv, 3 points with intensity up to 20 µv and 5 points with intensity up to 5 µv are permissible.)

Frequency Temperature Coefficient. Frequency departure temperature coefficient of the receiver in the interval of temperature from +5 C to +50 C does not exceed 20×10^{-6} on the I and II subranges, and 10×10^{-6} on all other subranges.

Frequency Stability. Departure of the first, second and third local-oscillator frequency at plate voltage fluctuation from +5% to -20% and at filament voltage fluctuation from +5% to -10% does not exceed 1,000 cps.

Total frequency departure of the first, second and third local oscillators due to internal heating during 2 hours of operation (beginning 30 minutes after switching on) does not exceed 1,000 cps and remains for the following 2 hours within the limits of ±300 cps if the ambient temperature, humidity and power supply voltage remain constant.

Jamming Band Width Due to High-intensity Interference EMF in the Receiving Antenna. Jamming band width due to EMF of 30 v in the antenna in not greater than ±10% for I, II and III subranges, and not greater than ±8% for all other subranges.

Jamming band width due to EMF of 3 v in the antenna is not greater than ±5% for I, II and III subranges, and not greater than ±4% on all other subranges.

"Hissing" type Noises. Throughout the whole frequency range of the receiver, except for frequencies within the jamming band as indicated in the Technical Specification, no "hissing" or "cracking" noises will be observed if the voltage supplied to receiver input is equal to 30 v while operating on frequencies 3,5,10,15,21 and 22 Mc.

The Dial. Calibration of the receiver is done directly on the dial. The receiver has a coarse-tuning and a fine-tuning dial.

On the coarse-tuning dial the graduation marks are placed every 0.1 Mc and numbers are placed every 0.5 Mc.

The fine-tuning dial is optical; here every 100-kc section of the coarse dial is subdivided into 50 sections, i.e., into 2 Kc.

Numbers on the fine-tuning dial are placed every 10 Kc. The fine-tuning dial serves as an electric vernier to the coarse-tuning dial.

The subrange indicator is combined with the coarse-tuning dial.

Accuracy of Calibration. Possible total error of claibration and setting of the receiver frequency (when using the optical dial) for the temperature interval from +5 C to +50 C and for power supply voltage fluctuation within ±10% does not exceed 2 Kc at any point of the range (after preliminary correction with a crystal calibrator which forms part of the receiver and with power supply from a stabilized rectifier).

Frequency-setting error of the coarse-tuning dial does not exceed 25-35 Kc.

Dial Scale Correction. To reduce the possible calibration error due to the action of various destabilizing factors (sudden change in temperature, humidity, change of tubes, etc.) the receiver is provided with a correction system and a special crystal calibrator having 500-Kc fundamental frequency.

The error of the crystal calibrator does not exceed 15×10^{-6}.

Calibration correction is carried out with the aid of a trimming capacitor located in the circuit of the second local oscillator--"electrical corrector" and with the aid of a movable hairline frame of the optical dial--"the mechanical corrector".

Control Elements of the Receiver. The control elements of the receiver are:

1. Main tuning knob with two reduction ratios of 1 : 5 and 1 : 45.

2. Subrange selector switch.

3. High-frequency gain control knob.

4. Audio-frequency gain control knob,

5. IF band-selector switch with four positions: 1, 3, 6 and 12 Kc.

6. Frequency-control knob of the third local oscillator with a vernier.

7. Audio-frequency band-selector switch with three positions: 0.3, 2.5, and 5 Kc.

8. Tube current and supply voltage control switch

9. Fine tuning of input circuit

10. Mechanical corrector of the dial with the stop

11. Electrical corrector of the dial

12. Time-constant ASC selector switch for 3 positions (the fourth position - "off"): 0.05, 0.1 and 1 sec

13. Antenna switch for 3 positions

14. Power supply toggle switch

15. Third local oscillator toggle switch

16. Crystal calibrator toggle switch

17. Noise limiter toggle switch

18. Half-duplex toggle switch

Receiver Tubes. The receiver has in all 18 tubes as follows:

2	tubes	-- 6Zh4
10	"	-- 6KZ
2	"	-- 6A7
1	"	-- 6P6S
3	"	-- 6Kh6S

Type SG3S neon stabilizer is used to stabilize screen voltage of the second local oscillator.

Power Supply System of the Receiver. Generally power supply of the receiver is obtained from either a 127 or 220 v (50 cps) ac power line. A rectifier with ferroresonant stabilization of plate and filament voltages is included with the receiver. Such a rectifier is designed to draw power from either 127 or 220 v ac power line.

The receiver has provision for disconnecting the ferroresonant stabilization with the aid of a special socket; in such case the output voltage is maintained at those of the power line.

To ensure a complete power supply of the receiver from the reserve emergency power supply units (plate and filament storage batteries) a special cable is included with the power supply equipment.

Plate Voltage Fluctuation. Plate voltage fluctuation does not exceed 0.1%.

Power Data of the Receiver. Rated plate voltage is 160 v. Rated filament voltage is 12.6 v.

At the rated voltages the current consumption does not exceed 100 miliamp for the plate and 5 a for the filament.

The power consumption of the receiver when supplied through a stabilized rectifier is 180 volt-amp.

Overall Dimensions and Weight of the Receiver. The overall dimensions of the receiver with lid closed and including the projecting parts are: width --650 mm, height --450 mm, depth --460 mm; the overall dimensions of the receiver with shock absorbers are: 650 X 520 X 530 mm.

Weight of the receiver in operating condition (with tubes and shock absorbers) is 90 kg.

II. Material Section

I. General Information

The radio receiver is packed in two boxes.
The dimensions of box No 1 are 1,100 X 750 mm (see fig. 61).
This box holds: 1) receiver with housing and shock absorbers 2) [text obliterated]

The dimensions of box No 2 are: 1050 X 700 mm and it holds:

1) rectifier
2) box with combat outfit
3) box with spare parts

2. General Description of the Design of the Receiver

The receiver consists of two units placed one above the other and enclosed in a common metal housing. (see fig. 1)

The lower section — the section comprising the radio-frequency and first intermediate frequency (see Fig. 2) — is mounted on a rigid cast Silumin (silicon-aluminum alloy) plate. On the right is the drum-type band switch, the segments of which contain stages of the radio-frequency and first-local-oscillator circuits.

In the center of the plate there are three tubes: the radio-frequency amplifier tube, the first mixer tube and the first local oscillator tube. The bottom of the plate is divided into segments containing the system of contacts, the wiring and components of the various stages (See Fig 3). Underneath, the segments are closed by the bottom.

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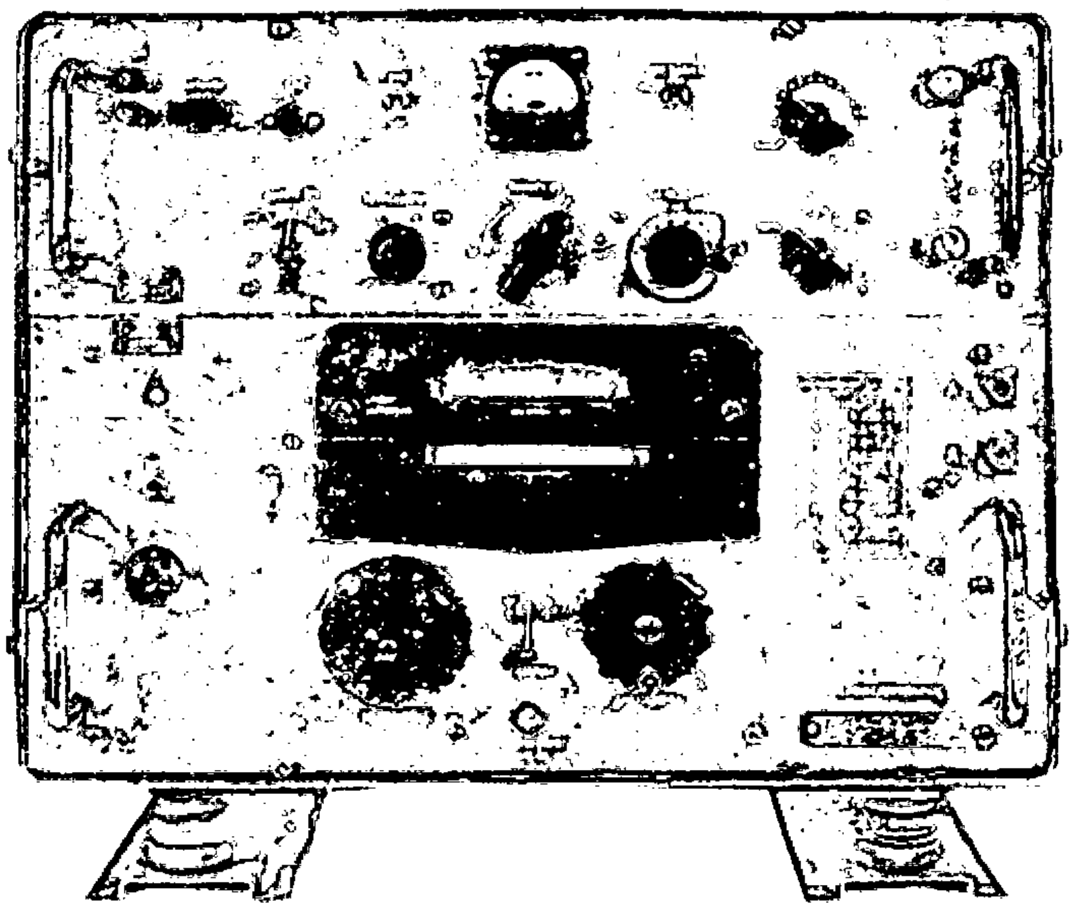

Fig. General View of the Receiver
Рис. 1. Общий вид приемника

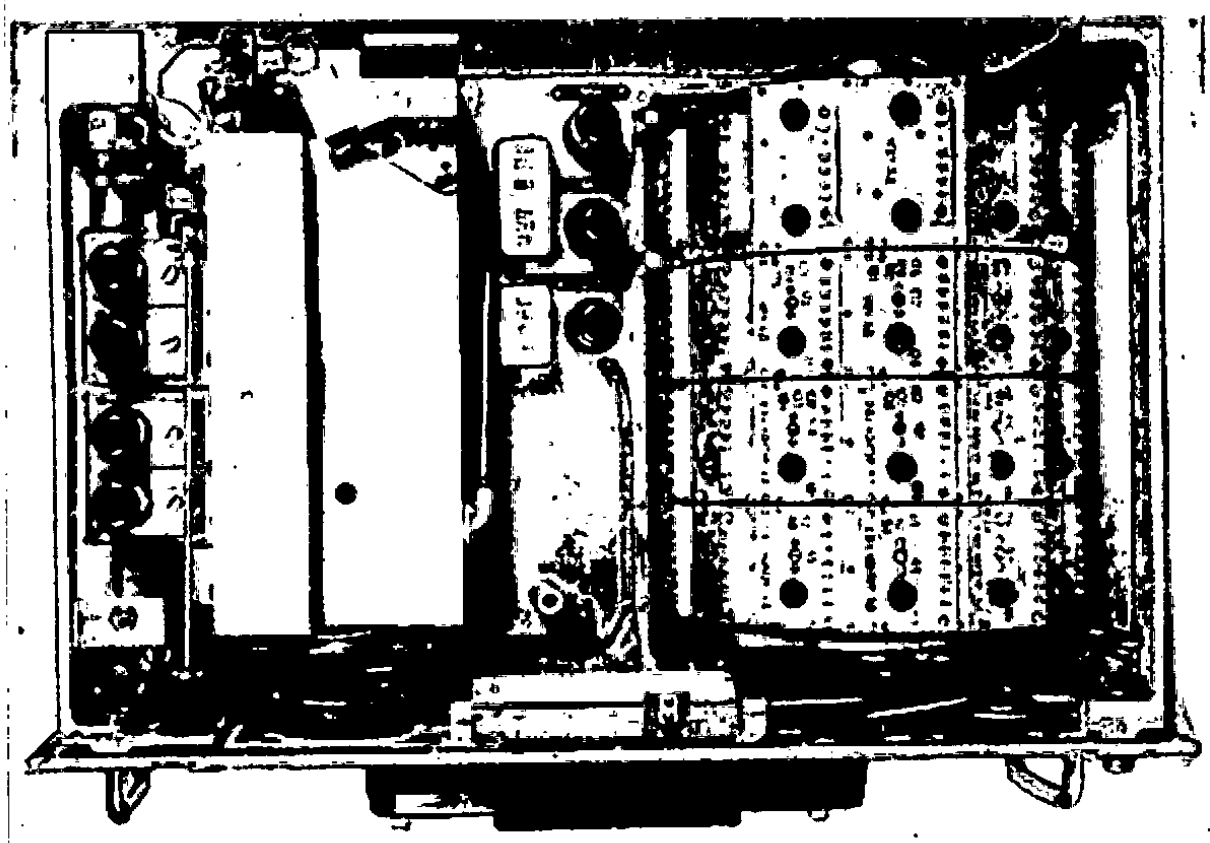

Рис. 2. Блок высокой частоты. Вид сверху

Fig. 2. Radio-Frequency Section. View From Above.

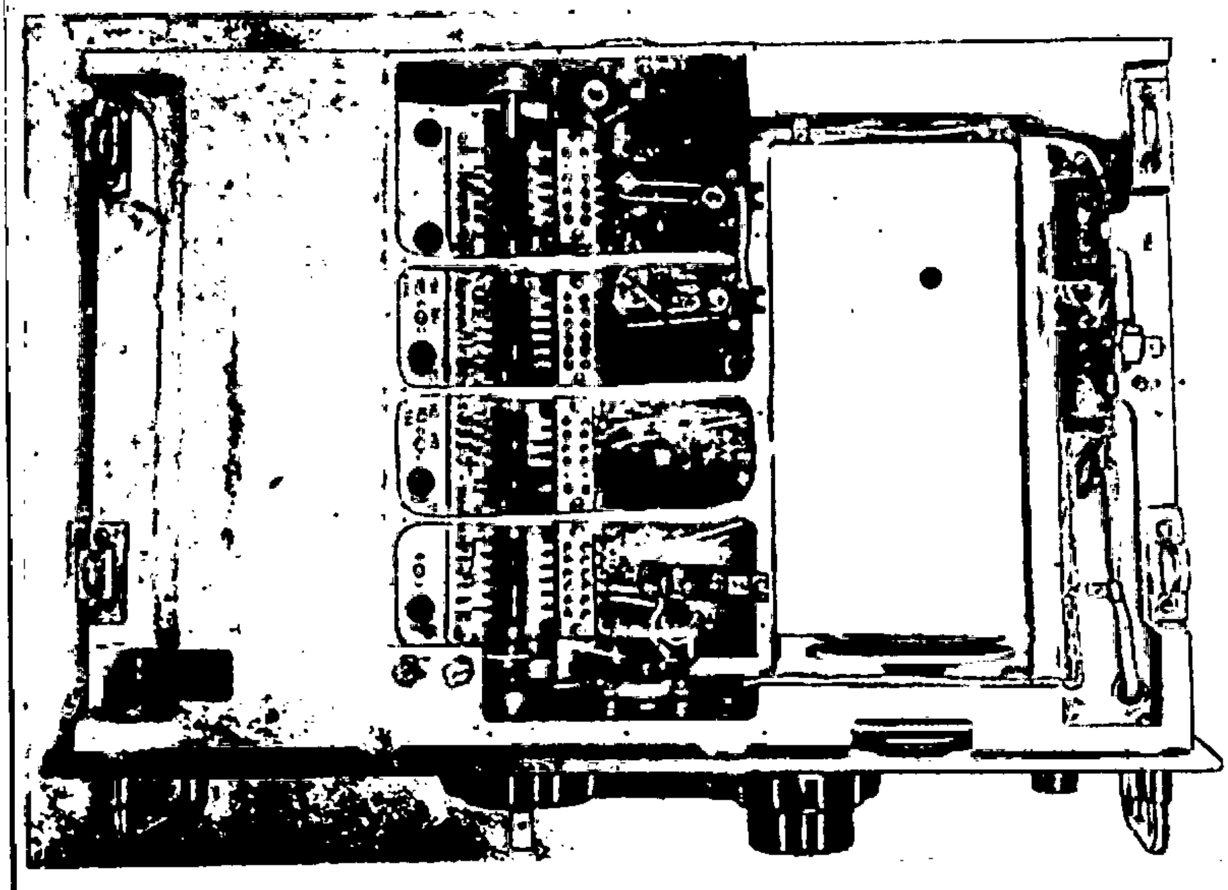

Рис. 3. Блок высокой частоты. Вид снизу

Fig. 3. Radio-Frequency Section. View From Below.

To the left of the tubes is a bank of gang capacitors consisting of four-gang and three-gang variable capacitors (See Fig 2.). 50X1-HUM

Both gang capacitors are mounted in cast Silumin boxes. The gangs are rigidly attached to one another, but electrically insulated from each other and from the plate. The shafts of the capacitor gangs are connected by a playfree pair of cylindrical gears (1 : 1 ratio).

In the center of the plate is the vernier, which has two ratio, 1:5 and 1:45. Playfree gears are used in the vernier to avoid the possibility of slack. A flexible coupling connects the vernier with the shaft axis of the lower capacitor bank.

In back, on the shaft of the upper gang capacitor, there is a specially mounted glass disk on which a microphotoscale with two rows of number is inscribed. One row of numbers represents the optical scale for the second subband; the other row of numbers, displaced 50 kilocycles from the upper one, is the optical scale for the remaining 11 subbands.

The objective lens projects (twelvefold magnification) the dial onto a ground glass on the front panel.

The trimmers and coils of the first intermediate-frequency circuits (See fig 4.) are in the upper part of the gang capacitor boxes.

To the left (near the front panel) is the toggle switch marked "Half-duplex".

On the left wall of the box are two compartments, the first (from thefront panel) containing the crystal calibrator and intermediate-frequency stage, and the second the first mixer and second local oscillator.

To the left and in back are two tube adaptors, each with 10 contacts.

The housing contains four tube adaptors with receptacles which connect the lower section to the upper. When the radio-frequency section is installed in the housing, the knife contacts fit into the corresponding sockets of the adaptors on the back wall of the housing (See Fig 5; adaptors 1 and 2). Underneath the plate (shelf) there are four rollers which roll along angle-iron guides when the section is drawn out of the housing.

The front panel of the radio-frequency section is attached to the plate by means of screws. At the center of the front panel is the coarse tuning dial, and under it the ground glass of the optical dial, framed in plastic (See Fig 1.).

Under the coarse tuning dial are the main control knobs: to the left the double tuning knob, to the right the knob of the subband switch at the center the antenna selector switch, and under it "Antenna Tuning".

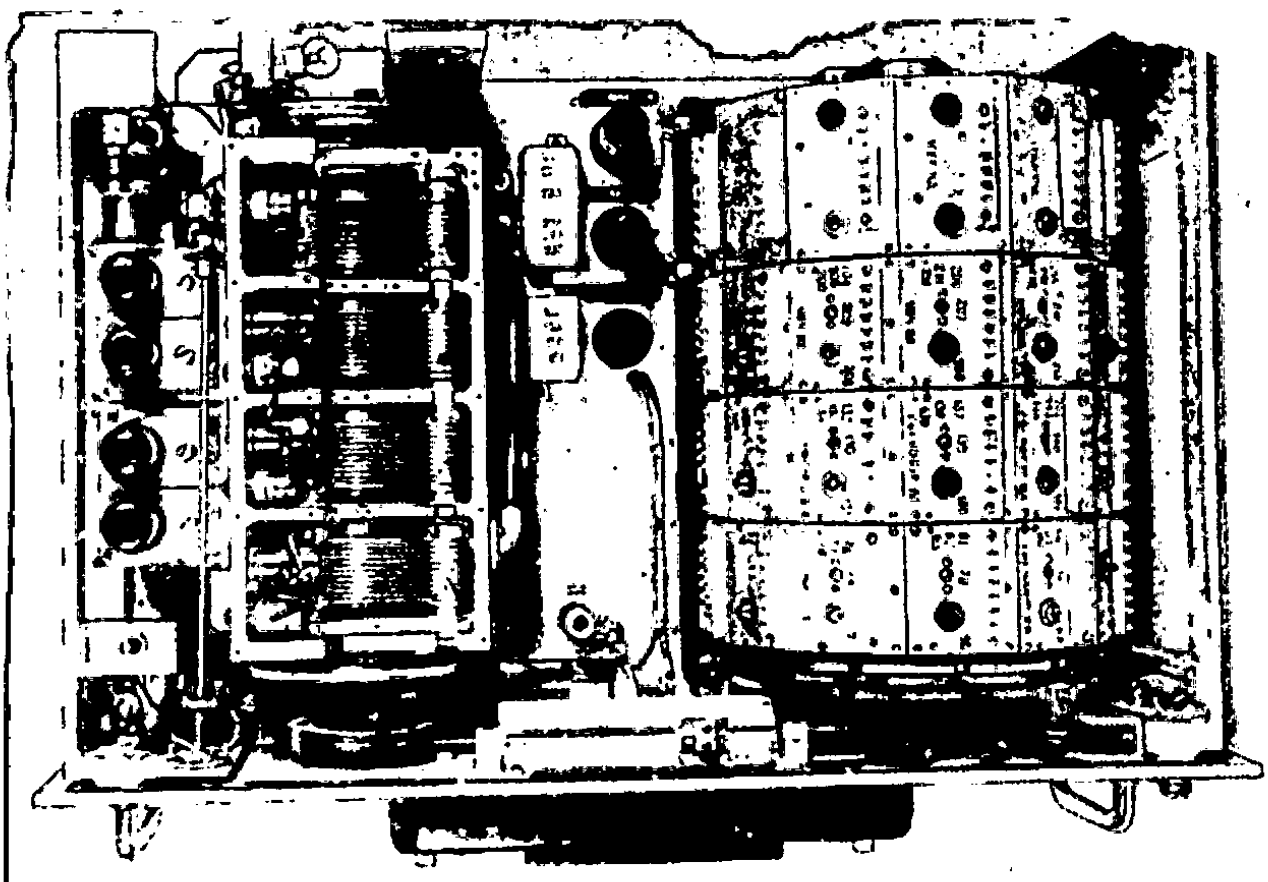

Рис. 4. Блок высокой частоты. Вид сверху со снятой крышкой с конденсаторного блока

Fig 4. Radio-Frequency Section. View From Above With Cover of Capacitor Bank Removed.

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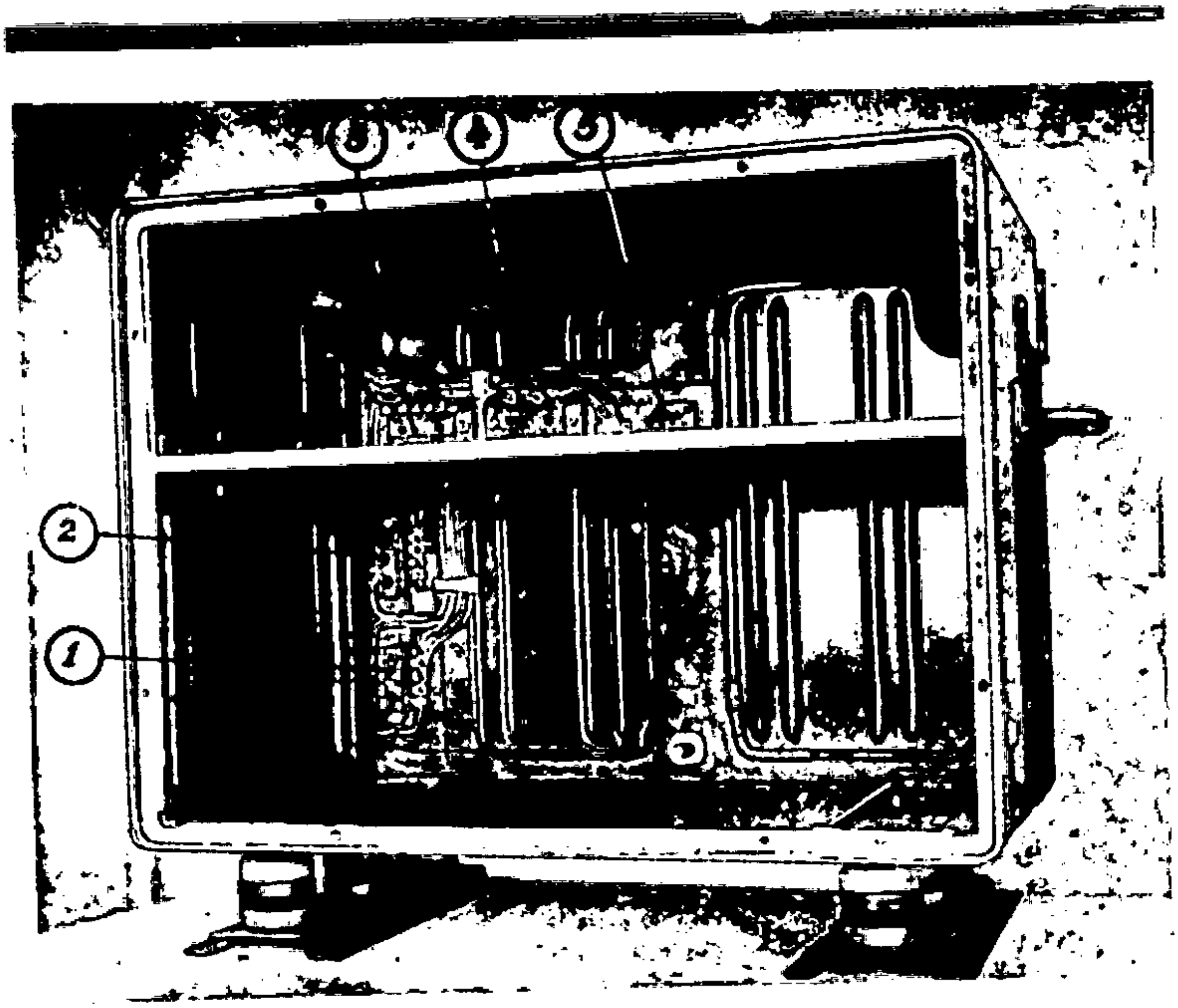

Рис. 5. Кожух приемника

Fig. 5. The Receiver Housing

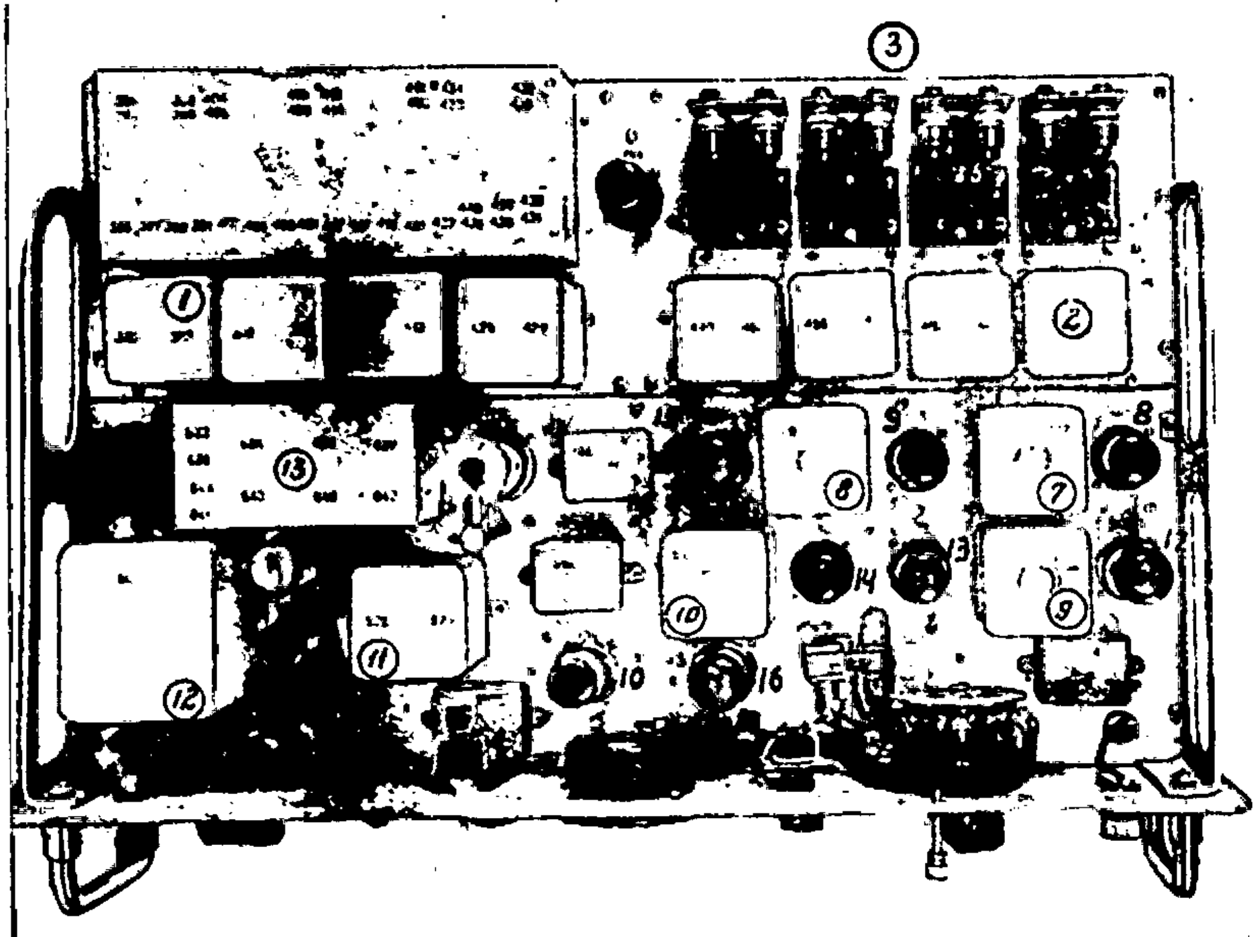

Рис. 6. Блок выходных устройств. Вид сверху

Fig 6. Output Section. View From Above

On the left side of the panel, looking from the top down, are the electrical dial corrector, the crystal calibrator toggle switch, and the radio-frequency gain control knob.

On the right side of the panel are the two antenna plugs (at the top) and (below) the receptacle with four telephone plugs.

The upper section, the output section, is attached to a sheet steel chassis with two horizontal panels (See Fig 6.), one for the high-selectivity filters and one for the components of the second intermediate-frequency and output stages (in front).

On the panel with the high-selectivity filters there are two groups of sealed cans, four cans in each group, containing the filter circuits (See Fig 6, Nos 1 and 2), and behind them the trimmers (No 3) for tuning the filter circuits.

Between the two groups of high-selectivity filter circuits is the tube of the first stage of the second intermediate frequency (tube No 7).

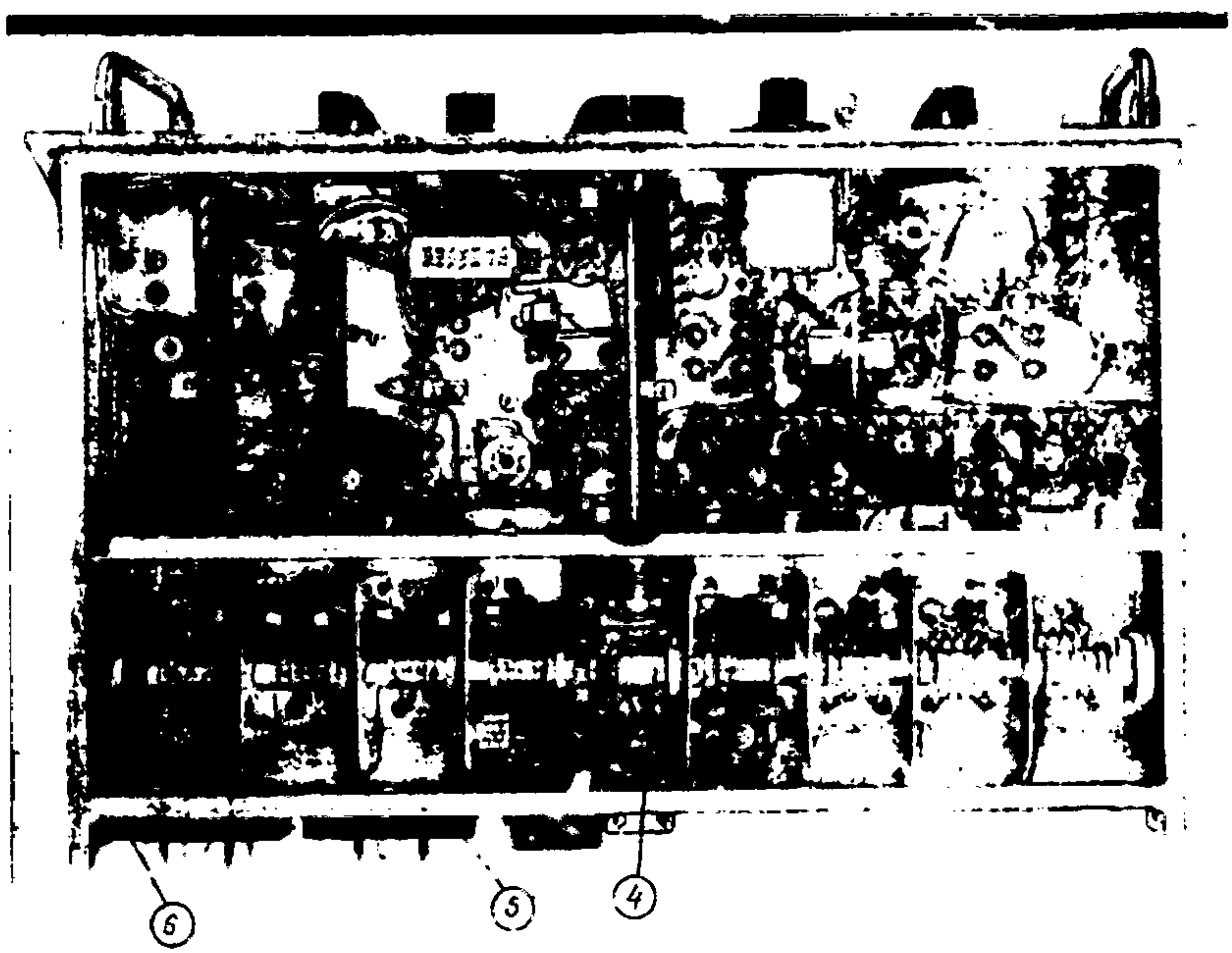

Fig 7. Output Section. View From Below

A selector switch is located below the panel (see Fig. 7). It has eight poles and four directions (pos. 4), and makes it possible to change frequency bands.

Two banks of contacts are located on the left, beneath the panel (pos. 5 and 6). They accommodate ten contact blades which close their respective contacts when the unit is inserted in the housing. (See Fig. 5, pos. 3 and 4).

On the second IF panel of the output systems, located in front of the sharp-selection filter panel, the following tubes and circuits are located, (see Fig. 6):

Second IF, second and third stage amplifier tubes (tubes No. 8 and 9), and their respective circuits (pos. 7 and 8); tube (No. 13) and circuit of the automatic sensitivity regulator (pos. 9); the automatic sensitivity control detector tube (tube No. 17); third local oscillator tube (No./14) and its circuit (pos. 10); third detector tube (No. 15); noise-rejection tube (No. 16); three audio-frequency amplifier tubes (Nos. 10, 11 and 12); audio-frequency filter (pos. 11); and output transformer (pos. 12). The power-supply filters (pos. 13) and a neon-type plate voltage stabilizer (No. 19) of the second local oscillator receiver circuit, are located on the left side of the panel.

All circuits are hermetically sealed.

The bulk of the assembly is mounted on a distributing frame, most of the elements being first mounted on individual mounting frames.

The front panel is attached to the chassis in front of the output systems assembly. All the control devices are concentrated here. Reading from left to right and from top to bottom, they include the following (See figure 1):

Two power supply terminals; a double toggle switch for cutting in the power supply; a safety fuse; an audio-frequency band selector handle (for 5, 2.5, and 0.3 kc.); a "telephone-telegraph" toggle selector switch; a device for controlling plate current and voltage; the IF band selector handle (for 12, 6, 3 and 1 kc.); a noise-rejection switch; a continuous-wave tone-control knob (with vernier device); a current and voltage selector handle; the automatic sensitivity regulator control handle; the IF output plug; and the automatic sensitivity regulator plug.

Special handles are provided at the left and the right of the front panel to facilitate its removal from the output system housing. Similar handles are provided on the front panel of the RF assembly.

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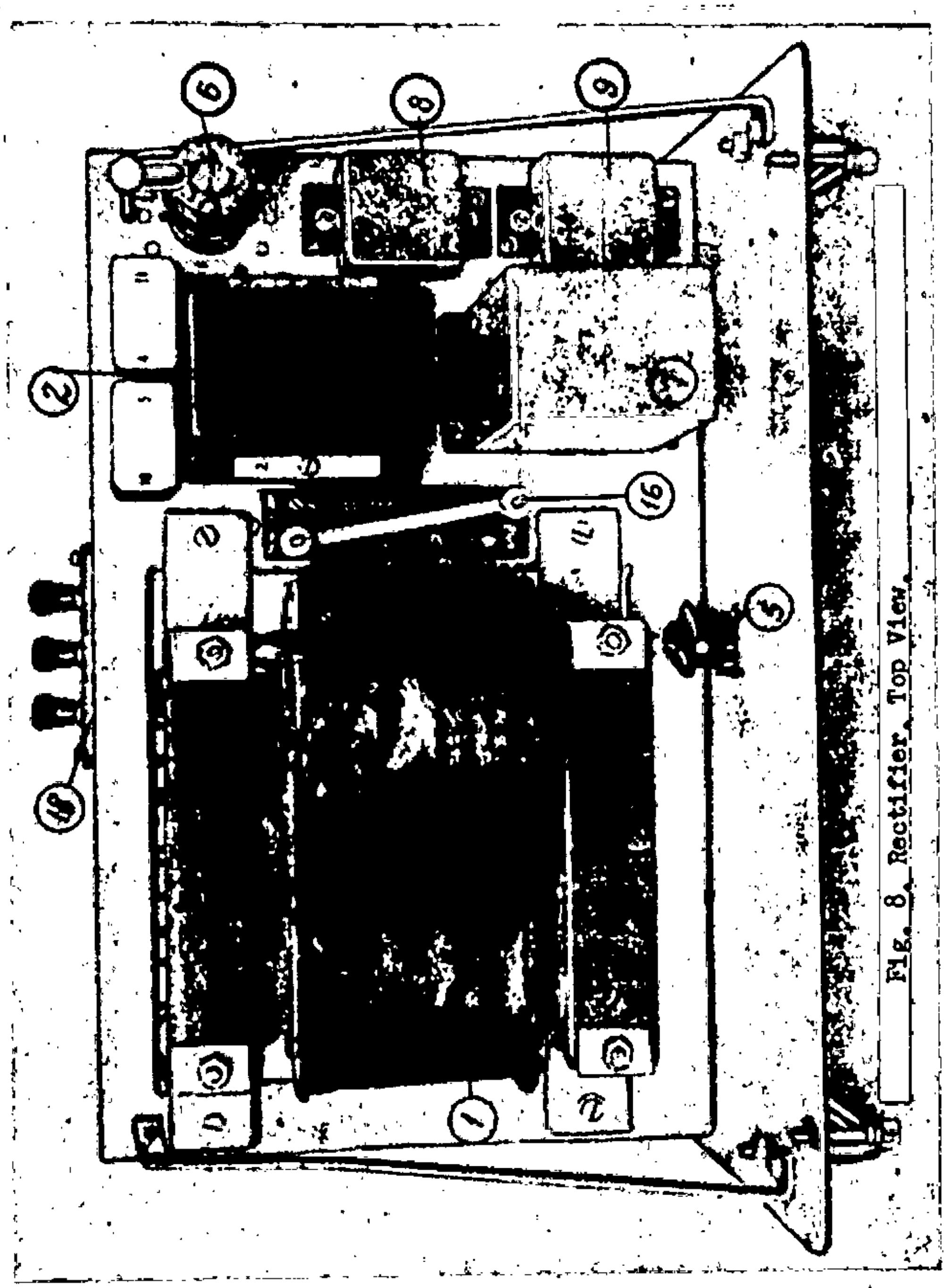

Fig. 8. Rectifier, Top View

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A five-terminal power-supply plug is installed in the housing. along the left wall (see Fig. 5). Along the rear inside wall, are four contact panels, with plugs (pos. 1, 2, 3, 4) connecting the upper and lower assemblies, as well as a five-terminal plug (pos. 5) which duplicates the receiver's output channel to the line and the automatic sensitivity control. To the same wall is also connected a wire from the half-duplex. The power supply plug is connected to the banks of contact clips.

3. DESCRIPTION OF THE RECTIFIER DESIGN

The rectifier, provided with a ferro-resonance voltage stabilizer, is mounted on a steel chassis. (see Fig. 8). Located at the top of this chassis are two filter sections, as part of the voltage supply circuit (pos. 3 - 10 and 4 - 11); tube 5 Ts4S (pos. 6); a plate filter choke (pos. 2); a ferro-transformer (pos. 1), and the plate filter capacitors (pos. 8 and 9).

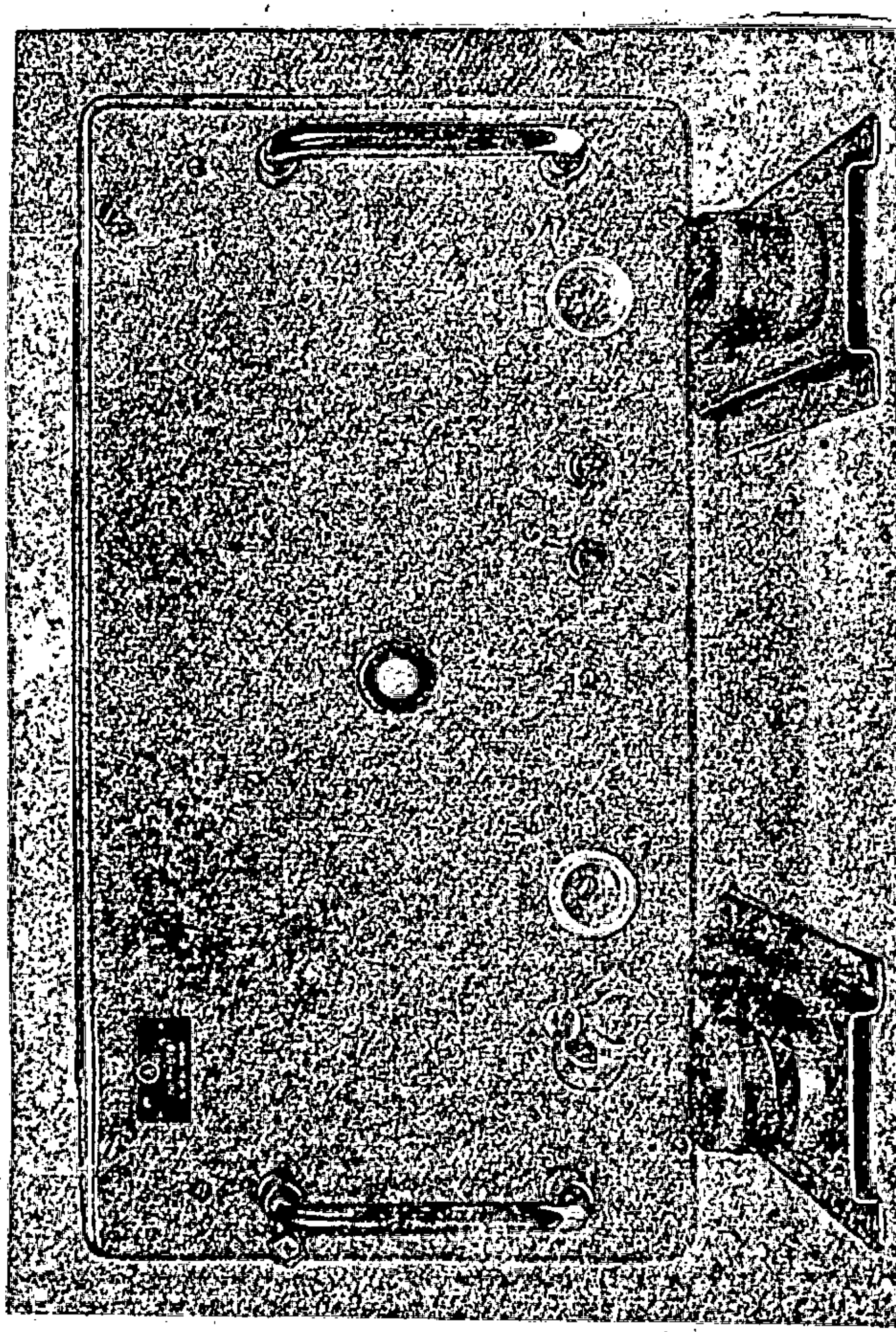

Fig. 9. General View of the Rectifier.

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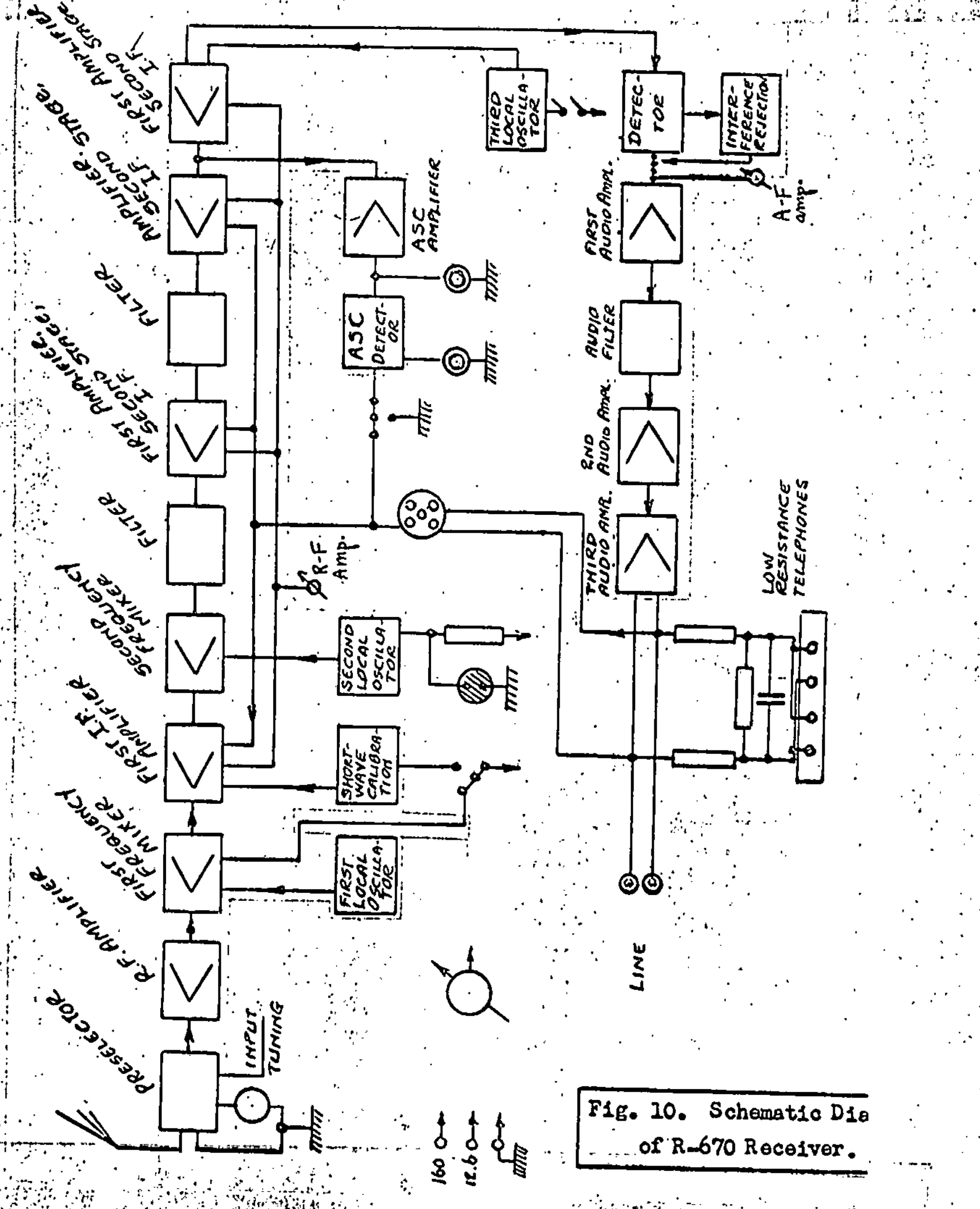

Fig. 10. Schematic Dia
of R-670 Receiver.

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In the center of the chassis, a special voltage stabilizer switch panel is installed (pos. 16), while along the rear wall of the chassis there is a three-clamp contact plate for connecting the plate and filament voltage of the rectifier (post. 18).

On the front panel, from the left to the right, are located (see figure 9): a connector for closing the circuit, a circuit voltage selector knob, a toggle switch, two fuses for power supply line, and a five-contact connector for the main power supply of the receiver. A signal light with a demountable cap is located in the middle of the panel.

The rectifier chassis -- complete with its shock-absorbers -- is inserted in a steel housing and fixed in place by means of screws inserted from the front. Size of the rectifier -- not counting the shock absorbers -- is as follows: width: 495 mm.; height: 265 mm.; depth: 340 mm. Including the shock absorbers, the above dimensions become, respectively, 495 x 330 x 340 mm.

The weight of the rectifier is not more than 30 kilograms.

III. THE ELECTRICAL LAY-OUT OF THE RECEIVER AND PRINCIPLE OF ITS OPERATION

The receiver is a superheterodyne with double frequency conversion in all sub-ranges except the first (see Fig. 10). The first IF is variable, ranging from 1.5 to 3.5 mc.

There is only a single frequency conversion in the first substage because, in this case, the range of the first IF is also the range of the reception frequency.

The entire frequency range of the receiver -- from 1.5 to 25.5 Mc. -- is divided into 12 partial sub-ranges.

One feature of the R-670 receiver is the use of quartz frequency stabilization in the first local oscillator which provides for a smooth, uninterrupted coverage of frequency ranges and insures a high degree of frequency stability and considerable accuracy in calibration, since the highest-frequency local oscillators -- in this case -- are quartz-stabilizied.

The gist of the superheterodyne method of radio reception with quartz frequency stabilization of the first local oscillator, consists of the following:

The entire range of receivable frequencies is broken down in such a way that an identical number of cycles is covered in each subrange. (In the present case, this number is 2,000 kc.).

Since in all the sub-ranges -- because of the manner in which they are subdivided -- an identical number of kilocycles is covered, it follows that the change of the first IF in all sub-ranges will also be the same. In selecting the quartz-stabilized frequencies of the first local oscillator in such a way that the frequency in one sub-range differs from the frequency in another sub-stage by the exact value of the frequency coverage (in this case, 2,000 kc.), we shall obtain limits of change in the first IF -- in all sub-ranges -- which will be identical not only in terms of coverage, but in absolute values as well. Thus the amplifier of the first IF becomes a wide-range amplifier (with -- in our case -- limits of frequency variation from 1,500 kc. to 3,500 kc.)

The second local oscillator of the receiver is calculated for such a range as to make the difference between the frequency of the 2nd local oscillator and the first IF, constant after the second IF conversion. (In our case, the value of this constant would be 215 kc.)

The rest of the superheterodyne receiver circuit follows the usual pattern.

1. INPUT STAGE

The input circuit of the receiver is a two-circuit selector, connected to the grid of the first tube. The receiver input is calculated for four types of antennas:

a) symmetrical -- with a wave resistance from 60 to 400 ohms;

b) asymmetrical -- with wave resistance from 60 to 400 ohms;

c) the "inclined beam" type, with an equivalence of 100 to 300 uuf and 100 ohms, active;

d) rod antennas -- with an equivalence of 50 uuf or more.

The switching over from one type of antenna to another is accomplished by means of a selector switch (pos. 28). In work with symmetrical or asymmetrical types of antennas, the coupling between the antenna and the receiver circuit is of the inductive type, while with the pole-type or open antennas it is of the capacitive type.

The first selector circuit features limited frequency trim which is carried out by means of trimmer (pos. 31). This insures matching the input of the receiver in shifting from one type of antenna to another.

To protect input circuits against excessive voltage of high-frequency signals (in cases of proximity to a powerful transmitter), a gas-type surge-voltage suppressor is connected in parallel with the first circuit (pos. 20). As voltage in the circuit approaches the threshold of ignition of this gas-filled safety device, i.e. 60 to 80 volts, a glowing discharge takes place in the tube, the conductivity of the discharge medium causes the excess voltage to bypass the circuit, and thus eliminates the possibility of further voltage increase in the subsequent links of the circuit.

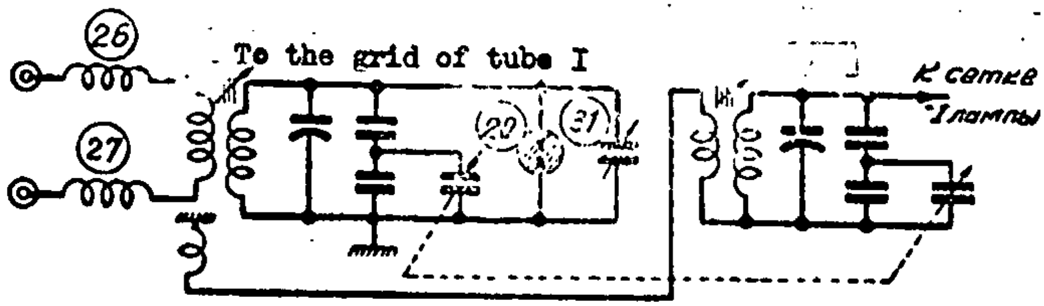

Рис. 11. Входная цепь приемника при работе от симметричных антенн

Fig. 11. Input Circuit of Receiver Operating with Balanced Antenna

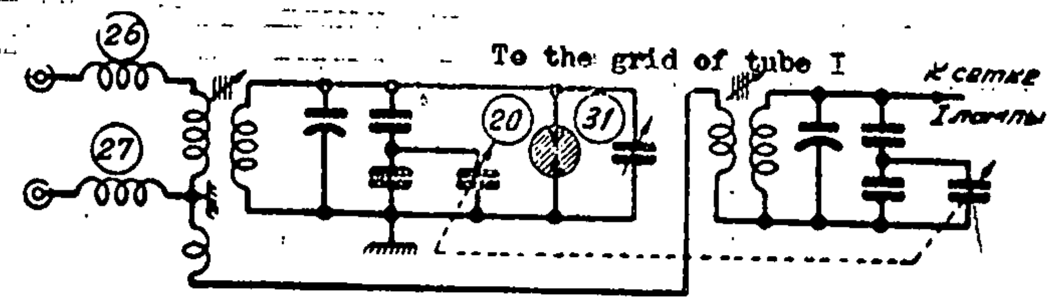

Рис. 12. Входная цепь приемника при работе от несимметричных антенн

Fig 12. Input Circuit of Receiver Operating with Unbalanced Antenna

At the input of the receiver there is an anti-radar filter, consisting of two choke coils (pos. 26 and 27).

The basic elements of each preselector circuit are: an induction coil, a variable capacitor, and a gang capacitor (except in the case of the first stage, where the necessary coverage is provided by the main variable capacitor). In the primary circuits, the gang capacitors are connected between terminals 3 and 5; in the secondary circuits the connections are made between terminals 5 and 6. Coupling between the preselector circuits is inductive. For instance, for the third sub-range, the main elements of the primary circuit are: the circuit coil (pos. 41), the variable capacitor (pos. 145), and the gang capacitor (pos. 43).

The antenna coupling coil (inserted in the circuit between terminals 1 and 2) -- which also connects with the secondary selector circuit -- is positioned together with the circuit coil.

Additional elements are: a trimmer (pos. 42), and a supplementary capacitor (pos. 44) which is connected in parallel with the variable capacitor.

The main elements of the secondary circuit are: a circuit coil (pos. 96), (which is positioned with the coupling coil of the primary coil of the selector, connected between terminals 1 and 4), variable capacitor (pos. 146), and a gang capacitor (pos. 98).

Additional elements are: a trimmer (pos. 97), and an additional capacitor (pos. 99) connected in parallel with the variable capacitor.

A simplified diagram of the input circuits of the receiver (i.e. those of the preselector), while operating with symmetrical antennas, is shown in Fig. 11. The same circuits, with assymmetrical antennas, are shown in Fig. 12, and while working with open or pole antennas -- in Fig. 13.

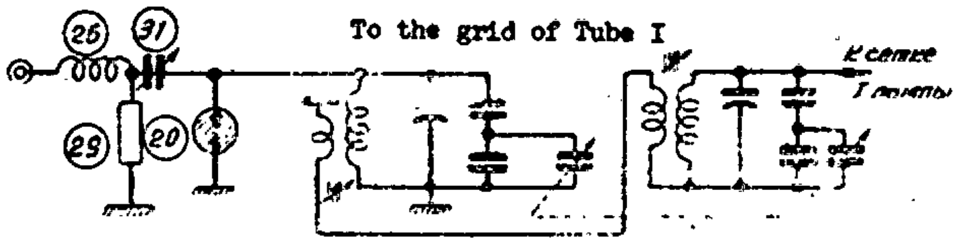

Рис. 13. Входная цепь приемника при работе от открытых или штыревых антенн

Fig. 13. Input Circuit of Receiver for Open or Rod Antenna

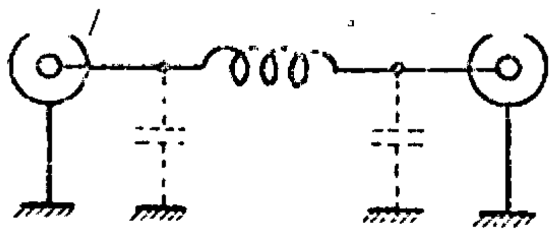

Рис. 14. Схема противолокационного фильтра

Fig. 14. Circuit of Anti-Radar Filter

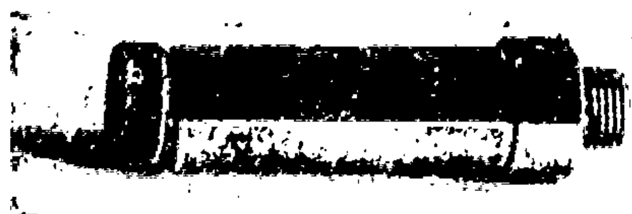

Fig. 15. Anti-Radar Filter.

Рис. 15. Противолокационный фильтр

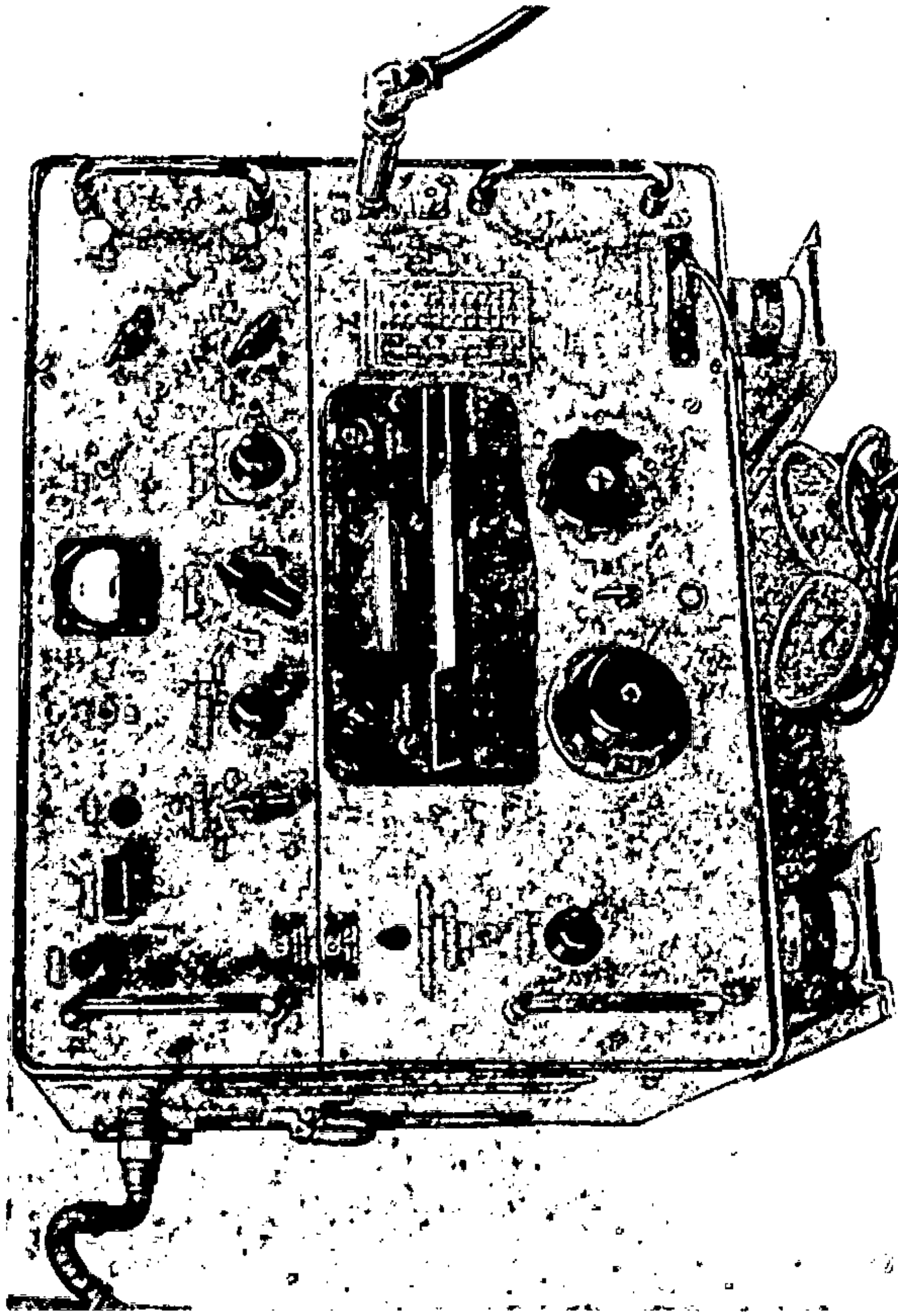

Fig. 16. Receiver with Anti-Radar Filter.

As can be seen from the schematic diagram, all circuits of the various frequency sub-ranges (circuit coils, coupling coils, ga 50X1-HUM capacitors and parallel capacitances) are in the form of plug-in units.

The receiver also features a special anti-radar filter, which suppresses UHF and decimeter wave-bands. In case of radar interference, the anti-radar filter is connected to the input of the receiver. Fig. 15 shows the outside appearance of the anti-radar filter, while its circuit diagram is shown on Fig. 14.

Fig. 16 shows the coupling of the single-line feeder to the anti-radar filter and the manner in which the filter is connected.

2. RADIO-FREQUENCY AMPLIFIER

After passing through the pre-selector, radio-frequency signals are amplified in a single RF stage, using tube 6Zh4 (tube No. 1). A simplified diagram of this stage is shown on Fig. 17

The stage is designed on the transformer principle. In a number of sub-ranges (the 2nd, 3rd, 4th and 5th), an additional capacitive coupling is used between the plate of the tube and the circuit, which insures uniformity of amplification in the stage, within the limits of the given sub-range.

Basic elements of the amplifier circuits are the following: circuit coils (connected between terminals 4 and 6 in all the sub-ranges except the first, where this coil is connected between terminals 4 and 5), anode coils (connected between terminals 1 and 2), a variable capacitor (217, connected between contacts 4 and 5), and gang capacitors (connected between contacts 5 and 6). For instance, for the third sub-range such elements are: the plate and circuit coils as shown at (167), the coupling capacitor (166), the gang capacitor (169), and the additional elements, trimmer (pos. 168) and an extra capacitor (pos. 170).

In sub-ranges from 5th to 12th, an additional capacitance is added, in parallel with the trimmer;

The sub-range circuits are of the plug-in, interchangeable type. (see schematic diagram).

3. FIRST MIXER

After passing through the amplifier, the radio frequency signals go to the grid of the first frequency mixer, a function performed by tube 6A7 (tube No. 2). The circuit of this first frequency mixer is shown on Fig. 18. The plate output of the first frequency mixer is loaded on the circuit of the first intermediate frequency (by the method of auto-transformer coupling).

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Voltage from the first local oscillator is supplied through the 200 uuf capacitor (225) to the heterodyne grid of the first frequency mixer.

The plate circuit of the first frequency mixer works in a smoothly-changing frequency range of from 1.5 to 3.5 Mc. While working in the first sub-range, the first frequency mixer is shifted to an amplifier mode (with the first local oscillator disconnected), so that in this sub-range only a single frequency-conversion takes place. Elements of the plate circuit are: the coil (299), variable capacitor (302), and the trimmer (300).

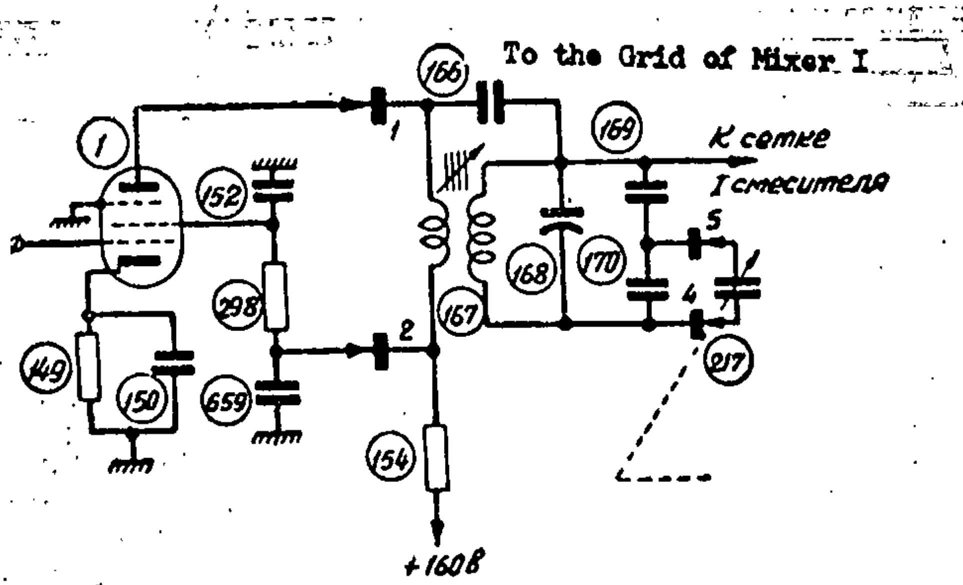

Рис. 17. Схема каскада УВЧ

Fig. 17. Circuit of the ASC Stage.

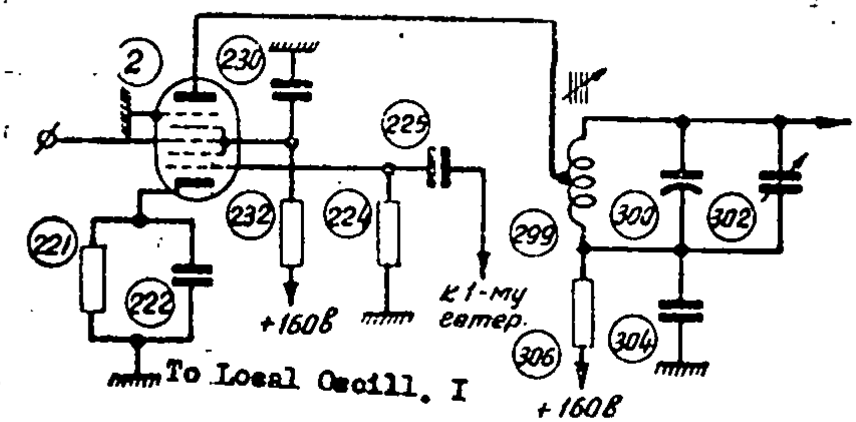

Рис. 18. Схема первого смесителя

Fig. 18. Circuit of the First Mixer.

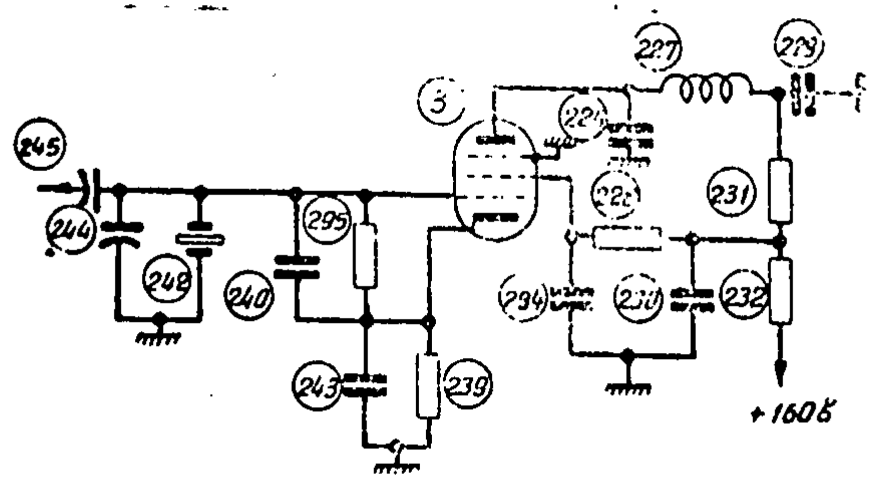

Рис. 19. Схема первого гетеродина

Fig. 19. Circuit of the First Local Oscillator.

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4. FIRST LOCAL OSCILLATOR

The first local oscillator of the receiver (tube No. 3, a 6Zh4), operates in all sub-ranges, except the first, on crystal-- as shown on Fig. 19 -- without any tuning circuit.

In the first sub-range, the tube of the first local oscillator (No. 3) does not operate and its grid is grounded.

Two crystals are used in the second sub-stage; one -- for a frequency of 2.05 Mc (296), and the other -- for 1.95 Mc (297). The two crystals operate consecutively: first on one sector of the 2.05 Mc. scale, then on the other sector of the 1.95 Mc scale.

The use of two crystals shifts the frequency of the first local oscillator upward with respect to the first IF, by a value of 50 kc (on the 3.5 to 4.0 Mc. sector), and shifts it downward by the same amount in the sector from 4.0 to 5.5 Mc. Thismakes it possible to exclude in the receiver the effected sector of the sub-range; such a sector would be present with the use of a single 2-Mc crystal. (This is so because, in this case, the crystal frequency would coincide with the first IF, which changes smoothly from 1.5 to 3.5 Mc.)

The use of two crystals makes it possible to eliminate the effected sector and, at the same time, provide a coverage for the second sub-range so that there should be no dead frequency interval in the reception.

The system of crystal selection in the second sub-range (see schematic diagram of the receiver), which is coupled with the tuning capacitor, is designed in such a way as to provide a scale up to 4 Mc. when operating with one crystal, and a scale starting with 4 Mc and going upward when operating with the other crystal (at each point on the 4 Mc. level there is a frequency reserve of at least 20 kc.).

On the coarse tuning dial and on the optical dial, there are marks to indicate the dead-frequency area in which the crystal switch-over takes place. This switch-over is accomplished by means of two contacts installed at the open end of the variable capacitor assembly. This also is the point where the crystals of the second sub-range are located. The schematic diagram of the first heterodyne, forworking in the second sub-range, is shown in Fig. 20.

In the third sub-range, the frequency of the first local oscillator is 4 Mc, in the IVth -- 6 Mc., in the Vth -- 8 Mc., in the 6th -- 10 Mc., in the VIIth -- 12 Mc., in the VIIIth -- 14 Mc. (7-Mc. crystal, with the use of the second harmonic); in the IXth -- 16 Mc., (8-Mc. crystal, with the second harmonic); in the Xth -- 18 Mc.

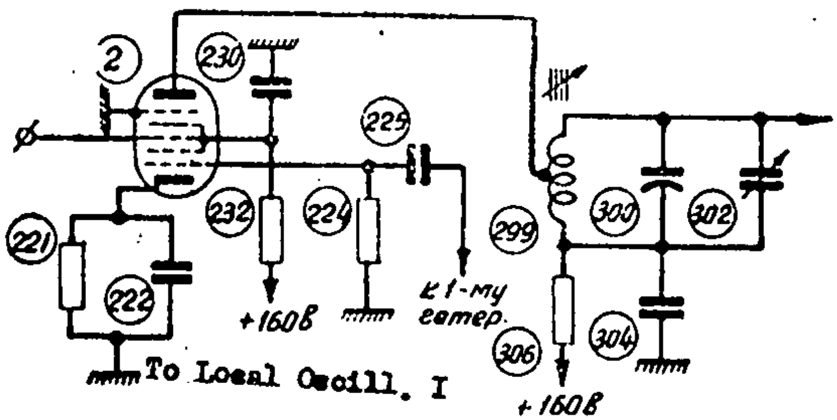

Рис. 18. Схема первого смесителя

Fig. 18. Circuit of the First Mixer.

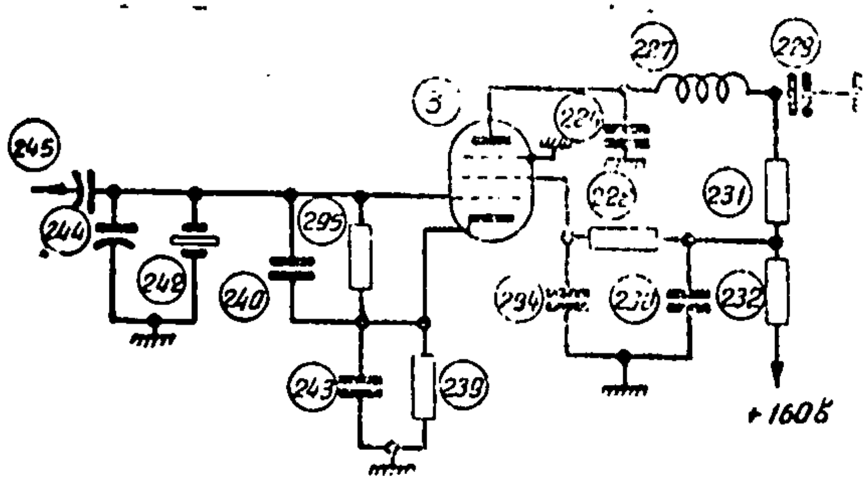

Рис. 19. Схема первого гетеродина

Fig. 19. Circuit of the First Local Oscillator.

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4. FIRST LOCAL OSCILLATOR

The first local oscillator of the receiver (tube No. 3, a 6Zh4), operates in all sub-ranges, except the first, on crystal-- as shown on Fig. 19 -- without any tuning circuit.

In the first sub-range, the tube of the first local oscillator (No. 3) does not operate and its grid is grounded.

Two crystals are used in the second sub-stage; one -- for a frequency of 2.05 Mc (296), and the other -- for 1.95 Mc (297). The two crystals operate consecutively: first on one sector of the 2.05 Mc. scale, then on the other sector of the 1.95 Mc scale.

The use of two crystals shifts the frequency of the first local oscillator upward with respect to the first IF, by a value of 50 kc (on the 3.5 to 4.0 Mc. sector), and shifts it downward by the same amount in the sector from 4.0 to 5.5 Mc. Thismakes it possible to exclude in the receiver the effected sector of the sub-range; such a sector would be present with the use of a single 2-Mc crystal. (This is so because, in this case, the crystal frequency would coincide with the first IF,which changes smoothly from 1.5 to 3.5 Mc.)

The use of two crystals makes it possible to eliminate the effected sector and, at the same time, provide a coverage for the second sub-range so that there should be no dead frequency interval in the reception.

The system of crystal selection in the second sub-range (see schematic diagram of the receiver), which is coupled with the tuning capacitor, is designed in such a way as to provide a scale up to 4 Mc. when operating with one crystal, and a scale starting with 4 Mc and going upward when operating with the other crystal (at each point on the 4 Mc. level there is a frequency reserve of at least 20 kc.).

On the coarse tuning dial and on the optical dial, there are marks to indicate the dead-frequency area in which the crystal switch-over takes place. This switch-over is accomplished by means of two contacts installed at the open end of the variable capacitor assembly. This also is the point where the crystals of the second sub-range are located. The schematic diagram of the first heterodyne, forworking in the second sub-range, is shown in Fig. 20.

In the third sub-range, the frequency of the first local oscillator is 4 Mc , in the IVth -- 6 Mc., in the Vth -- 8 Mc., in the 6th -- 10 Mc., in the VIIth -- 12 Mc., in the VIIIth -- 14 Mc. (7-Mc. crystal, with the use of the second harmonic); in the IXth -- 16 Mc., (8-Mc. crystal, with the second harmonic); in the Xth -- 18 Mc.

(9-Mc. crystal, second harmonic), in the XIth -- 20 Mc (10-Mc crystal, second harmonic), and in the XIIth -- the frequency of the first local oscillator is 22 Mc. obtained with an 11-Mc. crystal as a second harmonic.

In this way, in any sub-range, the difference between the frequency of the incoming signal -- at any point -- and that of the first local oscillator will be within the limits of from 1.5 to 3.5 Mc, i.e. the first IF.

In all, twelve crystals are used in this receiver, in the circuits of the first local oscillator.

5. FIRST I.F. AMPLIFIER

The first IF of the receiver varies from 1.5 to 3.5 Mc. The schematic diagram of the amplifier of the first I.F. is shown on Fig. 21. The amplifier of the first I.F. is of a single-stage type, using tube 6K3 (tube No. 4). A twin-circuit broad-band filter provides the plate load for the stage. The principal elements of the filter are: two induction coils (325 and 333) and two variable capacitors (326 and 332).

Internal and external capacitive coupling between the filter circuits is effected -- respectively -- by capacitors 330, 328 and 329. The system of coupling between the circuits of this stage is so arranged that as the IF frequency increases, stage amplification declines, thus compensating for the increase of amplification in other stages of the receiver.

Three tuned circuits are also in operation -- together with the circuit of the first converter -- in the first I.F. section of the receiver. In the first sub-range, as already explained, the amplifying stage of the first I.F. functions also as amplifier of the incoming-signal frequency.

Thus, in the first sub-range the incoming frequency is amplified in three stages (tubes No. 1, 2, and 4), and the total number of circuits tuned to the incoming frequency turns out to be six.

6. SECOND MIXER.

The second frequency mixer utilizes tube 6A7 (tube No. 5). The signal voltage of the incoming signal is directed to the signal grid, while the voltage of the second local oscillator is supplied to the heterodyne grid after passing through capacitor (343). A sharp selection filter constitutes the plate load of the second frequency mixer. This filter is tuned to the second I.F., i.e. to f = 215 kc.

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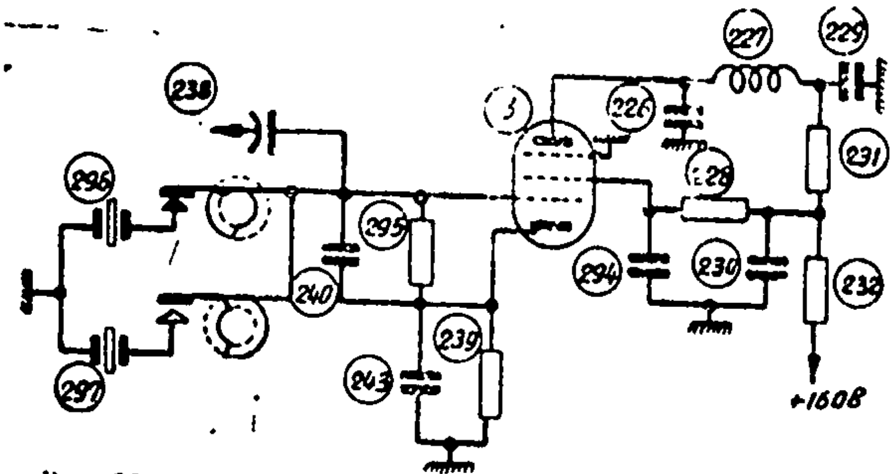

Рис. 21. Схема первого гетеродина на II-м поддиапазоне
Fig. 20. Circuit of First Local Oscillator for 2-nd Subrange

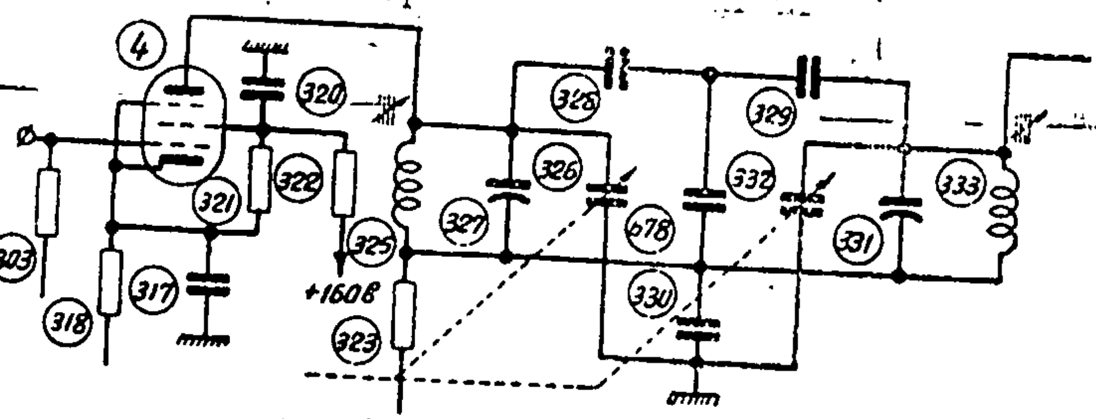

Рис. 21. Схема усилителя 1-й П. Ч.
Fig. 21. Circuit of 1-st IF Amplifier

To reduce the range of combination frequencies arising from the harmonic beats of the first and second local oscillators, a filter, consisting of a choke (336) and a capacitor (337), is included in one of the circuits of the frequency mixer.

A simplified schematic diagram of the second frequency mixer is shown on Fig. 22.

In the first sub-range, the second frequency mixer becomes the first mixer, so that the receiver -- in this sub-range, works with a single frequency conversion.

7. SECOND LOCAL OSCILLATOR

The second local oscillator of the receiver (in the first sub-range it becomes the first local oscillator) covers a continuous frequency range from 1.715 Mc. to 3.715 Mc (tube No. 6 of the 6K3 type).

In this way, the second I.F., which represents the frequency difference between that of the second local oscillator and the first I.F., is constant and equals 215 kc.

The local oscillator is assembled on the principle of a modified Hartly circuit. A simplified schematic diagram is shown on Fig. 23. In the first sub-range, the temperature coefficient of the receiver is determined primarily by the stability of the second local oscillator (in this case, the first-using tube No. 6). The temperature frequency coefficient of the second local oscillator is no more than $20 \cdot 10^{-6}$, and good stability is achieved by:

a) having all elements of the circuit with low temperature coefficients, which are partly compensated for by a capacitor with an adjustable temperature capacitance coefficient (357), connected in parallel with the circuit;

b) by chosing weak coupling between the circuit and the tube;

c) by proper selection of the tube mode.

The voltage from the second local oscillator, supplied to the second frequency mixer,

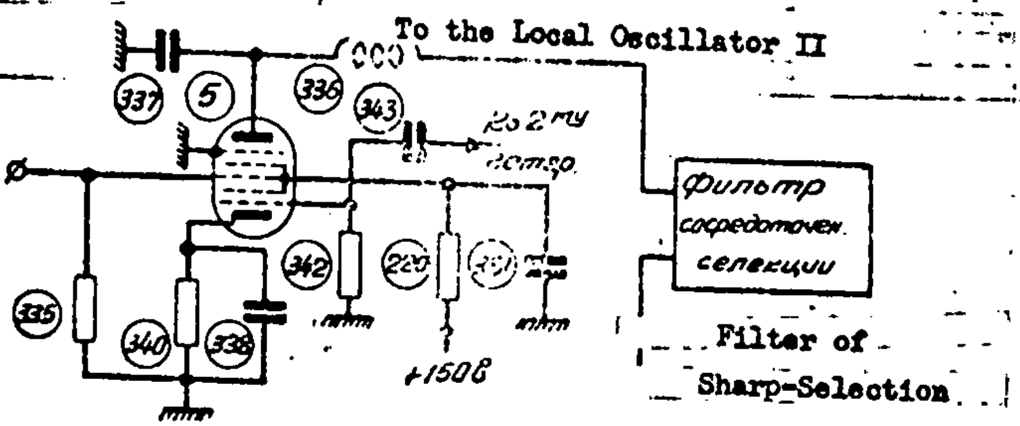

Рис. 22. Схема второго смесителя

Fig. 22. Circuit of the Second Mixer.

is drawn from the plate circuit of the second local oscillator from resistor (344) through the capacitor (343).

To correct the calibration, a special trimming capacitor (358) is connected to the circuit, in parallel with the circuit of the second local oscillator. The shaft of this capacitor is extended to the front panel where accurate manual adjustment is thereby made possible. To prevent voltage leakage from the local oscillator into the plate circuit, a special filter is installed in the local oscillator circuit (347, and 348).

No additional gang capacitors are used in the circuit of the second local oscillator. Instead, within the circuit of the local oscillator, the method used is that of the fixed rotation of the capacitor rotor with respect to the position of the rotors of the amplifier capacitors of the first I.F.

It was possible to use this method because the dial of the receiver is linear and the second local oscillator has no sub-range frequency selector. This makes for great precision in gang tuning and excludes extraneous components from the local oscillator circuit.

The variable capacitors of the preselector, the amplifier of the incoming signal frequency, as well as those of the first frequency converter, first I.F. amplifier and the second local oscillator are joined in a common assembly unit (seven variable capacitors in all), activated by a single tuning handle of the receiver.

8. CORRECTING THE CALIBRATION

The first local oscillator of the receiver--in all sub-ranges except the first--is crystal-stabilized. Therefore, in correcting the graduation of the receiver, it is possible to check the graduations on all of the sub-ranges. One should only remember that, for the second sub-range, the checkpoints of the scale of the second sub-range are shifted 50 kc as compared with the checkpoints of the scales of all other sub-ranges. For correcting the graduation, the receiver is equipped with a special crystal calibrator free of the tuning circuit (tube No 18, of the 6 K 3 type). From the crystal calibrator, the voltage is applied to the grid of the tube of the first amplifier of the first I.F., through the small coupling capacitance formed between the lead going to the grid of tube No 4 and the one going from the crystal calibrator and two turns of wire wound on it.

In this way, in correcting the graduation of any sub-range, we correct and check each time only the frequency of the second local oscillator.

Such a system of verification is possible only because the first local oscillator is crystal-stabilized and therefore requires no calibration.

As the crystal calibrator is turned on, voltage is removed from the plate of the first mixer and the screen voltage of the amplifier of the first I.F. is reduced. Reception of the incoming signal is thereby greatly reduced. The toggle switch which controls the crystal calibrator (311) is installed in the front panel of the receiver.

The fundamental frequency of the crystal calibrator is 500 Kc. Therefore, the checkpoint frequencies used for calibration are multiples of 500. The schematic diagram of the crystal calibrator is shown on Fig. 24.

When the receiver is manufactured at the factory, correction of the graduations of the scale is carried out, usually, at the extreme checkpoints of the scale. Under operating conditions, however, it is regarded advisable to carry out the correction by checking the middle checkpoints, i.e. the second and the fourth.

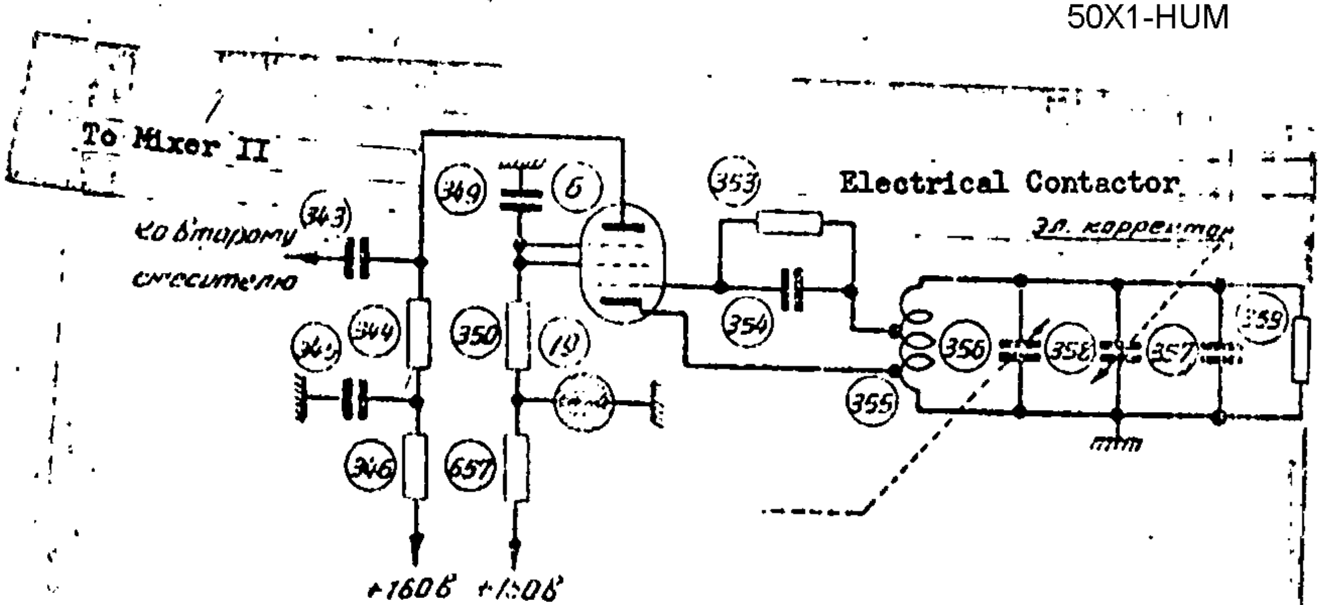

Рис. 23. Схема второго гетеродина

Fig. 23. Circuit of the Second Local Oscillator

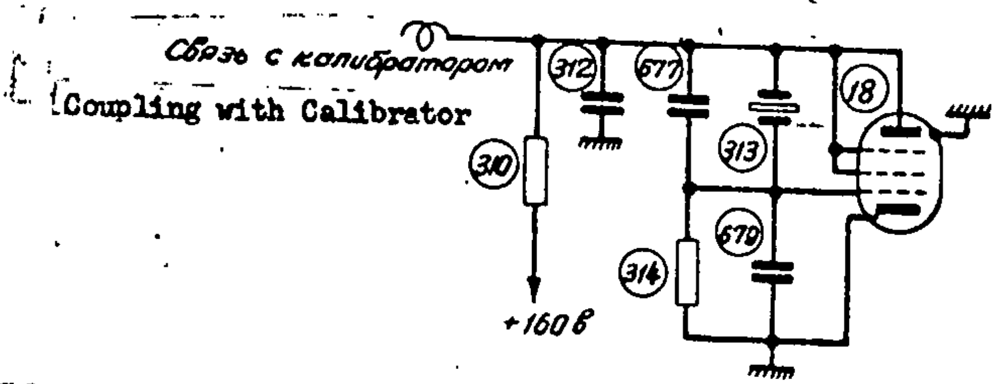

Рис. 24. Схема кварцевого калибратора

Fig. 24. Circuit of the Crystal Calibrator.

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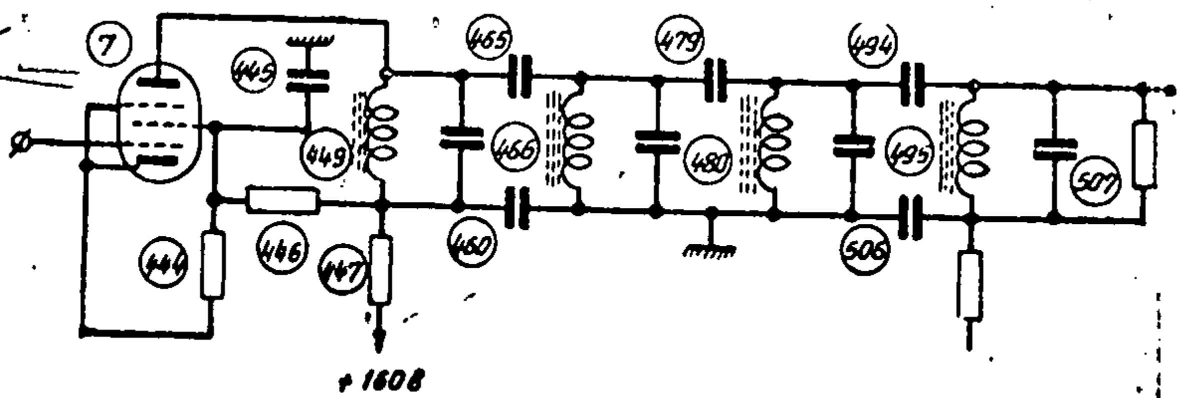

Рис. 25. Схема первого каскада усилителя II-й П. Ч.

Fig. 25. Circuit of the First Stage of 2-nd IF Amplifier

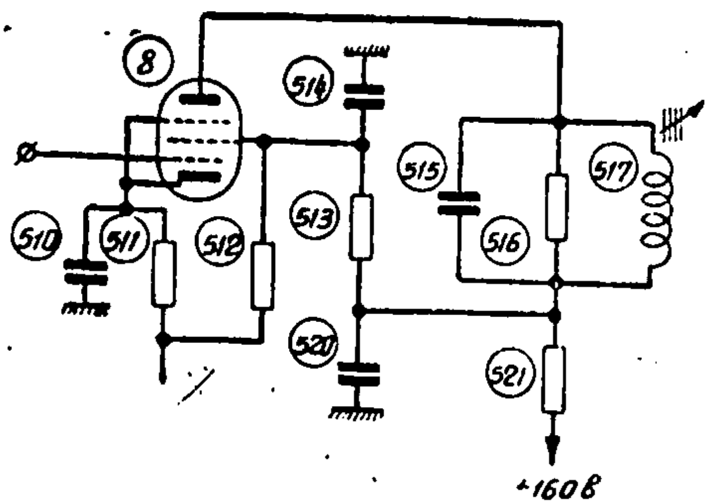

Рис. 26. Схема второго (третьего) каскада усилителя II-й П. Ч.

Fig.26.Circuit of 2-nd Stage of 2-nd IF Amplifier

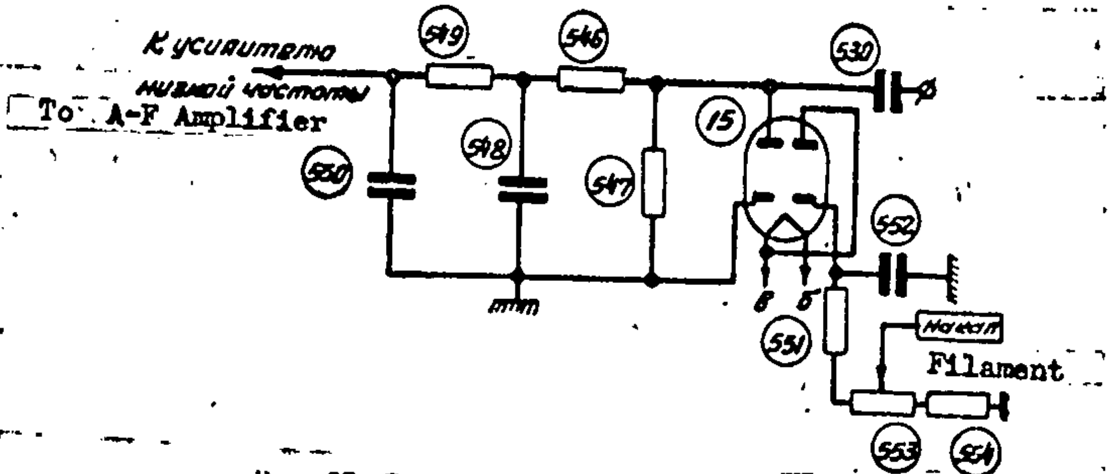

Рис. 27. Схема детектора основного канала

Fig. 27. Detector Circuit of the Main Channel

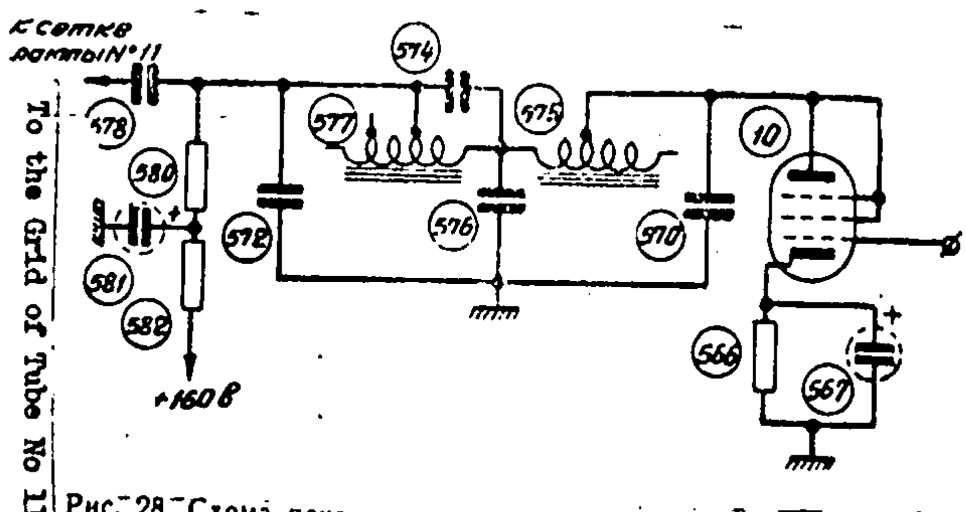

Рис. 28. Схема первого каскада УНЧ для полосы 5 кгц

Fig 28. I-st Stage Circuit of AF Amplifier for 5-Kc Band

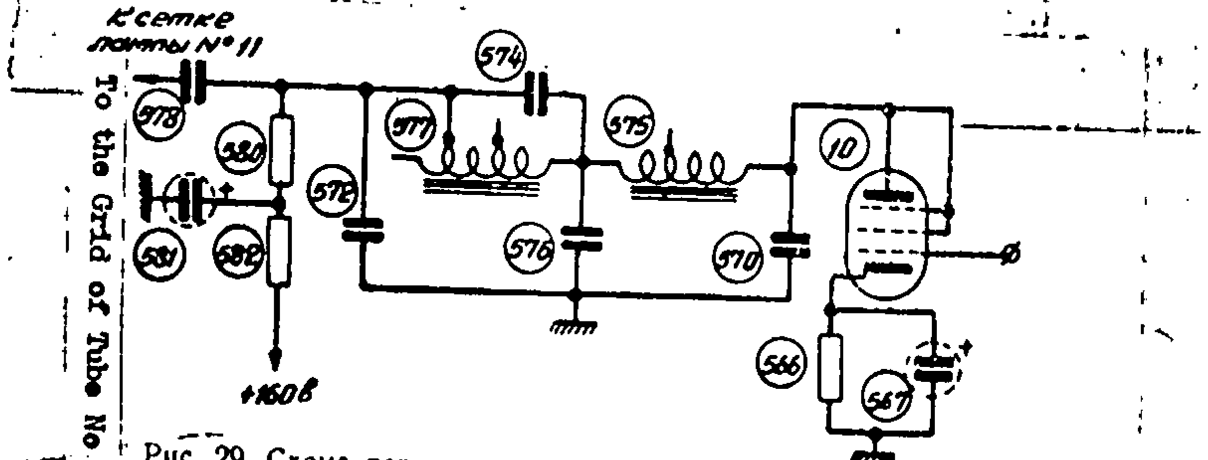

Рис. 29. Схема первого каскада УНЧ для полосы 2,5 кгц

Fig. 29. 1-st Stage Circuit of AF Amplifier for 2.5-Kc Band

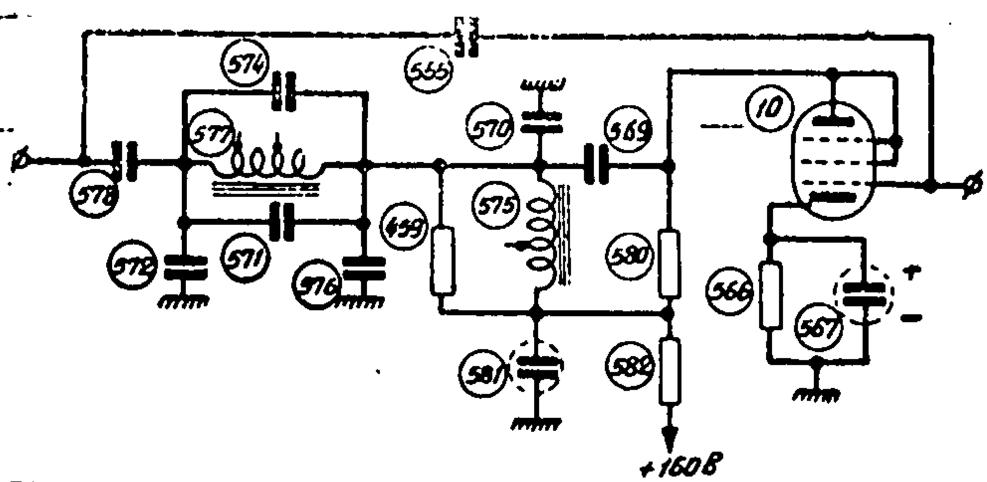

Рис. 30. Схема первого каскада УНЧ для полосы 0,3 кгц

Fig. 30. 1-st Stage Circuit of AF Amplifier for 0.3-Kc Band

9. SECOND I.F. AMPLIFIER

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The second intermediate frequency of the receiver is 215 Kc.

The amplifier of the second I.F. is of the three-stage type.

The first stage (tube No 7 of the 6K3 type) uses a sharp selection filter as plate load. The second and third stages (tubes No 8 and 9 of the 6K3 type) use a resonance amplifier circuit with a direct coupling of the system to the plate circuit.

Variable selectivity of the receiver (there are four pass-bands with nominal values of 1, 3, 6 and 12 kc.) is achieved by means of selective coupling of the pass-bands in two sharp selection filters which are, in turn, connected to the plate circuits of the second frequency mixer and to the first amplifier stage of the second I.F.

Each sharp selection filter includes four circuits connected with each other by means of external capacitive coupling. Thus, for instance, for the 12-kc. passband capacitance of the coupling is 51 uuf (381, 411, 427, and 465, 479, and 494).

Filter outputs are loaded with resistors, the value of which is equal to the wave resistance of the filter (resistor 438, 439, 440, 507, 508, and 509).

In changing the pass-band, there is a corresponding change in the coupling capacitance and the load resistance of the filter.

With any increase in capacitance, the filter with the external capacitance coupling produces a widening of the band to one side of its midband values. Additional capacitors are therefore switched on in the circuit at the same time as the wave-band is shifted. These extra capacitors are connected in parallel with the induction coil of each filter circuit. As pass-bands are switched, the extra capacitors make it possible to maintain a constancy of the midband frequency at all frequency bands.

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The filter coils with the fundamental capacitance (510 μμf for the extreme circuits, pos. 383, 429, 450 and 496; 1200 μμf for the intermediate circuits, pos. 399, 413, 467 and 481), are placed in special, hermetically sealed shields.

Additional tuning elements of the filter are mounted on special plates affixed near the hermetically-sealed shields. The coupling capacitors are mounted under the panel, between the terminals of the band selector.

The schematic diagram of the first amplifier stage of the second I.F. is shown on Fig. 25. For the sake of simplicity the circuit is shown only as it applies to a single pass band.

The inductance coil (No 517) and the capacitor (No 515) are the principal elements of the second stage amplification circuit. To widen the pass-band of the stage, the circuit is shunted by a resistance.

The third amplification circuit for the second IF has a coil (No 529) and a capacitor (No 528) similar to the circuit of the preceding stage. A diode detector on the principal channel (Tube No 15) renders shunting effect on the circuit.

The second and third amplification stages for the second IF affect but slightly the overall selectivity of the receiver and they bring about the needed amplification for the second IF.

The schematic diagram for these stages is shown in Fig. 26.

Fig. 26. Schematic diagram of the second (third) stage for the I-F amplifier.

10. Detector

The voltage of the second IF after the third amplification stage is fed to the diode detector (which uses one diode of tube No 15 6Kh6S); the load of the detector is the resistor (No 547). The audio frequency voltage from this resistor is applied through the IF decoupling filter, consisting of resistors (No 546, 549) and capacitors (548, 550), to the grid of first-stage of audio-frequency amplifier.

The schematic diagram of the detector is shown in Fig. 27.

The other half of the diode (Tube No 15) is used to measure the filament voltage (see Section 17 "Currents and voltages control").

11. Audio frequency amplifier

The audio frequency amplifier has three stages. The first stage is comprised of tube 6K3 (Tube No 10, triode connection).

To the plate circuit is connected a audio frequency filter with change-over bands of "5", "2.5" and "0.3" kilocycle per sec.

On the two bands "5" and "2.5" Kc the audio frequency filter consists of two π-section. The main elements of the filter are two chokes with taps (No 575 and 507) and fixed capacitors (Nos. 570, 574, 571, 576, and 572). When switching over from one band to another the inductance values change, while the capacitance values remain constant.

The schematic of the first stage of audio frequency amplifier for the "5" and "2.5" Kc bands are given in Figs. 28 and 29.

The schematic of the first stage of audio frequency amplifier for the "0.3" Kc band is given in Fig. 30. The resonant frequency of the filter, which is determined by the plate circuit characteristics, is between 900-1100 cps. The audio filter band pass is of the order of 300 cps; for tenfold attenuation (from the resonance) the band width is not more than 800 cycle per second. This is attained by presence of:

a) A negative feedback from the grid of the first stage to the grid of second stage through capacitor (No 565) and

b) A filter (choke No 577 and capacitors Nos 571, 574 and 572).

Transition from one band to another is achieved by the audio frequency band switch (No 573).

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The second stage of the audio frequency amplification consists of a rheostat circuit on tube 6K3 (Tube No 11, triode connection). This stage provides the necessary audio frequency voltage for the operation of the final stage of the receiver. The frequency response of the stage, which is determined by the parameter of its plate circuit, does not affect appreciably the overall frequency response of the amplifier. The operating mode of the tube is chosen such as to secure minimum of distortions.

The schematic diagram for the second driver stage is shown in Fig. 31.

The third final stage of the audio amplifier is designed for:

a) With a pair of low impedence headphones of type TA-4 with a rated input of 1.5 volts

b) With a 600-ohm line with a power output of at least 0.5 watts.

The tube operating mode is selected so that the gain characteristic of the output stage, when operating with a pair of headphones, is almost linear up to 4 volts; and when operating with the line, almost linear up to 17 volts.

The nonlinear distortion factor of the entire receiver is no greater than 8% when operating with a 600-ohm line (at 0.5 watts) or when operating with a pair of headphones (at 1.5 volts) in the headset mode. Maximum output of the output stage is on the order of one watt.

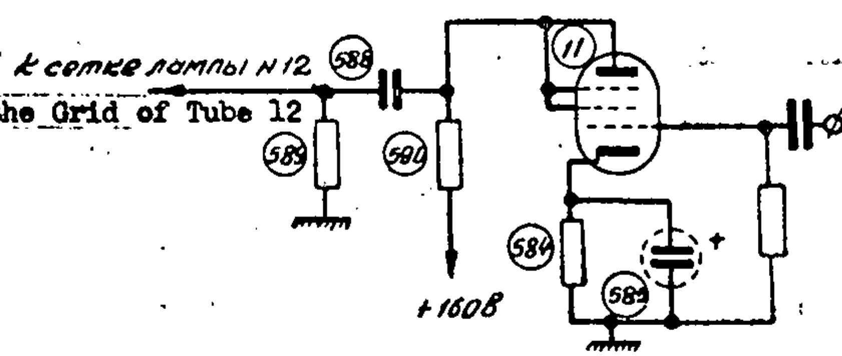

Рис. 31. Схема второго каскада УНЧ

Fig. 31. 2-nd Stage Circuit of AF Amplifier

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The final audio stage utilizes a transformer network with a 6P6S tube (Tube Number 12).

When operating with the line, the output of the stage is taken off the entire secondary winding of the transformer (Number 601).

For connecting the line, there are two terminals with the inscription "Line" on the front panel of the receiver. To prevent possible overloading of headphones and to accentuate the frequency characteristics in the high frequency range in the headset circuit, a voltage reducing resistor and a compensating capacitor are connected (Numbers 373, 375, 372, and 586).

For connecting the headset, a special receptacle with four telephone jacks is provided. For operating the receiver with two headsets, the second pair of headgear is connected in parallel with the first.

Telephone jacks and the "Line" terminal are insulated from the receiver chassis (i.e., they are not grounded).

The main circuit diagram of the third stage of the audio amplifier is shown in Figure 32.

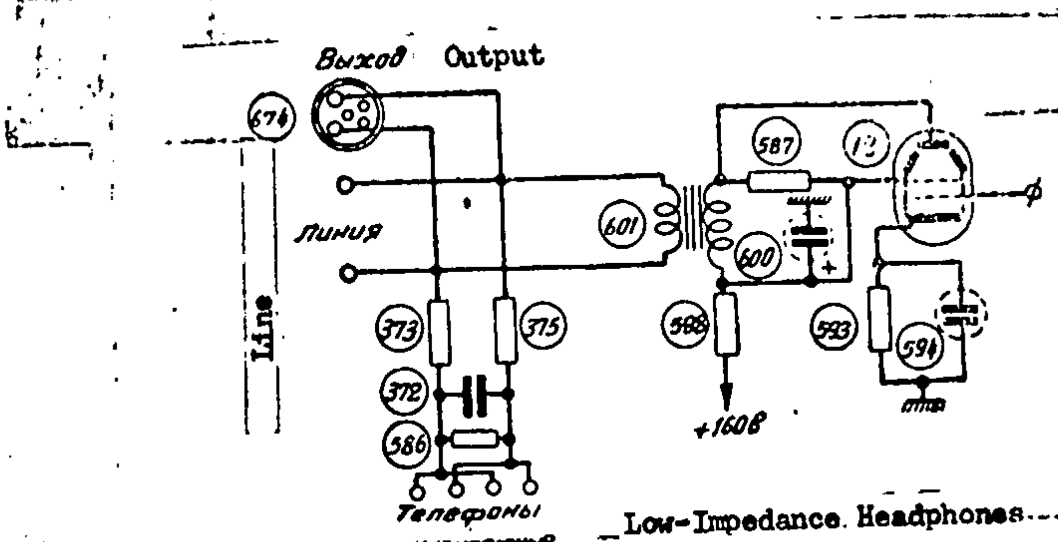

Рис. 32. Схема оконечного каскада УНЧ

Fig. 32. Terminal Stage Circuit of the AF Amplifier

A second "Line" socket (Number 674) is located on the rear wall of the housing.

12. Third Local Osillator

The third local oscillator of the receiver utilizes a tube of type 6KB (Tube Number 14).

For telegraph reception, the voltage from the third local oscillator is applied to the third (final) stage of the second IF amplifier through a coupling capacitor (Number 532).

A variable capacitor (Number 541) is connected to the third local oscillator network making it possible, to a limited extent (+ 3 Kc), to change the frequency of the local oscillator. This also changes the tone of the beat signal of the second IF mixed with the third local oscillator. The beat frequency may be set (with an accuracy of up to 100 c) on the dial linked with the control knob of the third local oscillator variable capacitor and located on the receiver front panel.

A toggle switch (Number 544), which grounds out the local oscillator screen grid circuit, turns off the third local oscillator.

The main circuit diagram of the third local oscillator and its coupling network with the final stage of the second i-f is shown in Figure 33.

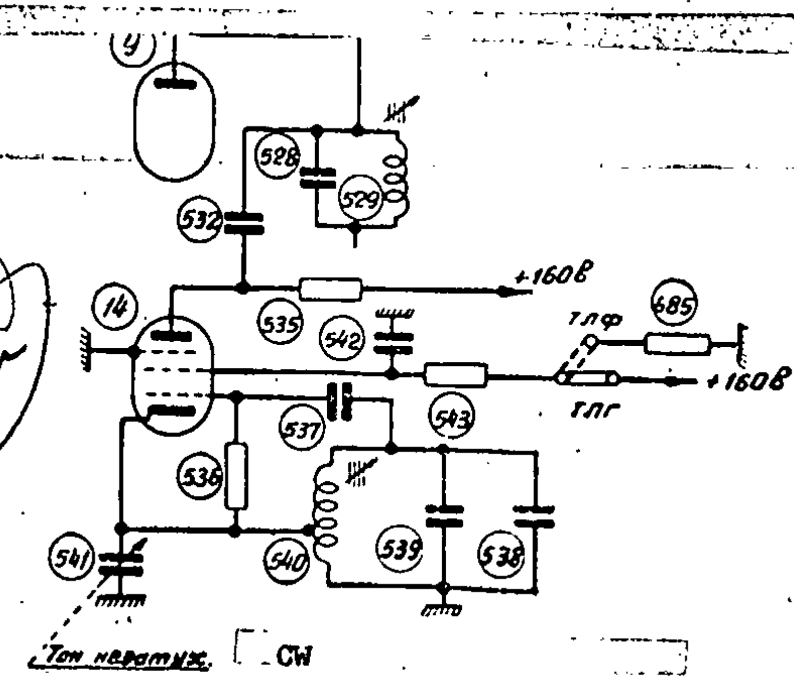

Рис. 33. Схема третьего гетеродина
Fig. 33. Circuit of the Third Local Oscillator.

13. Noise Limiter

A tube of type 6Kh6S (Tube Number 16) is used to limit pulse noise. The use of a circuit with a twin diode provides a top-bottom limiting of the amplitude of the signal pasing through the limiter. The circuit functions on the following principle: The voltage from the input resistor (Number 557) of the limiter is applied to the cathode of the first diode, while the load resistor (Number 560) is connected to the plate circuit of the diode and is used to apply to the plate a small positive voltage to control the limiting threshold; the positive voltage appears across the divider consisting of resistors (Numbers 559 and 564).

The circuit of diode I is completed through resistors 557, 559, and 560; and of diode II, through resistors 558, 559, and 560.

When there is no signal or noise, because of the application of positive voltage to the plates of the tube, the dc component of the plate current, which creates a voltage drop in the resistor (Number 560), will pass through both diodes, as shown in Figure 34. For convenience of explanation, the twin diode tube Number 16 is represented as two separate tubes.

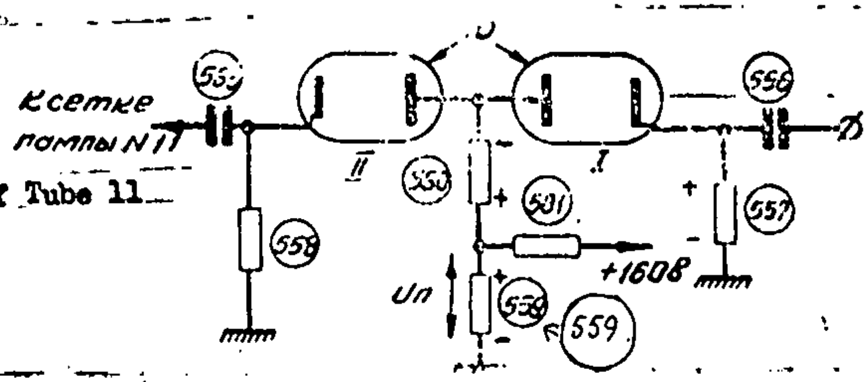

Рис. 34. Упрощенная схема ограничителя

Fig. 31. Simplified Circuit of the Limiter

When a signal appears, in addition to the dc voltage, an ac voltage component will appear in the circuit of diode I because of the drop in the audio frequency voltage across the resistor (Number 557). Under the effect of this voltage, an ac component will be superimposed on the dc current component of diode I.

During the positive half-cycle, over-all voltage between the plate and the cathode of diode I will decrease, and the current through the diode will also decrease; and, vice versa, during the negative half-cycle, when the voltage has a dc component, the current through diode I will increase and will change in relation to the change in the incoming voltage.

A decrease in the current of diode I produces a decrease in the voltage drop across the resistor (Number 560), i.e., it produces a voltage increase in the plate of diode II, which, in turn, produces an increase in the current in the network of diode II. Inversely, an increase in the current in the network of diode I corresponds to a decrease in the current in the network of diode II.

Figure 35-a shows currents through the diodes and wave forms across the resistor (Number 558) for cases when signal amplitude does not exceed the limiting threshold.

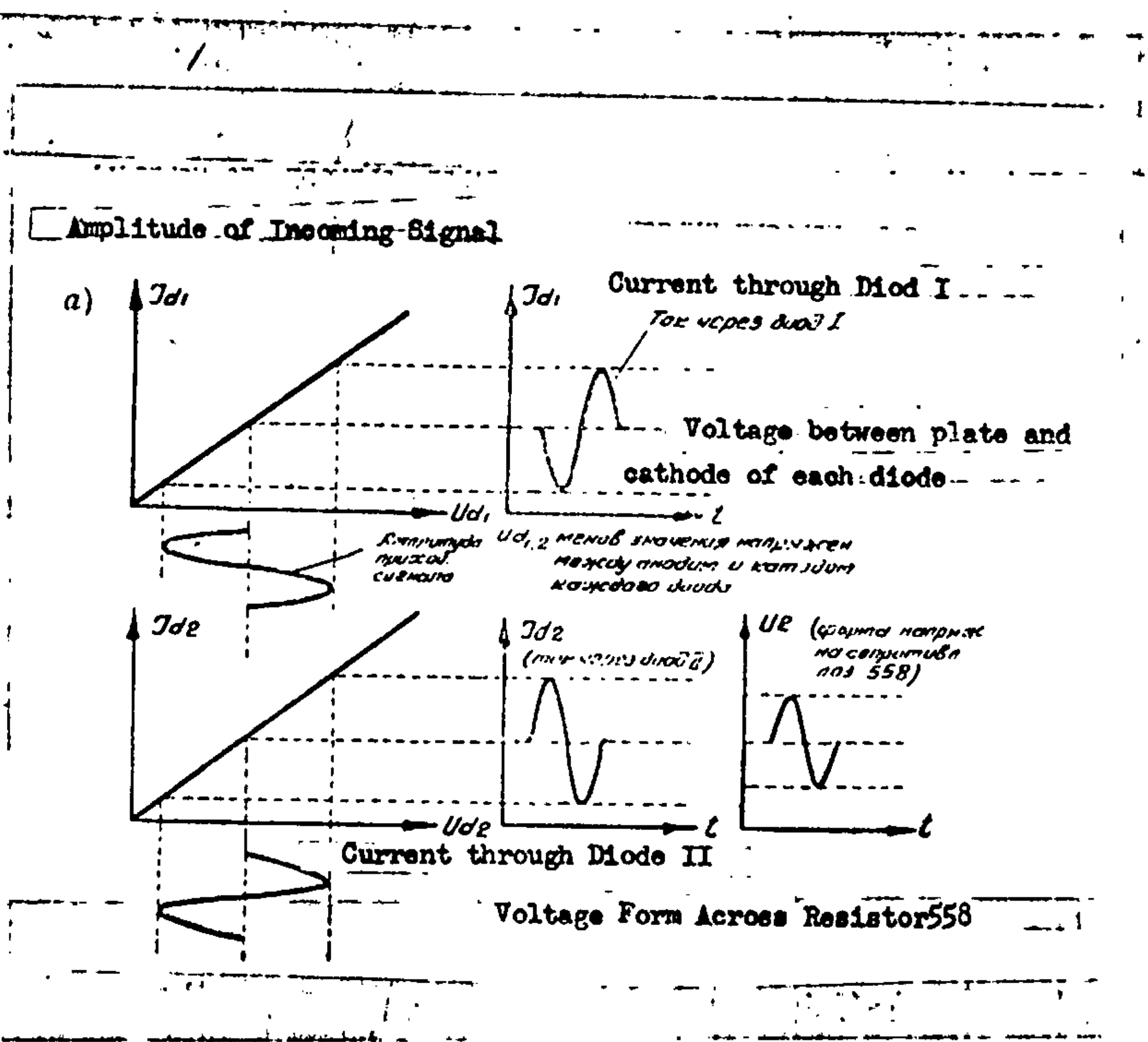

Fig. 35 (a). Diagram explaining the operation of the limiter

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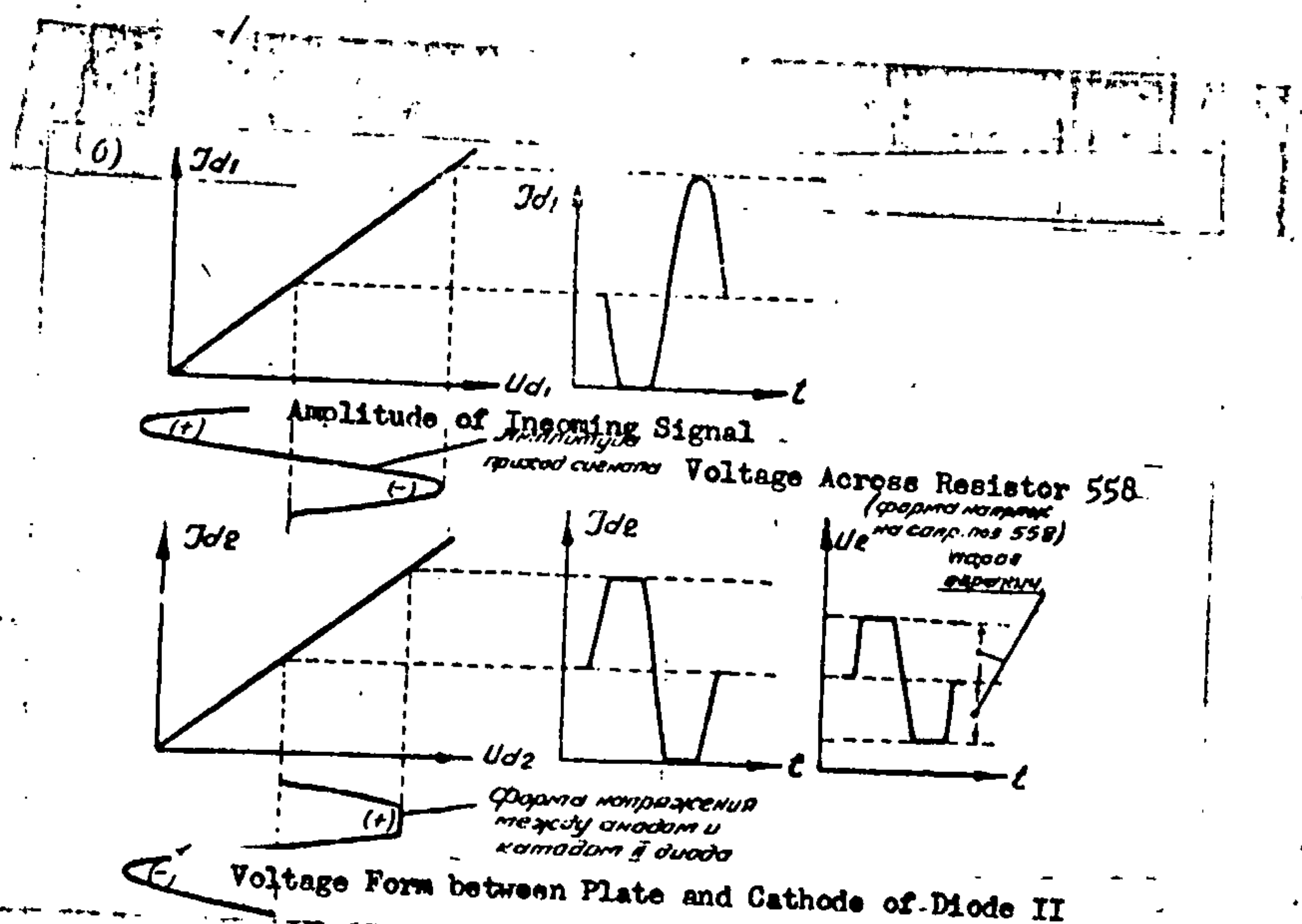

Рис. 35. Графики, поясняющие работу ограничителя

Fig. 35 (b). Diagram explaining the operation of the limiter

S-E-C-R-E-T

If the voltage at the limiter input is greater than the dc voltage in the circuits of the diodes, then the current in the circuit of diode I at first gradually decreases to zero, and then, with any instantaneous voltage of the positive half-cycle exceeding the limiting threshold it will be equal to zero, because the voltage between the plate and cathode will be less than zero.

Current equal to zero in the network of diode I will produce a constant voltage at the plate of diode II, and the current in the network of diode II, upon reaching maximum value, will remain unchanged until the current of diode I is equal to zero.

Constant current in the diode II network will produce a constant voltage drop across the resistor (Number 558), as long as diode I current is equal to zero. This comprises the limiting action of the network -- an increase in the incoming voltage exceeding the limiting threshold does not result in an increase in the outgoing voltage.

With a negative audio frequency half-cycle, the over-all potential on th plate of diode I increases in respect to the cathode, the current through diode I increases, and, when under the effect of the incoming voltage it reaches a value when the voltage drop across the resistor (Number 560) from this current is equal to the constant voltage in the network corresponding to the limiting threshold, the potential of the plate of diode II in respect to its cathode will be equal to zero, the current through this diode will cease to flow, and, consequently, there will be no voltage across the resistor (Number 558). It will appear again after the instantaneous value of the incoming voltage drops sufficiently to open diode II once again. Current change curves and wave forms for large values of outgoing voltage signals or of noise are shown in Figure 35-b.

Thus, the negative half-wave taken off the resistor Number 557 passes without limiting through the first diode, and the positive half-wave is limited in the event that its amplitude exceeds the limiting threshold.

The second diode of tube number 16 is connected in opposition to the first diode, and, on the same principle, limits the negative half-wave. As a result of limiter action, the signal, whose amplitude is less than or equal to the limiting threshold, will pass through both diodes practically unchanged (See Figure 35-a).

When signal amplitude exceeds the limiting threshold, the positive half-wave will be limited by the first diode; and the negative half-wave, by the second diode (See Figure 35-b). As a result, the amplitude of both the positive and negative sides of the signal at the output of the limiter across the resistor (Number 558) will be limited.

With the use of a limiter, the amplification of the useful signal should not exceed the limiting threshold. Then the pulse noise exceeding the limiting threshold will not pass through the limiter circuit, and thus, the noise limiter will operate efficiently only when the pulse noise level is greater than the amplitude of the useful signal.

Limiting takes place in the audio frequency channel. The limiter is connected between the detector of the main channel and the first stage of the audio frequency amplifier.

The limiter is turned on with a toggle switch (Number 555) located on the front panel of the receiver.

14. Automatic Sensitivity Control

The automatic sensitivity control (ASC) consists of an amplifier buffer stage and a detector (See Figure 36).

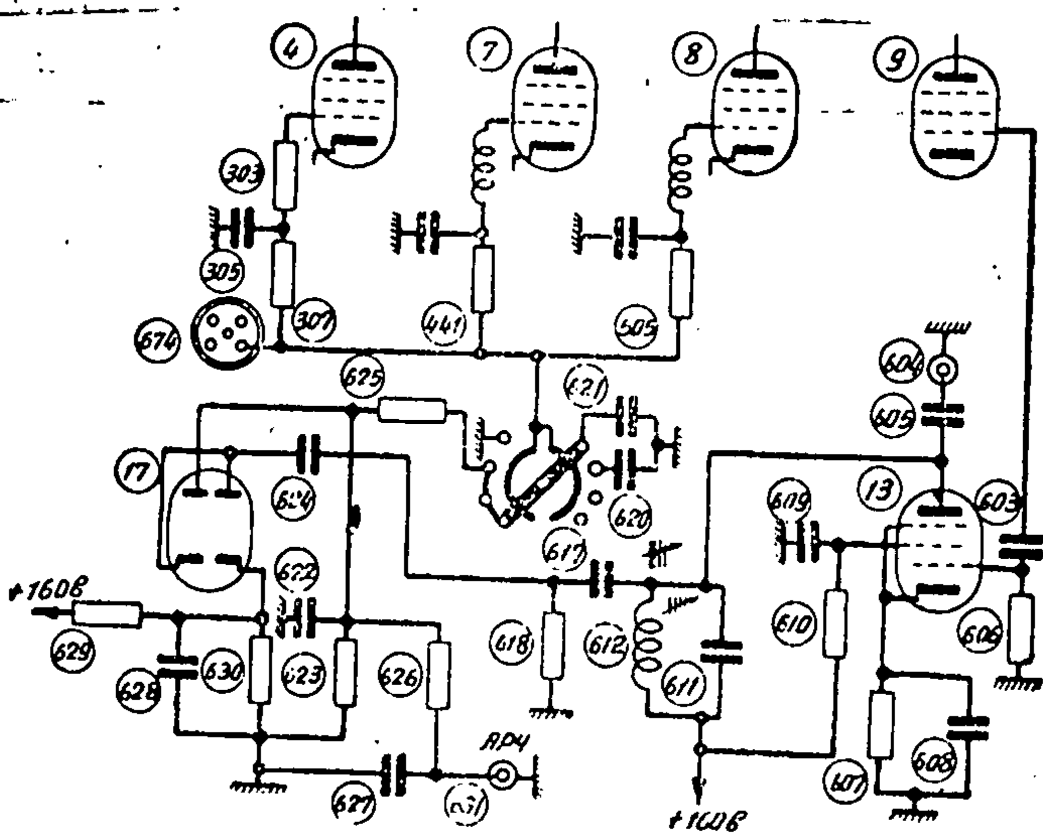

Рис. 36. Схема АРЧ

Fig. 36. Circuit of the ASC

The buffer stage uses a circuit similar to the circuit of the second or of the third stage of the second i-f amplifier and provides the necessary amplification of the second i-f before the ASC detector.

The ASC buffer stage also serves as the i-f output stage. This is accomplished by applying the plate voltage from the buffer stage network through a capacitor (Number 605) to the i-f output socket (Number 604).

The ASC detector operates at a doubled rectified voltage.

Doubling is accomplished as follows:

At the instant the positive half-wave is applied to the detector input, the voltage across the right diode charges the capacitor (Number 624). The left diode is shut, and there is no rectified voltage on the load (Number 623). At the instant of arrival of the negative half-wave, the voltage operates the left diode where the voltage is nearly double (because of the summing of the applied and of the stored-in-the-capacotor 624 voltages); thus, the value of the ASC voltage rectified by the detector is also doubled.

Although the current flows through each diode only part of the time, the ASC voltage applied to the resistor (Number 623) is practically constant because of the presence of the capacitor (Number 622) which cannot charge and discharge rapidly. This makes it possible to have normal ASC operation with relatively small i-f voltages in the buffer stage network.

A "delay" is effected in the cathode circuit of the ASC detector by applying a positive voltage to the cathode of the diode. This voltage appears on the divider consisting of resistors (Numbers 629 and 630). The diode will be shut and the ASC will not operate until the network voltage exceeds the delay voltage.

Thus, delay and amplification is introduced in the ASC system of the receiver.

The rectified voltage is applied to the control grids of the regulator tubes through a variable time-constant network consisting of the resistor (Number 625) and capacitors (Numbers 620 and 621).

Switching these capacitors varies the time-constant of operation of the ASC network (0.05 sec., 0.1 sec., and 1 sec.).

For combining ASC action of several receivers (for double or triple reception with diversity (spaced antennas), the voltage from the load (Number 265) of the detector is fed to a special ASC socket (Number 6310) located on the front panel of the receiver.

ASC operation is turned off by breaking the ASC voltage supply circuit by grounding out resistors (Numbers 307, 441, and 505).

Figure 36 shows the main ASC circuit diagram, regulator tubes, and the ASC switching-on circuit.

15. Manual Gain Controls

R-f gain may be controlled manually in the cathode circuit of the amplifier of the first i-f (tube number 4), in the cathode circuit of the first amplifier of the second i-f (tube Number 7), and in the cathode circuits of the second and third amplifiers of the second i-f (tubes Numbers 8 and 9) by means of the rheostat Number 360 (See the main circuit diagram and Figure 37).

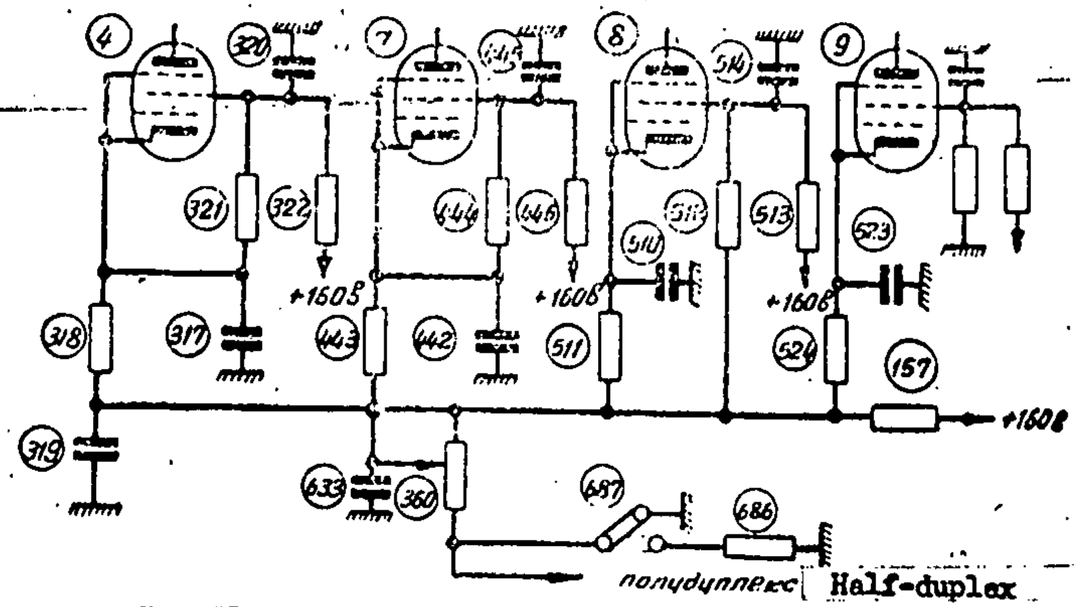

Рис. 37. Схема ручной регулировки усиления по в.ч.

Fig. 37. Circuit for Manual RF Gain Control

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During the operation of the half-duplex in the cathode circuits of tubes Numbers 4, 7, 8, and 9, an additional resistor (Number 686) is connected to shut off the receiver when the transmitter is on the air.

A potentiometer (Number 564) in the grid circuit of the first audio amplifier tube is used to control volume. The schematic volume-control circuit diagram is shown in Figure 38.

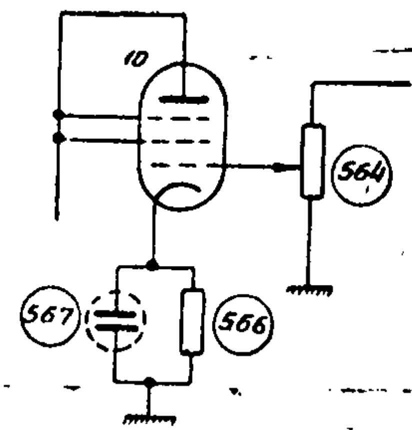

Fig. 38. Circuit for Manual AFGain Control

16. Power Supply Circuits

The 160-volt plate voltage and the 12.6 volt filament voltage are fed to the power supply outlet located on the common housing of the receiver.

Through a systems of adapter plugs, the voltage is fed to the main power switch of the receiver (Numbers 646 and 647).

A safety fuse (Number 645) and a filter consisting of chokes (Numbers 635 and 636) and capacitors (Numbers 637, 638, and 639), are connected in the plate voltage circuit; the voltage is then applied to the tubes of the receiver.

The screen grid voltage of second local oscillator is regulated with a neon voltage regulator (Tube Number 19). A filter, consisting of chokes (Numbers 640 and 641) and capacitors (Numbers 644, 643, and 642), is connected to the filament circuit.

To reduce ac background heard at the receiver output, a double shield is used on supply filters. Tube filament circuits of the receiver are connected in series by pairs, except the r-f amplifier tube (tube Number 1) and the noise limiter tube (Tube Number 16) which have separate additional resistors (Numbers 363 and 654).

The filament current of tube Number 12 (6P6S) and of tube Number 3 (6Zh4) is greater than the filament current of tubes types 6D3 and 6A7; therefore, to equalize the current in the series circuit of these tubes and to provide proper filament heating, resistors (Numbers 653 and 374) are connected in parallel with the filament of tube Number 11 paired with tube Number 12 and in parallel with the filament of tube Number 2 paired with tube 3.

For additional filtring, chokes (Numbers 364, 365, and 366) are installed in filament circuits of the r-f amplifier, first and second local oscillator, first i-f , first and second mixer, and calibrator tubes.

Together with plate and filament voltages, power supply cables are wired to the power supply receptacle (at terminals 1 and 2, see the main circuit diagram) and are connected when the receiver power is turned on. This turns on and off the rectifier connected in series in the receiver.

17. Testing Currents and Voltages

On the front panel of the receiver, there is meter to test the plate and filament supply voltages and currents. For normal values of tube current and voltage, the meter should read in the red section of the dial (when the r-f amplifier control knob is set at maximum, when the audio frequency amplifier control knob is set at minimum, and when the crystal calibrator is turned on).

The meter is connected, through a test switch (Number 656) to shunt resistors in the power supply circuit of the tubes to be checked (or in the circuit of an additional resistor for measuring voltage).

Numbers on the dial of the test switch correspond to receiver tubes numbers in the schematic circuit diagram.

Shunting resistors are variable. This makes it possible to obtain the same meter reading for all current and voltage measurements.

Note: Additional resistors are connected in parallel or in series with the variable shunt resistors in some circuits for testing current and voltage. This is done to facilitate the setting of the proper reading on the meter.

As an example, Figure 39 shows the position of the test switch for measuring the current of the audio output stage tube (Tube number 12).

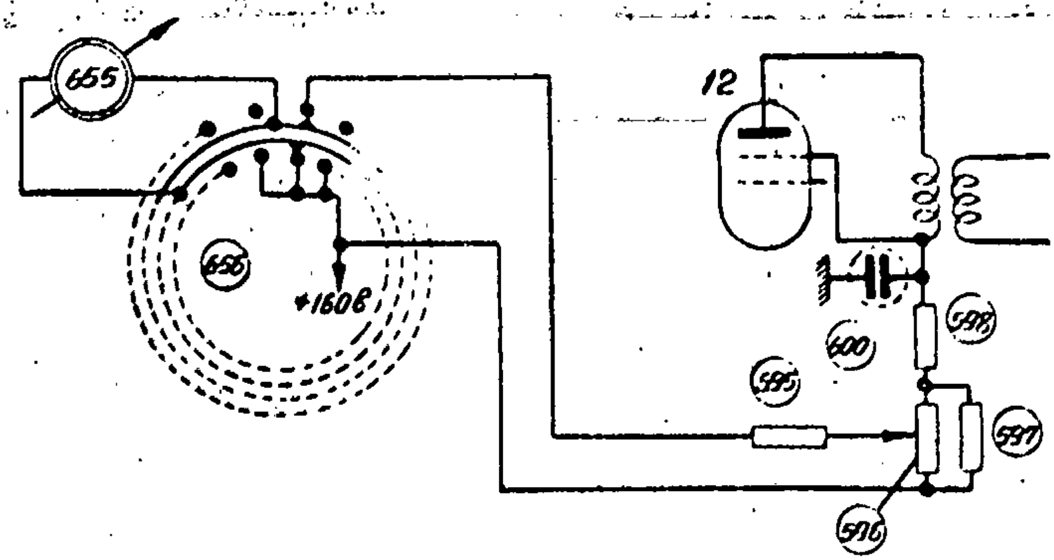

Рис. 39. Схема контрольного переключателя при измерении тока лампы оконечного каскада н. ч.

Fig. 39. Control-Switch Circuit for Current Measurement of The AF Terminal-Stage Tube

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For testing the filament, a 6Kh6S tube (the second diode of tube Number 15) is used as a half-wave rectifier. The porality of this rectifier, the additional resistor (Number 554), and the pulse-smoothing capacitor (Number 552) are selected to obtain identical reading on the test meter for both ac and dc filament supply voltages of the receiver.

The illumination of the coarse and optical dials of the receiver is taken off the filament circuit. Supplementary resistors (Numbers 361 and 362) lowering the voltage applied to the dial lamps are connected in series with the lamps to prolong their life-time (by operating them at a lower voltage).

18. Rectifier

For supplying power to the receiver solely from an ac power source, a rectifier with a ferro-resonant regulation of voltage is used in the receiver. The rectifier circuit consists of a voltage regulator and a rectifier.

The assembly which regulates the voltage of the rectifier consists of a ferro-resonant transformer (Number 1) and a capacitor (Number 7) which is connected to one of the transformers windings (Taps 30 and 36) and which forms, together with the winding, a resonance circuit (See the rectifier circuit diagram).

The magnetic circuit of the ferro-transformer has two cores of different cross sections. The supply line winding (Taps 21-9-10) and compensation windings (Taps 22-25; 26-29; 1-4; and 5-8) are located on the core with the large cross section. The circuit winding (Taps 30-36) and operating (output) windings (taps 31-35; 35-40; 11-14; and 15-20) are located on the core with the small cross section.

The voltage across the capacitor (number 7) varies in proportion to the amount of current flowing throught it and is opposite in phase to the voltage across the circuit winding, which, together with the magnetic circuit, forms the choke.

When the circuit voltage rises, the voltage across the choke, up to saturation, varies directly with the value of the current; however, after saturation, as the current rises, the voltage increase will be small even though the current rise is significant.

In figure 40, curves are shown for the relation of the change in voltage across the circuit winding (across the choke) and across the capacitor (number 7) to the amount of current flowing through the winding.

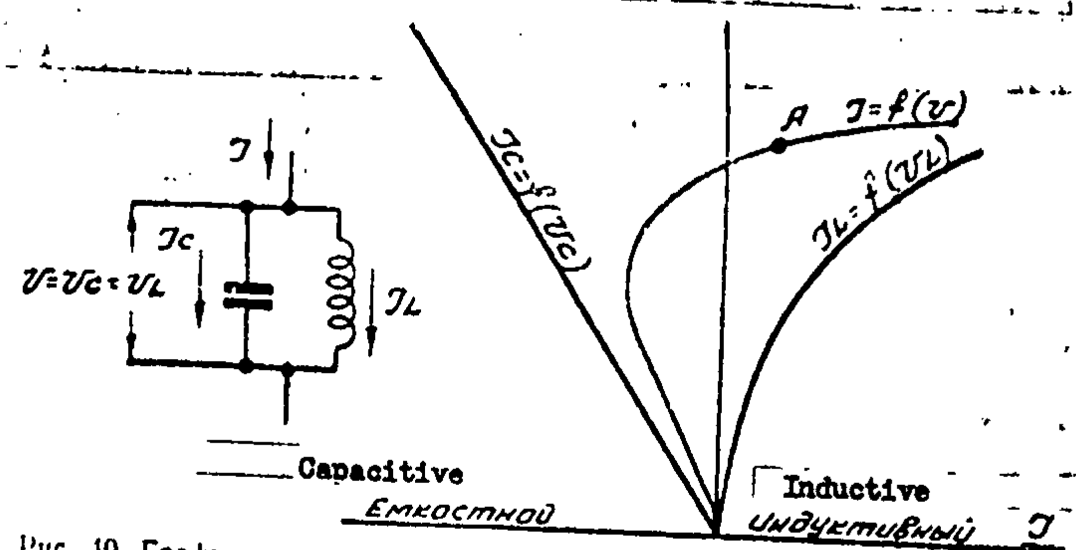

Рис. 40. График, поясняющий работу феррорезонансного стабилизатора напряжения

Fig. 40. Graph Illustrating Performance of Ferroresonance Voltage Regulator

The current in the unbifurcated portion of the network is the geometric sum of the currents in both circuits as is shown in figure 40. The resultant curve shows that with small voltages, the over-all current is of a capacitive nature, and, as the voltage increases, the current increases also; then the current begins to decrease and approach zero.

which is the resonance point of the currents. At this point, currents across the capacitor and across the choke are equal and opposite in phase; and, consequently, there is no current in the over-all circuit.

As the voltage continues to rise, the current again begins to increase, but will now be of an inductive nature; consequently, a phase reversal will take place at the point of resonance.

The operative range on the curve used in the regulator is beyond the point of resonance, where small changes in applied voltages correspond to significant changes in the reactive current.

This discussion was premised on the assumption that the network is ideal, i.e., there are no copper or magnetic losses.

In an actual circuit, current at instance of resonance will not be equal to zero, and the curve will shift somewhat to the right. The described regulative process takes place only until the supply voltage becomes too small to produce a state of saturation in the choke with the small cross-section core, when the regulative process breakes down and the outgoing voltage drops sharply.

All output windings are located on the small cross-section core of the rectifier ferro-transformer; these are the rectifier kenotron filament supply, receiver filament circuit supply, and the step-up winding of the plate rectifier, half of which (taps 31-35) is combined with the circuit winding of the regulator (taps 30-36). Each output (operating) winding is connected opposite in phase with its compensating winding.

Operating winding I (the plate winding). Compensating winding III (taps 26-29) corresponds to taps 31-35. Compensating winddging II (taps 22-25) corresponds to taps 35-40. Tap 35 is the midpoint of the plate winding.

Operating winding II (kenotron filament). Compensating winding IV (taps 1-4) corresponds to taps 11-14.

Operating winding III (receiver tube filament). Compensating winding V (taps 3-8) corresponds to taps 15-20.

When voltage is applied to the power supply winding I of the ferrite transformer (taps 21-9-10), the resultant magnetic flux will be insufficient to saturate a core of a large cross section, while a core of a small cross section will be greatly saturated.

When the power supply voltage changes, when it rises for example, magnetic flux and the voltage drop in winding I (the power supply winding) will increase, because reactive power in the circuit rises. As a result, the power supply voltage increase, in the main, will be offset in the power supply winding.

Besides, in as much as the output voltage is equal to the difference between voltages at the output of windings and the corresponding compensating winding (because these voltages are opposite in phase), the over-all volatage applied to the loads will vary even within smaller limit.

When the power supply voltage drops, small fluctuations of output voltages are also compensated by compensating winding voltages.

Loads of the stabilizer are as follows:

1. The rectifier operating on a full-wave rectification network, the main components of which are the kenotron 5Ts4S (number 6) and a smoothing filter consisting of a choke (number 2) and two capacitors (numbers 8 and 9).

2. The kenotron filament circuit (number 6).

3. Receiver tube filament circuits.

The rectifier supplies the receiver with a rated plate voltage of 160 ±10 volts and a filament voltage of 13.1 ±0.5 volts (at the receiver input).

The regulated rectifier provides stability of filament and plate voltages within ±3% when the circuit power supply voltage fluctuates ±15% (at 50 cycles), i.e., for a rated power supply line voltage of 127 volts, fluctuation limits are 108-146 volts; and for a rated power supply line voltage of 220 volts, fluctuation limits are 187-253 volts.

The power supply voltage is controlled with a switch (number 14).

When operating from a regulator, the dependency of voltage stability on the power supply frequency must be taken into account. A one-precent deviation in the power supply frequency produces a 1.5-2-percent fluctuation in the regulated voltage.

When operating with a power supply with unregulated frequency, the regulator may be turned off by means of the regulator switch (number 16). In this case, the ferrite transformer will function as an ordinary transformer and the output voltages are tapped directly from the secondary windings located on the core with the smaller cross section as follows:

-- kenotron filament from winding II, taps 11 and 12;

-- receiver tube filaments from winding III, taps 16 and 15;

-- plate winding from winding I, taps 34, 35, and 37.

The power supply voltage of the receiver plate and filament circuits are fed to the power supply socket (number 17) located on the front panet of the rectifier, and to the terminal (number 18) located on the back wall of the rectifier (for supplying power to auxialiary equipment).

In addition, terminals of one pole of the power supply voltage are connected in parallel to the circuit power switch (number 15) and are short circuited when receiver power is turned on.

A line filter consisting of two chokes (number 3 and 4) and two capacitors (numbers 10 and 11) is connected at the rectifier input.

A socket (number 19) is used to connect the 127-volt or the 220-volt power supply to the rectifier.

19. Antenna Matching Transformer

When operating with a symmetrical antenna with an active equivalent of 200 ohms, and when antenna symmetry is disturbed because of mismatch in the input stage of the receiver, the antenna matching transformer may be used.

The antenna matching transformer raises the degree of matching of theinput stage of the receiver. The mismatch factor when using the matching transformer is no greater than 3.3%

When using the matching transformer with an active antenna equivalent of 200 ohms, the sensitivity of the receiver is somewhat lower than the sensitivity of the receiver operating on the same frequencies without the transformer but with an antenna equivalent of 100 ohms.

The electrical circuit diagram of the antenna matching transformer is shown in figure 41.

The antenna matching transformer is built into a separate unit. Figure 42 shows the exterior view of the unit with the side panel removed to show the antenna transformer.

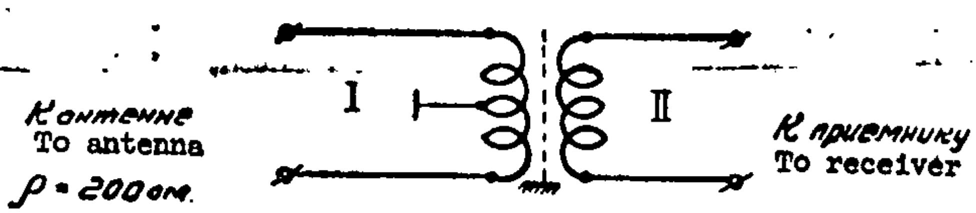

Рис. 41. Схема антенного симметрирующего трансформатора.
Fig. 41. Circuit of Antenna Matching Transformer

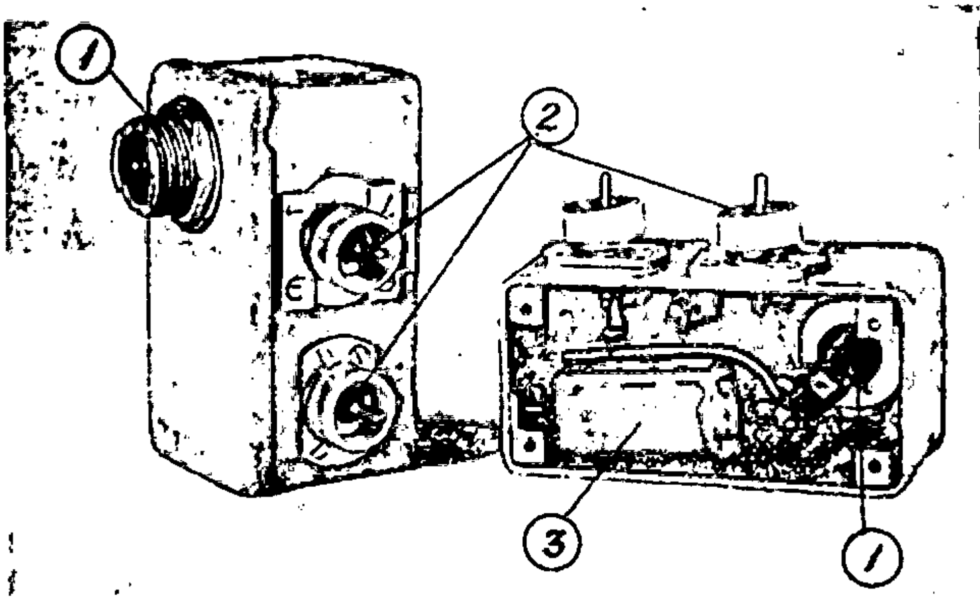

Fig. 42 General View of the Adapter with the Antenna Matching Transformer with the Cover Removed

[Numbered paragraphs 1-3 correspond to numbers on figure 42.]

1. Two-conductor socket for connecting the symmetrical antenna to the transformer to be used with the balanced cable RD-16 (if necessary, two nonbalanced cables of type RK-2 may be used). The primary winding of the transformer is connected to this socket.

2. Two single-conductor sockets for connecting the transformer to the receiver. The secondary transformer winding is connected to the sockets.

3. Antenna matching transformer shield.

The transformer has a ferrite core. The primary winding is grounded at midpoint. A copper foil shield is inserted between windings to eliminate stray capacitive coupling. The transformer itself is placed in a hermetically sealed dopper shield.

The antenna transformer may be connected to the receiver input without the use of auxiliary cables. This makes it possible to have uninterrupted shielding of the receiver, transformer, and antenna cable sheathing.

When operating with the antenna matching transformer, the antenna selector switch must be placed in the "Balanced Feeder" position.

A view of the receiver to which the antenna transformer has b 50X1-HUM connected is given in figure 43.

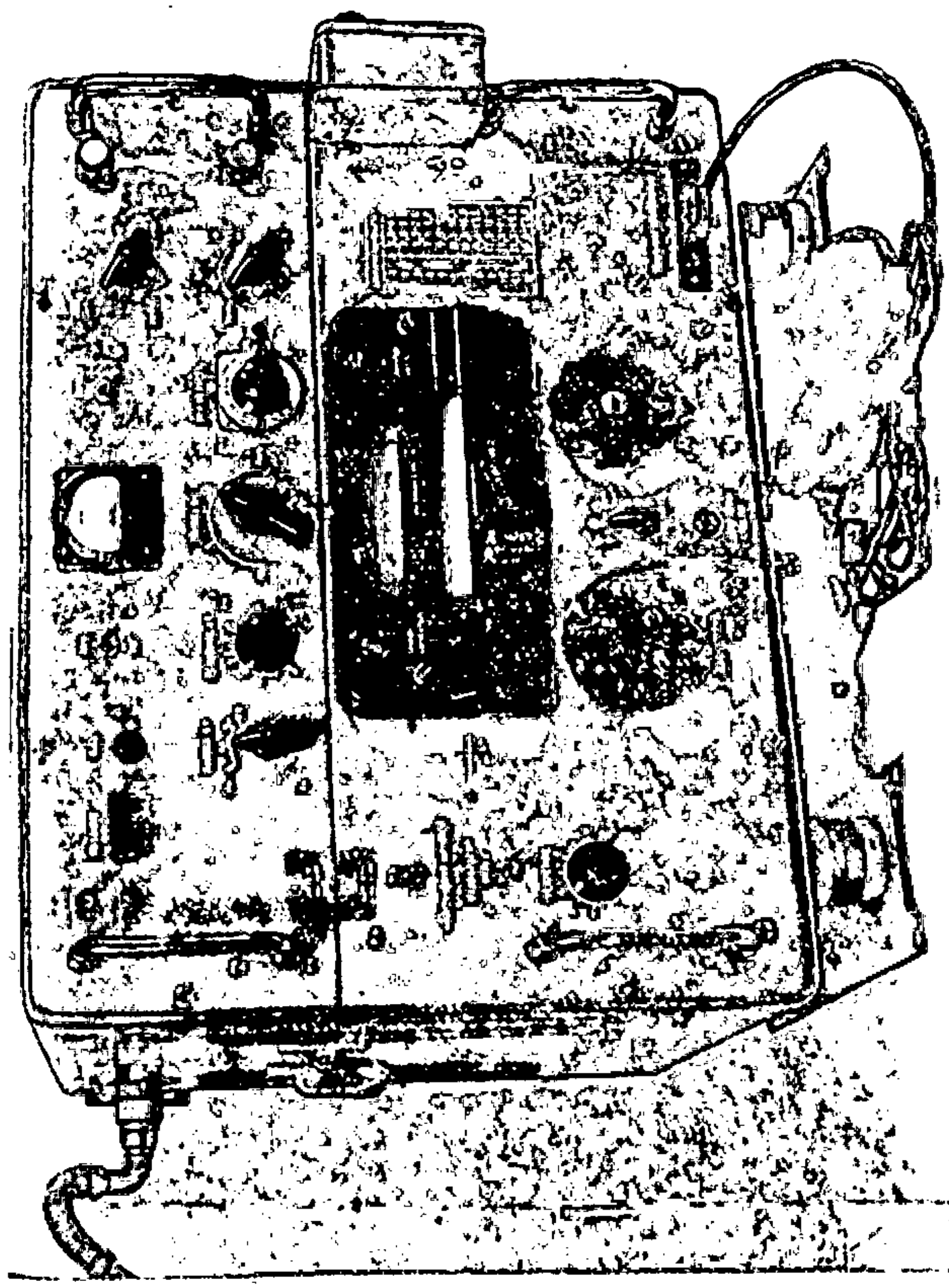

Fig. 43 General View of the Receiver with the Antenna Matching Transformer Connected

IV. DESCRIPTION AND DESIGN OF THE MAIN SECTION AND COMPONENTS OF THE RECEIVER

1. Variable Capacitor Banks

One four-gang and one three-gang variable capacitors of similar construction are used in the receiver.

To achieve high stability during operation and a low temperature coefficient, capacitors are assembled on large frames cast of silumin. Rotor and stator sections are mounted on polished porcelain shafts. The rotor shaft is mounted on roller bearings by means of conical bushings. One of the bearings is rigidly secured to the frame, and the other is fastened to the frame with a flexible diaphragm which compensates for the difference in variations in the rotor shaft and the frame when temperatures changes.

Similarly, the shaft mounting of the stator section is rigidly secured to the frame on one side, while the other side of the shafts is held by a spring from above. In this manner, the relative position of the rotor and the stator is preserved during fluctuations in temperature.

The rotor and stator sections are made of aluminum plates 0.7 mm thick. The gap between plates is equal to 9.7 mm and is provided by aluminum spacers. Plates and spacers are alternately placed on a duralumin sleeve and are tightened with a special nut. On the sleeve of the rotor section there are brass nuts with a special slit for holding the bronze current pick-up contact spring.

2. Sub-range Switch

The sub-range switch is in the form of a drum rotating on roller bearings. It consists of four sections (cast of silumin) mounted on a common shaft. The sections are insulated from each other and from the shaft. On the 12 sides of each section, there are aluminum plates on which coils, trimmers, small circuit components, and contacts are mounted.

All r-f coils are wound on frames of high frequency plastic with a tunable-inductance carbonyl core.

Trimmers used are of cylindrical air type on a ceramic base.

For sub-range switching, the drum is rotated about its shaft through the proper angle and the desired sub-range is connected to the contact system attached to the plate of the r-f unit.

A system of lift contacts is used in the device.

To ensure good contacts, gold wire is soldered to contact surfaces.

When switching from one sub-range to the adjacent sub-range, the drum is rotated through 30°. The sub-range is selected by rotating the knob. When switching from one sub-range to another, the contact springs are raised by means of 1:12 reduction gear; then, the drum is released from the catch (at the same time, the spring is released and the drum turns freely); after the drum has been turned through 30°, it is latched; the contacts are then lowered and tension is applied (contact tension is 120-150 g).

3. Dials

As indicated earlier, the receiver has two dials -- a coarse tuning dial and an optical fine tuning dial. Description of the construction of these dials follows.

A. Coarse Tuning Dial

This dial consists to two drums with a small diameter and twelve facets.

Dial marking of the coarse dial drum is on the side facets made of clear plastic.

Framing of the dial is such that when the coarse dial is turned, only the operating sub-range is seen in the opening of the frame.

The movement of the dial is connected with sub-range switch by means of a joint, sprocket, and a single-thread worm gear disc.

A 30° rotation of the sub-range (i.e., through one sub-range) will rotate the coarse tuning dial also through 30°.

The coarse tuning dial pointer is moved by means of a cable which, when the capacitor is rotated, is wound onto a disk connected to the variable capacitor.

Two 6.3-volt, 0.28-ampere lamps illuminate the dial and are located directly under the dial frame.

B. Optical Dial

The optical dial consists of the illumination lamp A-25 (12X6), a two-lense condenser, the glass disc of the dial itself, a three-lense micro-objective, and a ground glass screen.

The main diagram of the optical system is shown in figure 44.

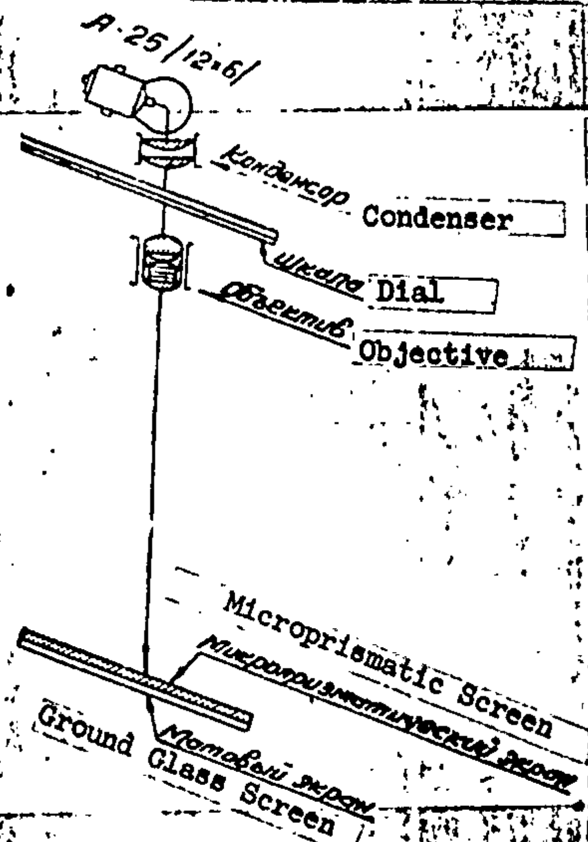

Рис. 44. Схема оптической системы

Fig. 44. Diagram of Optical System

NO FOREIGN DISSEM

The illumination lamp is mounted on a special cast base attached to chassis of the r-f unit. The bulb base is inserted inside a ball socket which is held by a clip.

This system makes it possible to place and to fasten the bulb in the most advantageous position for the illumination of the dial.

The two-lense condenser is located directly by the illumination lamp and concentrates the light through the disc of the dial and through the objective.

Condenser lenses are mounted in a rim to the base of which a bracket is rigidly connected. The bracket is then fastened to the top of capacitor of the second local oscillator of the receiver.

The glass disc is made of polished optical glass on which an optical scale is imprinted by microphotographic means. Before the optical scale is imprinted the surface of the disc facing the objective is covered with a light sensitive colloidal emulsion on which numbers and dial divisions are then photographically reproduced. The disc is fastened by a removable coupling directly to the shaft of the capacitor of the second local oscillator.

The objective is mounted in a brass rim and is fastened to the upper cover of the capacitor of the second local oscillator. The screen onto which numbers and divisions of the optical dial are projected has two main parts -- a microprismatic screen made of clear plastic and a ground glass screen.

The microprismatic screen has a surface cut into small prisms with a 22.5^{o} angle of refraction. This screen refracts the direction of maximum illumination of the dial and makes it perpendicular to the front panel of the receiver (the objective of the dial in the receiver is placed 22.5^{o} to the perpendicular to the front panel of the receiver, thus, without the microprismatic screen, maximum illumination of the optical dial would be shifted 22.5^{o} to the left of the perpendicular to viewing angle of the optical dial, i.e., maximum brightness of the optical scale would appear only if viewed from the right side).

A fine grain ground glass screen, which increases image contrast, is placed on the microprismatic screen. A reading hairline is located on the ground glass screen.

The screen of the optical dial may be moved to the right or to the left from the center position with a ratchet gear assembly connected to it. The screen may be moved with the help of a slotted pin brought out on the front panel through an opening in the frame of the dial (with the inscription "Dial Correction").

To lock the indicator hairline in a given position, a lock is provided also in the form of a slotted pin. The lock can also be controlled from the front panel through the frame opening (with the inscription "Lock").

The dial markings of all sub-ranges exactly coincide with one another, therefore, the fine reading dial becomes an electrical vernier to the coarse dial and is used for all sub-ranges. The exception is the second sub-range, the reading marks on which are exactly 50 Kc away from the marks of all the other dials. Because of this, the optical dial has two sets of numbers, and a shutter is placed in front of the projective screen to mask either the top or the bottom row of numbers.

The shutter is synchronized with the sub-range selector switch in such a manner so that the lower part of the dial is open on all sub-ranges except the second.

When the second sub-range is selected the shutter is lowered and the upper row of numbers (corresponding to the second sub-range) are revealed and the lower row is concealed.

On the optical dial of the second sub-range between two markings which correspond to 4 Mc, there is a row of dots.

This indicates the nonoperative part of the sub-range dial used for switching crystals of the first local oscillator of the receiver. A dead spot in the receiver band is avoided because one section of the dial of the second sub-range ends at 4 Mc, while the next begins with 4 Mc.

Frequency overlap at each limit is at least 20 Mc.

Several examples are given below to illustrate tuning and reading the frequency on the receiver tuning dial.

1. For reception on 5,000 Kc, proceed as follows:

a) Using the sub-range switch, select the second sub-range

b) By rotating the receiver tuning control set the coarse tuning dial pointer opposite the mark on the dial with the number 5.0

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c) With the same knob, make the fine setting of the frequency on the optical dial by making the 00 mark coincide with the reading indicator on the ground glass screen.

A view of the dial of a receiver tuned to 5,000 Kc is given in Figure 45.

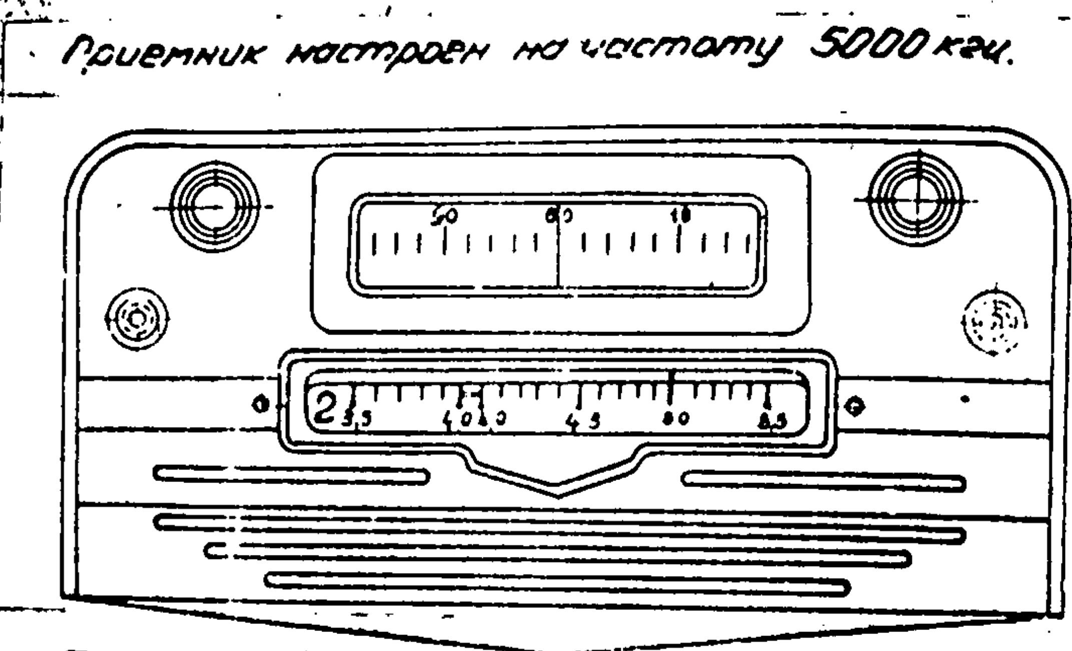

Fig. 45 View of the Receiver Dial Tuned to 5,000 Kc

2. For reception on 6,700 Kc proceed as follows:

a) With the sub-range switch, select the third sub-range.

b) By rotating the receiver tuning control, set the coarse tuning dial pointer opposite the mark on the dial with the number 6.7.

c) With the same knob, make the fine setting of the frequency on the optical dial by making the 00 mark coincide with the reading indicator on the ground glass screen.

A view of the dial of a receiver tuned to 6,700 Kc is shown in Figure 46.

Приемник настроен на частоту 6700 кгц.

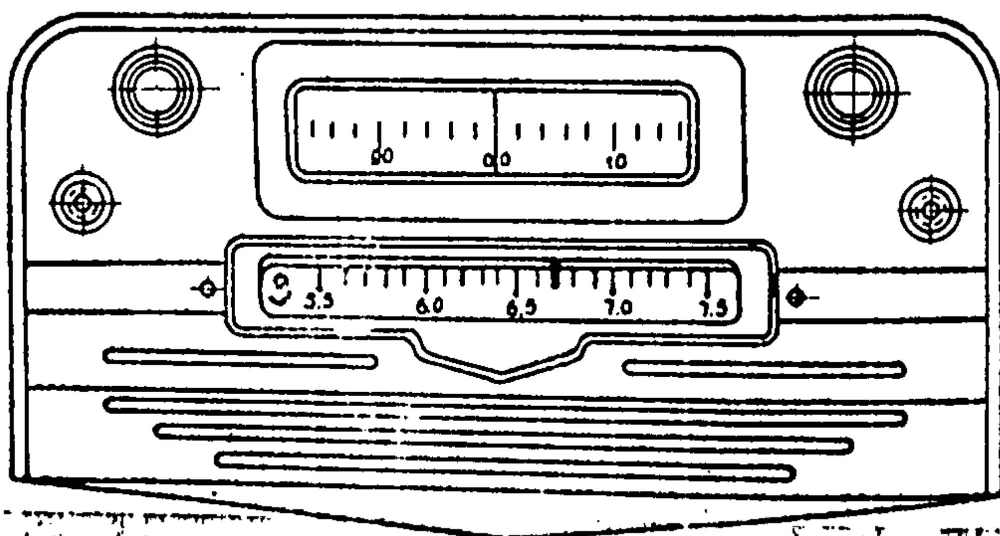

Fig. 46 View of the Receiver Dial Tuned to 6,700 Kc

S-E-C-R-E-T

3. For reception on 16,328 Kc proceed as follows:

a) With the sub-range switch, select the eighth sub-range.

b) By rotating the receiver tuning control, set the coarse tuning pointer opposite the mark on the dial with the number 16.3.

c) With the same knob, make the fine setting of the frequency on the optical dial by making the 28 mark coincide with the reading indicator on the ground glass screen.

A view of the dial of a receiver tuned to 16,328 Kc is shown in Figure 47.

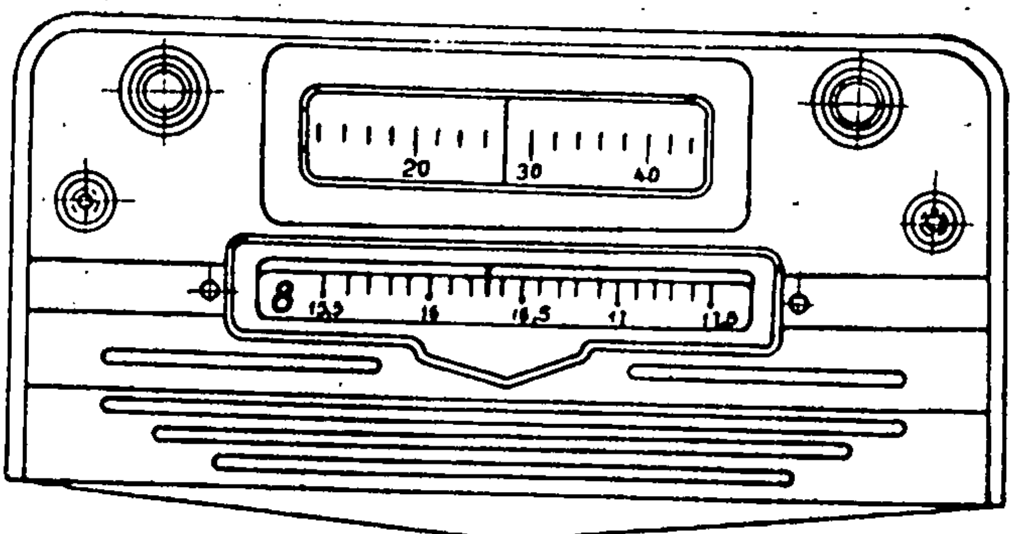

Fig. 47 View of the Receiver Dial Tuned to 16,328 Kc

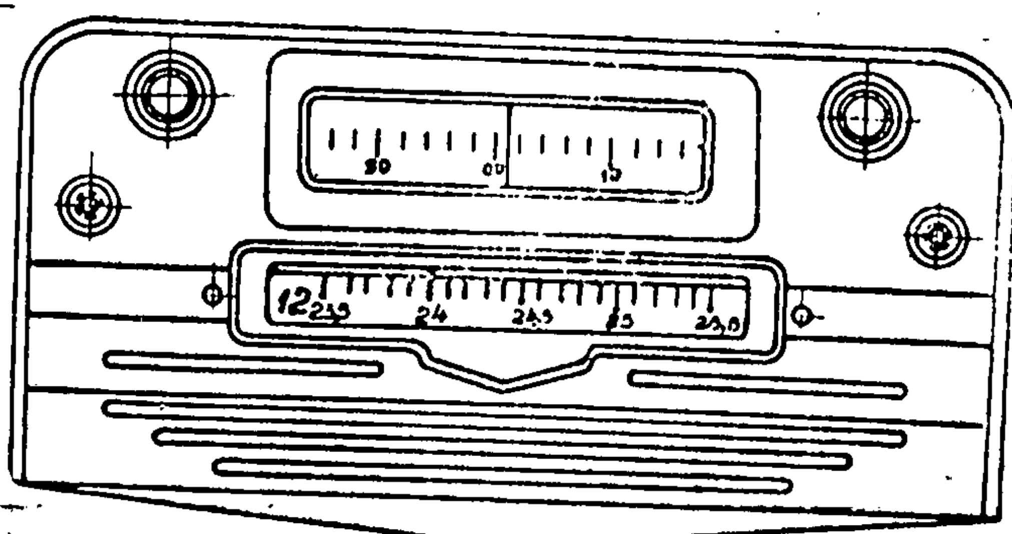

Fig. 48 View of the Receiver Dial Tuned to 24,001 Kc

Figure 49 shows the dial of a receiver tuned to 23,997 Kc.

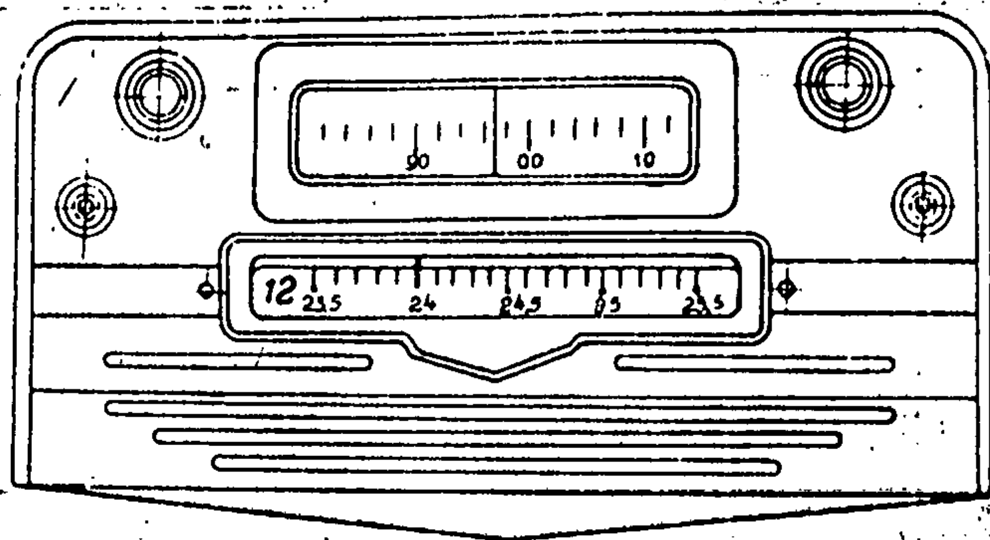

Fig. 49 View of the Receiver Dial Tuned to 23,997 Kc

4. High-Selectivity Filter Circuits

High selectivity filter circuits have complete shielding of their main and most important circuit components which stabilize the performance of the filter.

Circuit coils are wound with strand wire on carbonyl H-shaped cores covered with styrene varnish. After the coils are wound, they are thoroughly dried, then covered with styrene varnish and dried once more. Each coil is mounted on a special base under which circuit capacitors are installed.

The entire unit is mounted on a red copper bottom into which glass or ceramic bushing insulators are bonded. Through the insulators go leads to which, on the inside of the bottom, circuit wiring (coils, capacitors) is run. The entire network is covered with a common red copper shield which has a small opening in the upper corner.

The shield and the bottom are hermetically soldered at all seams. The network is then heated and dried. The opening on top is soldered when the unit is heated and dried for the last time.

The filter network is fastened to the chassis with nuts driven onto eight screws welded to the bottom of the unit.

V. INSTRUCTION FOR USE, MAINTENANCE, AND STORAGE

1. Setting Up the Receiver

Remove the receiver and rectifier from storage boxes. Check the rotation of all control knobs and switches.

When the receiver is to be used on a mobile installation (ship, motor vehicle, etc.) both the receiver and rectifier must be mounted on shock absorbers.

When the set is to be used in a stationary installation, the shock absorbers may be removed and the set may be placed directly on the operator's desk (the rectifier may be placed under the desk but protected from accidential kicking).

When the receiver is placed on the operator's desk, it is desirable for the room light to illuminate the front panel from the side. Avoid a strong light falling on the optical dial screen because it will be difficult to read.

Fasten the receiver to the desk with bolts screwed to the shock-absorber mounts (the use of cords is not permitted; they cannot withstand jolting because of the great weight of the receiver).

If a place of operation is specially built for a given receiver, it is desirable that the shock absorbers be installed in the desk with the lower supports of the receiver 20-30 mm above the table top.

Similarly install the rectifier, which should preferably be mounted on the left side of the receiver or under the receiver near the left side (near the outlet for the receiver power supply).

2. Installing the Tubes in the Receiver

To install the tubes in the receiver it is first necessary to take off the main cover from the forward panel, removing the screws holding the forward panels (upper and lower) of the receiver, and to remove the receiver part by part from the housing (or move it slightly forward).

Put the tubes in the sockets according to the markings by each socket. Onto those tubes for which provision has been made for rigid mounting, catches must be screwed tightly enough to completely eliminate all vibration of the tubes.

If the tubes have already been installed in the receiver, then it is necessary to verify that they are tight enough in the sockets.

To install the illumination bulbs for the optical dial (tube A-25, 12 x 6), situated in the upper left-hand corner of the lower unit, put a bulb in the socket, press in, and turn to the right as far as possible.

NOTE: When using bulbs with incorrectly placed filaments or bulbs that have been improperly placed, check for uniform illumination of the dial after the receiver has been turned on.

The installation of an illumination bulb can be done by selecting the most favorable condition for the bulb: the socket of the bulb is attached to a joint and can move in any direction.

It is first necessary to slightly loosen the lower side nut on the base of the bulb.

To install the illumination bulbs for the coarse tuning dial it is necessary to:

a) Remove the dial frame from the receiver.

b) Loosen the screws holding the bulb sockets and turn the sockets until the bulbs can be easily inserted.

c) Screw in the bulbs.

d) Tighten the screws holding the sockets, positioning the bulbs so that the greatest amount of light illuminates the face of the operational part of the dial.

It must be remembered that the illumination bulbs for the coarse tuning dial are connected in series, and in the event of a defect in one of them, neither one will light.

3. Connecting the Antenna and Output Equipment

Connect the antenna at outlets labeled A_1 and A_2, situated on the right side of the forward panel of the lower assembly. For optimal operation of each given type of antenna, it is necessary to have the antenna selection switch, located on the forward panel of the receiver, placed in the proper position (according to the label).

For operation with a symmetrical feeder, connect the ends to outlets A_1 and A_2.

For operation with an asymmetrical feeder or coaxial cable with an open or pole antenna, connect the feeder to outlet A_1.

Plug the headphone (low-impedence) into any pair of jacks on the forward panel of the lower assembly (labeled "Headphone").

For operation with the line, connect it to the terminals on the forward panel of the upper unit (labeled "Line") or to the outlet on the rear side of the housing.

For operation with the loudspeaker, connect the speaker to the "Line" terminals by means of a two-conductor line of the proper length. The headphone and line outputs of the receiver are symmetrical-- there is no contact with the frame of the receiver.

4. Switching on the Receiver and Testing for Operational Capability

To put the receiver into operation, place the voltage switch on the rectifier in the position corresponding to the rated power supply voltage. Connect the rectifier to the power supply and to the receiver by a cable (insert one end of the cable into the output socket of the rectifier, and the other, into the power supply socket on the left side of the receiver housing; see Fig. 50).

There is a special cable, supplied with the receiver spare parts set, for supplying power to the receiver directly from a battery. Insert the end of the cable terminating in a plug into the power supply socket on the left side of the receiver housing, and connect the battery to the leads at the other end of the cable (according to the labels on the cable lugs). Then turn the power switch of the receiver to the "On" position. After the tubes warm up, the receiver is ready for operation.

To test for operational capability, first check the current and voltage on the test meter of the receiver. Readings of the instrument for all positions of the test switch should normally lie within the red sector of the dial.

Tube No 4 presents an exception, since its current in some regions of sub-ranges II, III, and VIII may register outside of the red sector of the dial.

If for some positions of the control switch the readings are outside of the red sector (too high or too low), the tubes of the receiver corresponding to the numbers on the switch should be changed.

NOTE: Checking of currents and voltages is made under the following conditions:

a) The sub-range selector switch can be in any position except sub-range I.

b) The high frequency gain control knob is turned to maximum amplification (position "10").

c) The audio frequency gain control knob is turned to minimum amplification (position "0").

d) The calibrator is turned off.

e) The ASC is turned off.

f) The third local oscillator is turned on.

After the currents and voltages of the tubes of the receiver have been checked, a test for actual reception is made.

The receiver is operating normally if, when the audio and high frequency gain control knobs are turned to position "10" (maximum amplification), a loud noise is heard in the headphone and stations can be heard on all sub-ranges (with antenna turned on) by turning the tuning knob.

NOTE: At night on sub-ranges X, XI, and XII, i.e., on the highest frequencies of the receiver, few stations are usually heard, and occasionally nothing can be heard. This is explained by the presence of adverse conditions affecting these frequencies at night.

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5. Operation with the Receiver

A. Telephone Reception

After the power is turned on and the tubes are heated, proceed to tune the receiver as follows:

a) Establish the required band (containing the frequency of the transmitting station).

b) Turn on the automatic sensitivity control.

c) Turn the high frequency gain control knob to maximum amplification (position "10").

d) Establish an intermediate frequency band of 3 Kc, 6 Kc, or 12 Kc.

e) Establish a low frequency band of 2.5 Kc or 5 Kc.

f) Turn off the noise limiter.

g) Turn off the third local oscillator.

h) Turn off the crystal calibrator.

i) Previously turn the audio frequency gain control knob to position "2.5".

Establish the frequency of the transmitting station with the main coarse tuning knob and with the optical dial (make the setting as accurate as possible).

After receiving the station, adjust the audio frequency amplification until the desired volume of the signal is attained.

For telephone reception without automatic sensitivity control, all of the foregoing remains in effect, with the exception of items "c" and "i"; amplification is adjusted with the high frequency gain control, while the audio frequency gain control knob is turned to position "10."

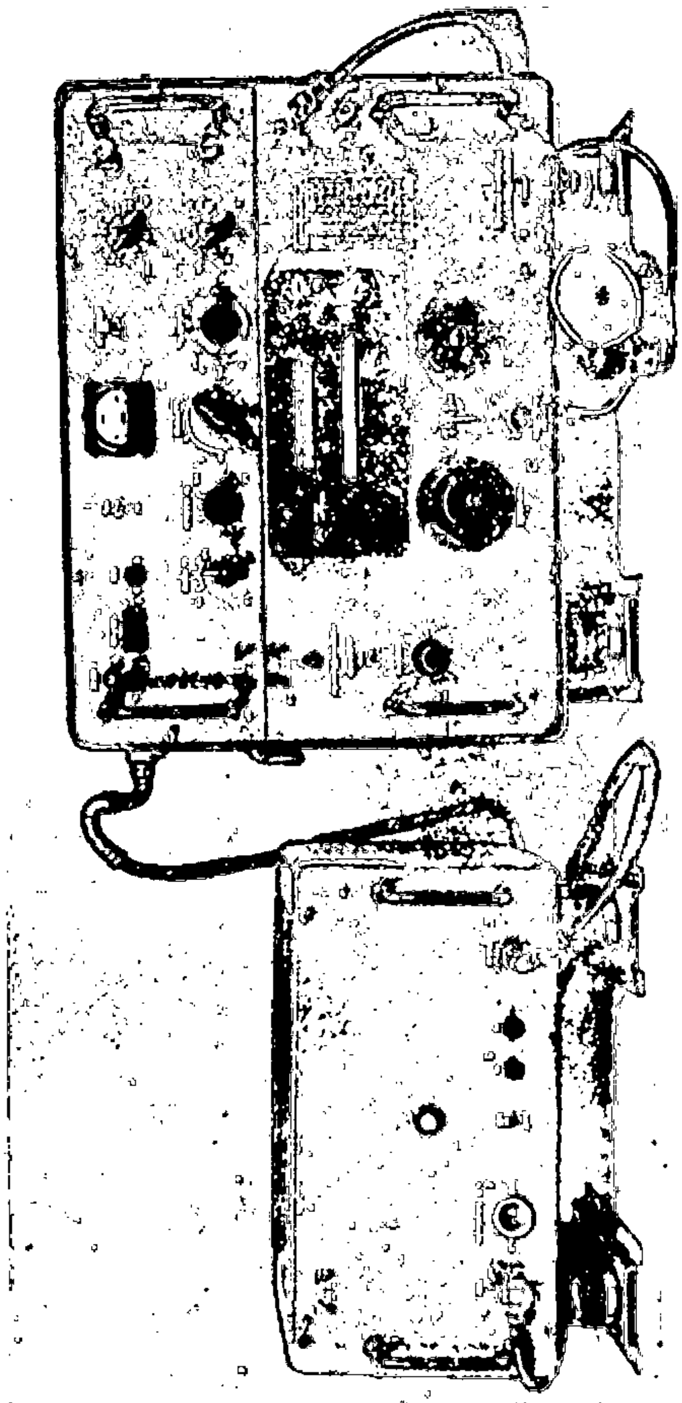

Fig. 50 General View of the Receiver with the Rectifier
Рис. 50. Общий вид приемника с выпрямителем

B. Aural Telegraph Reception

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The reception of voice-frequency carrier telegraphy is accomplished in the same manner as telephony reception.

When telegraphy is being received in the CW mode, all of the preliminary operations are carried out in the same order as for the reception of telephony. In addition, turn on the third local oscillator and turn the "Continuous Tone" knob to position "1" (the beat tone is on the order of one kilocycle).

When large interference is present, operate with an intermediate frequency band width of 1 kc and an audio frequency bandwidth of 0.3 kc.

C. Testing and Correcting Calibration

A check for calibration accuracy should be made 1.5 to 2 hours after turning on the receiver (an error in calibration can be larger by 700 to 1000 cycles immediately after the receiver has been turned on than after warm-up).

For a calibration check, turn the sub-range selector switch to any sub-range except the second, and turn on the cryatal calibrator of the receiver.

Turn on the third local oscillator. Establish an intermediate frequency bandwidth of 3 or 6 kc. Establish an audio frequency bandwidth of 5 or 2.5 kc.

Turn the audio frequency gain control knob to maximum amplification.

Carry out the amplification adjustment by means of the high frequency gain control knob.

Switch on the automatic sensitivity control.

Calibration reference points on the coarse tuning dial are in multiples of 500 kc (frequency setting in digits).

There are two methods for checking the calibration accuracy.

First Method: Turn the control knob for the beat tone of the third local oscillator ("Continuous Tone" knob) to the "0" position, and the course tuning and optical dials to one of the reference points (the fine tuning dial must be in the "00" position).

By turning the third local oscillator knob ("Continuous Tone"), determine the position of zero beat. The reading of the "Continuous Tone" dial will then give the magnitude of the error in kilocycles.

Second Method: Turn the control knob for the beat tone of the third local oscillator ("Continuous Tone" knob) to the "0" position. The calibration error is obtained directly from the optical dial as the difference in readings for the frequency of the reference point (zero on the optical dial) and the frequency corresponding to the zero beat (the optical dial is divided into 2-kilocycle intervals).

Calibration is within tolerance if the error does not exceed 2 kc.

If calibration error of the receiver, when checked for one sub-range does not exceed 2 kc, then the calibration is within tolerance for all other sub-ranges.

NOTE: The check for dial calibration accuracy can also be made on the second sub-range; however, it must be kept in mind that the frequency of the reference points on the dial must be shifted 50 kc relative to the dial reading for the second sub-range.

If an allowable dial calibration error of 2 kc is exceeded (possible with an excessively low or high ambient temperature), or if it is necessary to increase calibration accuracy, then the dial error of the receiver should be corrected, using for this purpose the incorporated calibrator and the alignment system in the receiver.

Mechanical and electrical aligners are used for this correction.

The mechanical aligners shifts the screen of the optical dial. To use it, it is first necessary to loosen the safety lock (located in the upper left-hand part of the frame of the dial and labeled "Safety Lock") with one or two turns. Then turn the aligner, located in the upper right-hand part of the frame of the dial and labeled "Dial Aligner."

The electrical aligner gives a fine tuning of the second local oscillator circuit. The slot for manipulating this aligner is located in the upper-left-hand corner of the panel of the high frequency unit, labeled "Electrical Aligner."

The alignment sequence for the dial is as follows: turn the "Continuous Tone" control knob to the "0" position, switch on the crystal calibrator, and turn the receiver tuning knob until the zero beat appears at the second reference point on the dial.

Then, turning the slot of the mechanical aligner, align the reading crosshair of the optical dial with the "00" mark, after which, retune the receiver to the fourth reference point on the dial and align the "00" mark of the optical dial with the reading crosshair. If the zero beat now appears, this means that the entire dial is in alignment, and the safety lock should be set.

If the zero beat does not appear, the electrical aligner should be turned until it does.

After this operation retune the receiver again to the second reference point of the sub-range, check dial calibration accuracy, and, if necessary, make a correction with the mechanical aligner, after which again align the dial at the fourth reference point by means of the electrical aligner.

The dial calibration check and alignment are made (2-3 times) for the middle reference points of the dial until a minimum dial calibration error is obtained.

After the correction is made, set the safety lock of the mechanical corrector and close the aperture of the electrical aligner.

NOTE: Since the digits of the optical dial for the second sub-range are shifted 50 kc relative to the other sub-ranges, it is recommended, in order to avoid errors, that the receiver not operate on the second sub-range during dial calibration.

After the dial has been aligned for any sub-range, the dial will automatically be in alignment for the second sub-range also.

D. Reception Under Conditions of Strong Interference

Lessening of interference from nearby radio stations can be done by shifting to a narrower i-f bandwidth (at the same time it is also advantageous to decrease the audio frequency bandwidth).

NOTE: For telephone reception it is not advisable to decrease the bandpass to less than 3 kc (for the strongest interference).

With strong interference, in the case of telegraph reception, it is possible to use an IF band-pass of "one" kc and a voice-frequency filter with a band-pass of "0.3" kc.

In this case it must be remembered that the beat tone from the third local oscillator should be on the order of 1000 kc (the "Continuous Tone" knob is in position "1").

If a transmitter situated nearby and operating on a frequency close to that of the receiver causes interference, and a shift to a narrower band-pass does not lessen the interference, then the audio frequency gain control knob should be turned to maximum amplification (position "10") and the radio-frequency amplification should be attempted. In this situation the automatic sensitivity control is turned off.

Strong pulsating disturbances from sparking of motors, relays, ignition of automobile engines, lightning discharges, etc., causing sharp clicks in the telephone, can be diminished by the use of a noise limiter in the receiver.

In this case it is usually necessary to adjust the radio-frequency amplification (it is better to turn off the automatic sensitivity control while striving for the clearest audibility).

It must be remembered that the noise limiter cuts out only peak voltages of excessive signals; it cannot completely eliminate interference.

E. Use of the Automatic Sensitivity Control

Under normal circumstances the receiver should be operated with an automatic sensitivity control.

For slow-rate telegraph reception and hand telegraphic transmissions, the time constant of the automatic sensitivity control must be increased to one second; otherwise, during transmission pauses (and also during slow transmissions and between telegraphic characters), the amplification of the receiver will build up and loud noise will appear.

During search, the time constant of the automatic sensitivity control must not be greater than 0.1 seconds; otherwise, it is difficult to locate a weak station, especially if a strong station happens to be operating on a nearby frequency.

F. Diversity (Antenna) Reception

For combining several receivers (diversity [antenna] reception), in the case of telephone reception, the outputs of the ASC of the receivers are connected in parallel, but the terminals of the outlet to the line are connected in series and to the ends of the common outlets (common telephone outlet).

The same time constant of the ASC should be established for all receivers operating together.

The method of combining receivers for telephone reception is shown in Figure 51 (three receivers are combined in such a manner).

NOTE: When combining receivers for telephone reception, it is better not to connect the load directly to the receivers but through auxiliary stages of audio frequency amplification, in which the grid circuits are connected to the outlets of the various receivers and the plate circuits are coupled and operate together on the load (see Fig. 52).

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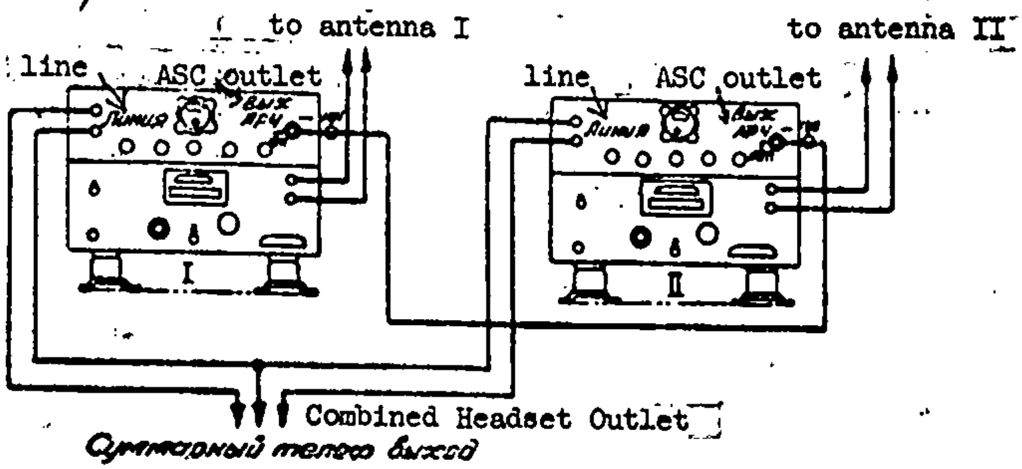

Fig. 51 Schematic for Connecting Receivers for Telephony Reception

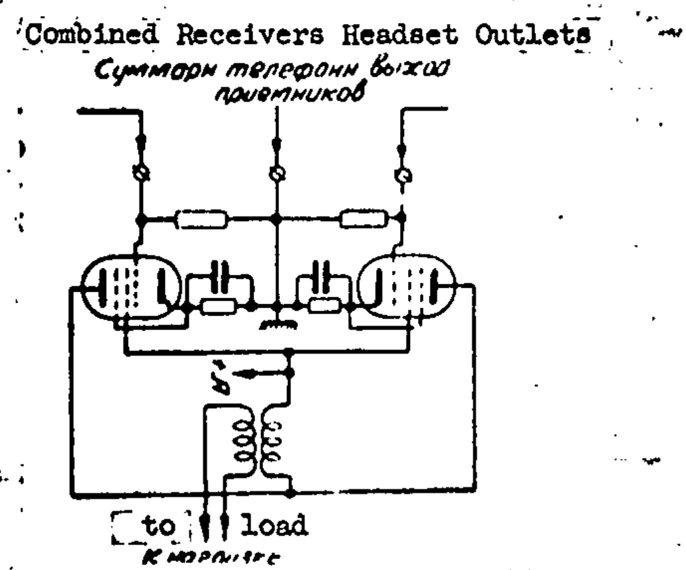

Fig. 52 Auxiliary Stage for Operation with Combined Receivers During Telephone Reception

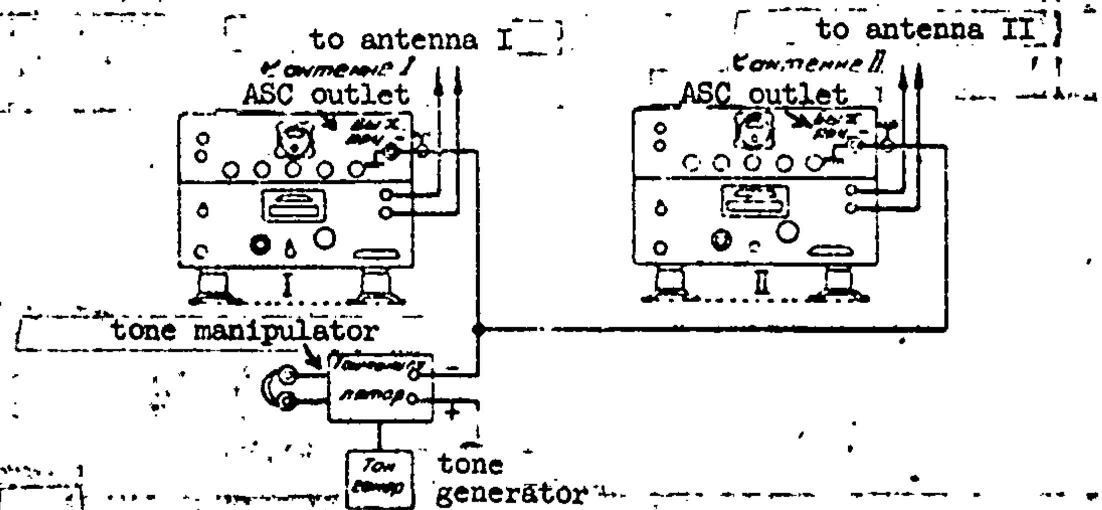

Fig. 53 Schematic for Connecting Receivers for Telegraphy Reception

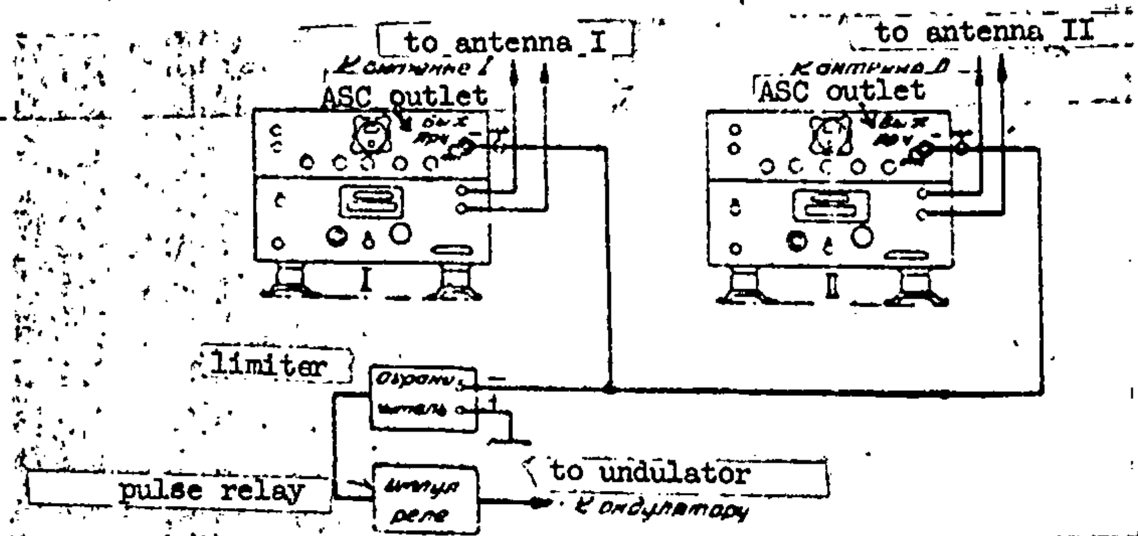

Fig. 54 Schematic for Combined Telegraphy When Recording with Undulator

This prevents the output stage of one receiver from affecting another.

Combined reception of voice-frequency (modulated) telegraphy is accomplished in a manner similar to that of telephony.

Combined reception of telegraphy with the third local oscillator (aural) is accomplished in a manner similar to that of telephony. However, in this case considerable experience is required by the operator, since even a slight difference in the beat tones of the two receivers will tire him greatly (he must carefully find and maintain the same beat tones from both receivers).

Combining three receivers makes this work even harder, since it is not possible to make a fine adjustment of the tone at any one receiver.

Combined receiver reception of telegraphy (in the case of aural reception) must usually be done using a tone manipulator. A diagram for such a situation is shown in Figure 53. A diagram for combined receiver reception in telegraphy with recording by an undulator is given in Figure 54: a system for limiting the amplitude of the signal is connected in parallel to the outlets of the ASC's of the receivers, following which is an electronic relay operating the undulator.

It must be remembered that the output of the ASC of a receiver supplies a negative voltage relative to the ground for a normal input voltage on the order of 3 volts.

The cables connecting the outlets of the ASC of the receiver must have a capacitance no greater than 1000-2000 uuf (especially for recording of rapid transmissions). The load resistance must be greater than 1,000,000 ohms.

6. Receiver Maintenance

A receiver possesses a high degree of reliability and is designed to retain this reliability over a long period of time. However, improper operation of the receiver can shorten its period of useful service or decrease the reliability of the data received.

An attentive attitude toward the receiver and observation of all the requirements and rules for its use enables the operator to operate the receiver confidently over long periods.

Below are listed the basic rules for handling of the receiver.

Recommended:

a) Turn on the receiver for 1.5 to 2 hours prior to operation if great calibration accuracy and high stability of operation are required; if a frequency drift on the order of 1000 and 1500 kc is attained during the first 1.5 to 2 hours of operation, then the receiver can be turned on for 5 to 10 minutes before operation.

b) Turn the receiver off during an interruption of 3 to 5 hours in its operation.

c) Do not switch sub-ranges unless it is necessary; do not shift quickly from one sub-range to another, turn the tuning knob quickly, or force it past the extreme positions on the dial.

d) Do not allow operators who are not familiar with the instructions for their operation to work with receivers.

e) Do not make a calibration correction of the dial or switch over to the control units unless it is necessary.

f) Do not remove the receiver from its housing unless it is necessary.

Forbidden:

a) To remove the optical dial of the receiver when it is in operation and to adjust the optical system of the objective, comprising the condenser lenses (except the illumination bulbs for the dial, whose adjustment is made in conformity with the present instructions).

b) To remove the cover of the capacitor units and uncover the compartments of the drum-type sub-range selector switch.

c) To make a fine tuning of the receiver circuits.

d) To remove the control knob for the third local oscillator ("Continuous Tone").

These operations can be carried out only by experienced engineers in a repair shop.

7. Care of the Receiver

To protect the mechanical and electrical parts of the receiver during its operation, moving, and storage, the following basic rules must be observed:

a) During continuous use the receiver mechanisms should be inspected every 2 months and its moving parts oiled (vernier, sub-range selector switch and its bearings, gear wheels and bearings of the band selector switch, etc.).

NOTE: Lubrication of the contacts of the sub-range selector switch is not allowed.

A special anti-freeze lubricant in the spare parts kit is used for oiling the moving parts of the receiver.

b) It is recommended that every 2 to 3 months of continuous operation of the receiver its internal parts be wiped with a soft, clean rag, slightly moistened in gasoline, to remove dust.

NOTE: Care should be taken not to damage the contacts of the drum-type switch when wiping them. Be careful not to leave any lint on them from the rag.

e) During prolonged interruptions in the operation of the receiver (more than 2 days) place the cover over the front panel.

d) Guard the receiver against sudden changes in temperature and spilling of water on it.

e) The receiver may be transported only in packing boxes, with the ordinary rules for moving valuable equipment being observed.

f) When a receiver is stored in warehouses over a long period of time, all the regulations for storing military equipment must be observed. The receiver and all spare parts kits must be in tightly covered packing boxes.

VI. TESTING THE RECEIVER AND GENERAL INFORMATION ON ITS REPAIR

1. Testing for Capability of Operation

The receiver is operating normally if:

a) The current in all tubes and the input voltage are read within the red sector of the dial of the control instrument (with the possible exception of tube No. 4 [see section 4 of the instructions for operation, handling, and maintenance]) when the radio-frequency gain control knob is turned to maximum amplification, the audio frequency gain control knob is turned to minimum amplification, and the third local oscillator is turned on (the ASC is turned off);

NOTE: The sub-range selector switch is in any position except that for the first sub-range;

b) The calibration error, as checked by the quartz calibrator, does not exceed 2 kc;

c) Noise is heard on the headphones when the radio and audio frequency gain control knobs are turned to maximum amplification for all sub-ranges of the receiver;

d) Distant stations can be heard on all sub-ranges when the antenna is switched on;

NOTE: When receiving, it should be remembered that the calibrator switch should be in the "OFF" position; otherwise, there will be no reception, since the quartz calibrator, when turned on, takes voltage from the plate of the first mixer, and the screen grid voltage of the first intermediate frequency amplifier is sharply reduced.

2. Testing the Tubes

If the current and voltage test switch gives no indication of the location of a malfunction in the receiver, a complete check of the voltage and resistance in all stages of the receiver must be made.

For this purpose, it is necessary to use the resistance and voltage diagrams included in the present instructions. Proceed in the following manner when using these diagrams:

a) Carefully remove the upper and lower panels of the receiver from the main housing and, without connecting them by a cable (separately by unit), measure the resistance with tester TT-1 (the internal resistance of tester TT-1 is 1 megohm).

Removing each tube in order, measure the resistance between each prong and the frame of the receiver.

Normal resistances are shown in the resistance diagrams (Figs. 58 and 60). Deviation (more than 20%) of the measurements from the resistances given on the diagram indicates a malfunction in the circuit checked.

b) After checking the resistance, measure the voltage; to do this, place the upper and lower panels of the receiver on a table, as shown in Figs. 55 and 56, and unite them with special connecting cables, found in the spare parts kit of the receiver (make the connections according to themarkings on the cable plugs and sockets on the panels of the receiver).

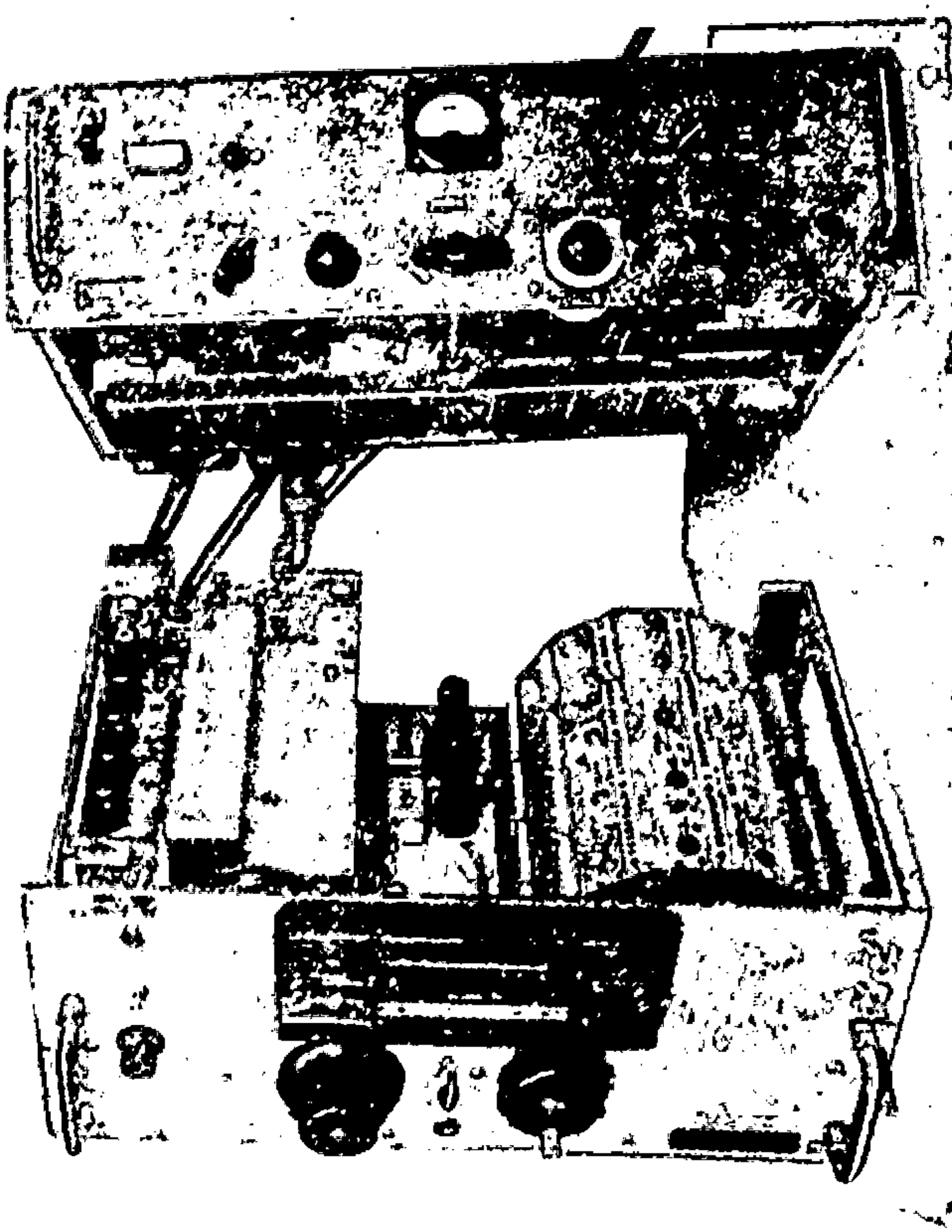

Fig. 55 Front View of the Two Receiver Units Connected with the Housing Removed

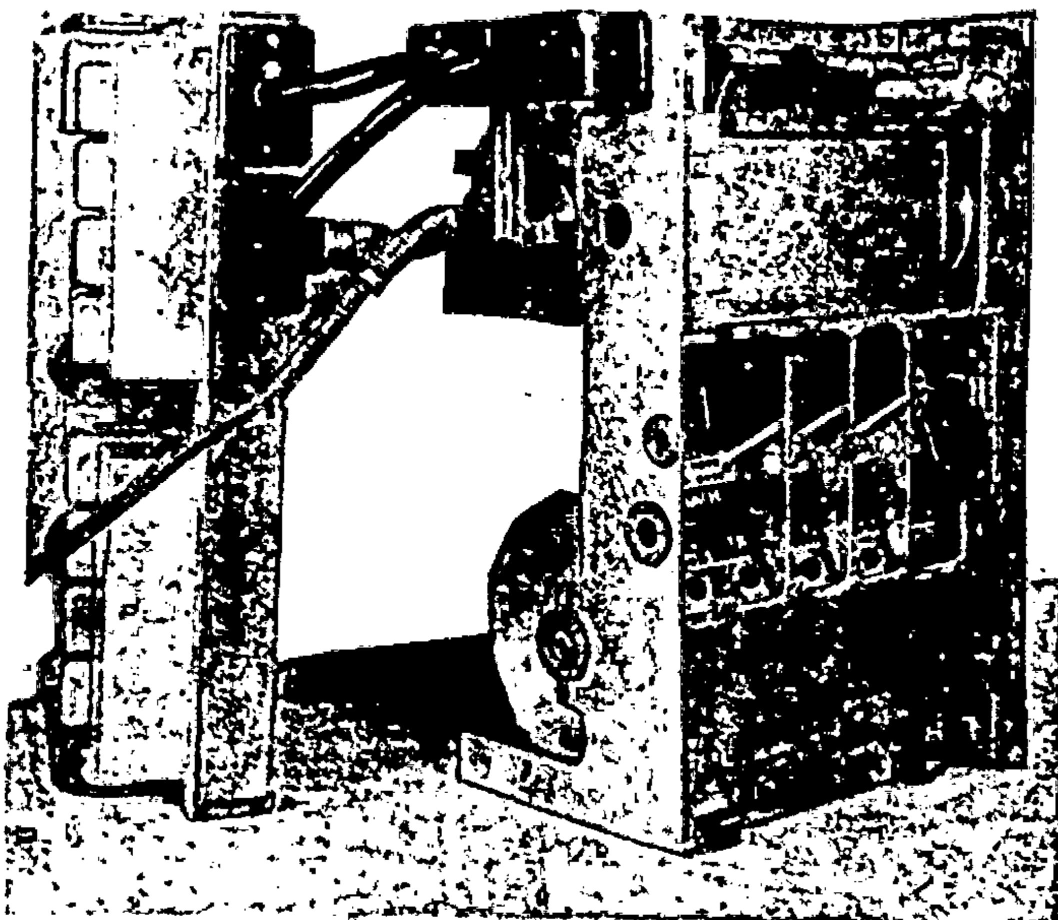

Fig. 56. Two Connected units of the Receiver, removed from the Housing. Rear View.

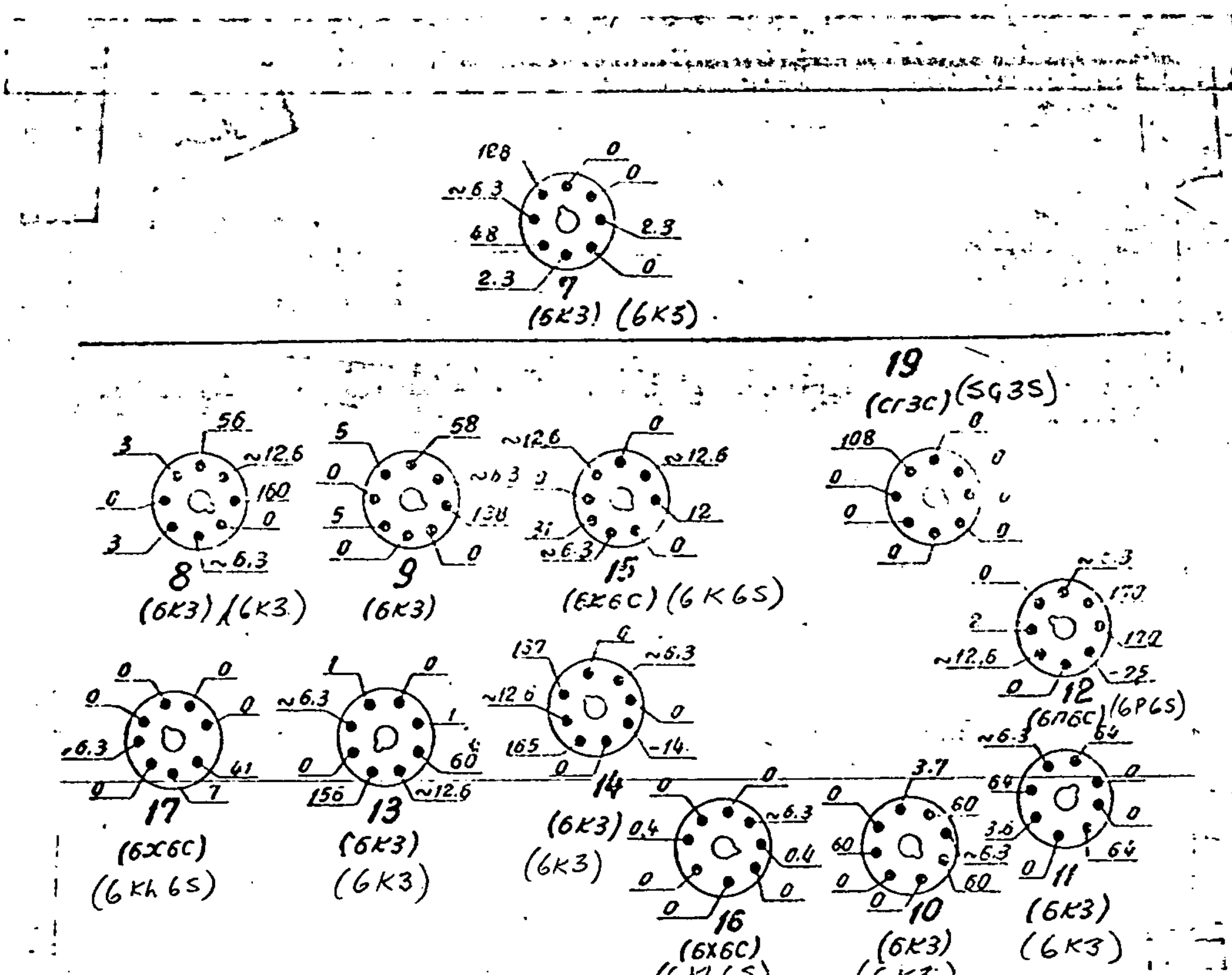

Рис. 57. Диаграмма напряжений блока выходных устройств

Fig. 57. Voltage Diagram of theOutput Sections

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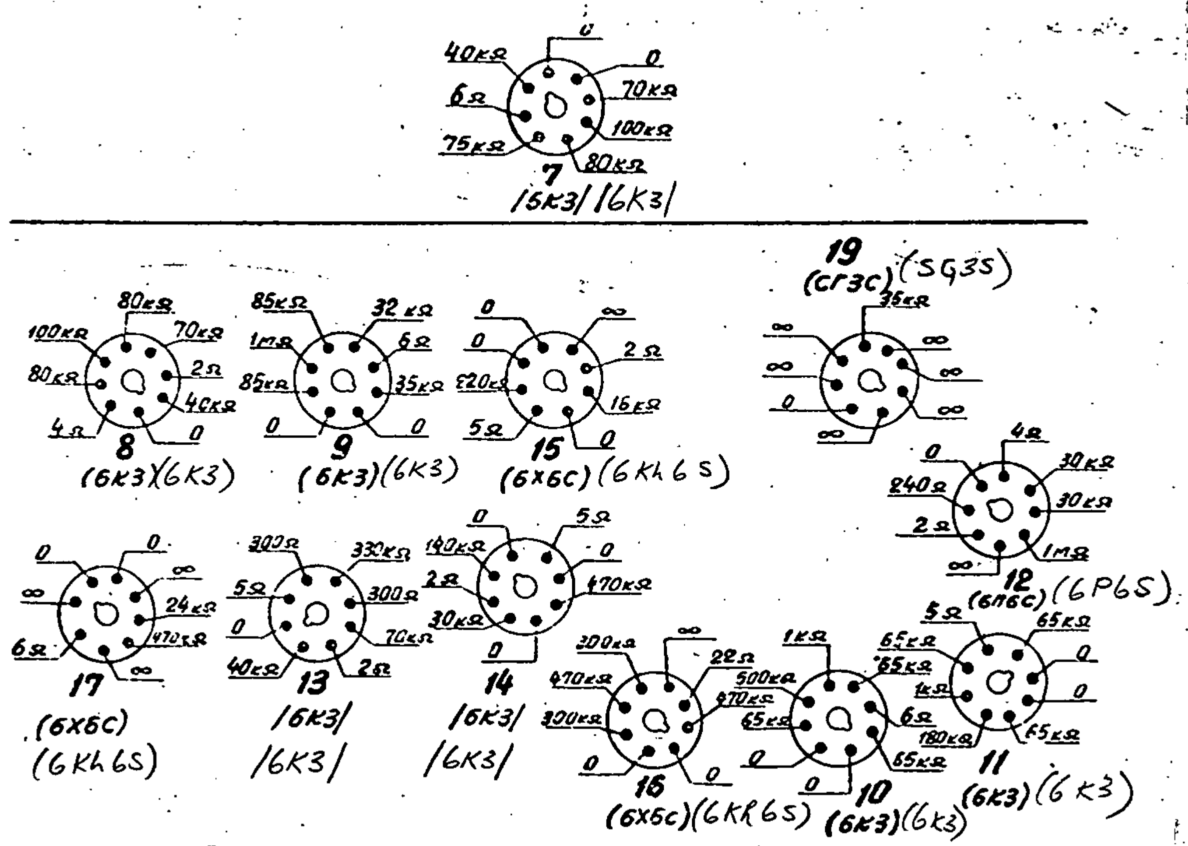

Рис. 58. Диаграмма сопротивлений блока выходных устройств
Fig. 58. Resistance Diagram of the Output Sections

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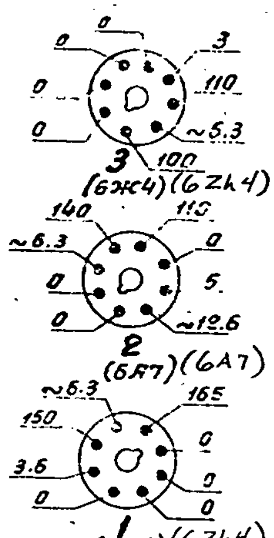
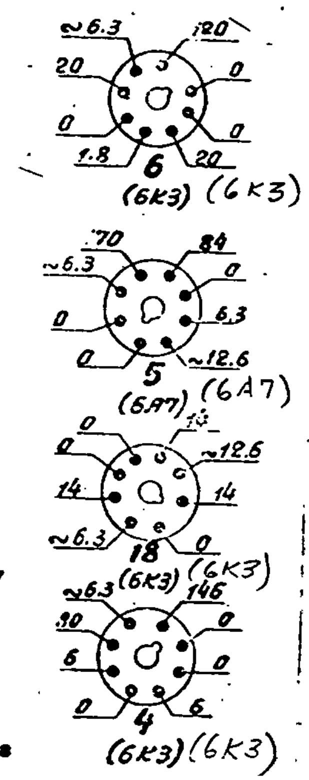
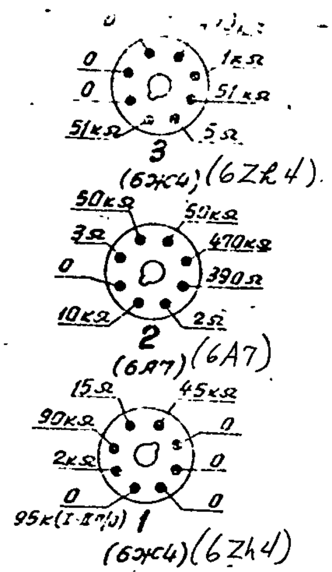


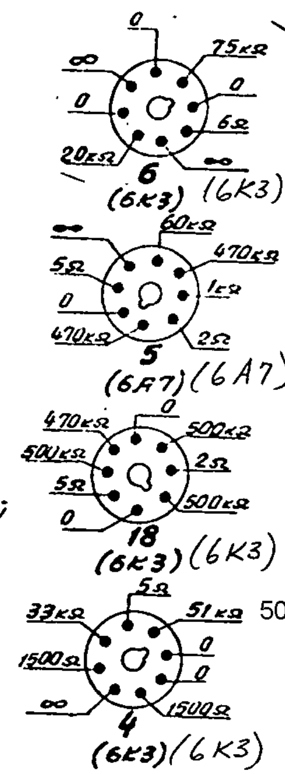


1. Ручки регулировки УВЧ и УНЧ макс. Род работы тлгр ограничитель помех вкл. АРЧ и кварцевый калибратор выкл. Вид на ламповые панели со стороны монтажа; счет ножек вести по часовой стрелке. Измерение производилось тестером ТТ-1
2. Измерение производилось при напряжении на выходе выпрямителя 176 в. При изменении напряжения на выходе выпрямителя величины напряжений, указанные в диаграмме, должны быть соответственно скорректированы.
3. При измерении напряжений на лампе № 18 кв калибратор должен быть включен.

Fig. 59. Voltage Diagram of the Output Sections

Рис. 59. Диаграмма напряжений блока высокой частоты





1 Ручки регулировки УВЧ и УНЧ на макс; род работы ТЛГР, кварцевый калибратор и АРЧ выкл. Ограничитель помех включен.

2 При измерении сопротивл. на лампе №18 калибратор включен

3. Вид на ламповые панельки со стороны монтажа, счет ножек вести от ключа по часовой стрелке.

4 Измерения производились тестером ТТ-1

Рис. 60. Диаграмма сопротивлений блока высокой частоты
Fig. 60. Resistance Diagram of the Radio-Frequency Section

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In the lower panel, open the tray and the cover of the section that houses the crystal calibrator and the second local oscillator. Switch on the power to the receiver and with the tubes installed use the TT-1 tester (from the wiring side) to measure the voltage between each pin of the tube and the chassis.

(Fig 57. Voltage Diagram of the Output Sections) [See next pages]

The rated votage values are shown in the voltage diagrams (Fig 57 and Fig 59). A deviation of more than 20 percent in the measured voltage from the value given in the diagram indicates a fault in the tested circuit.

(Fig 58. Resistance Diagram of the Output Sections) [See next pages]

(Fig.59. Voltage Diagram of the Output Sections) [See next pages]

1. Gain knobs R-F gain and A-F gain at maximum; mode telegraph. Turn on noise limiter and turn off automatic sensitivity control and crystal calibrator; view toward wiring side of tube board pins numbered clockwise; use TT-1 tester for measurements.

2. Measure with 176 volts at the output of the rectifier; if there is a difference of voltage at the rectifier output, the voltage given on the diagram should be corrected accordingly.

3. The crystal calibrator should be switched on when the voltage of tube 18 is being measured.

Fig. 60. Resistance Diagram of the Radio-Frequency Section

1. Set the Gain knobs R-F and A-F at maximum; mode switch on telegraph; turn off the crystal calibrator and ASC (automatic sensitivity control); and turn on the noise limiter.

2. Calibrator switched on when resistance of tube 18 is being measured.

3. View toward wiring side of tube board; pins numbered clockwise from the key.

4. TT-1 tester used for measurements.

3. GENERAL LABORATORY TESTS
(in the repair shop)

A. Testing Accuracy of Calibration

A frequency standard, accurate within 10^{-5}, is required for testing the calibration.

B. Testing the Receiver Sensitivity

Receiver sensitivity is checked by supplying a high frequency voltage from the standard generator to plugs A_1 and A_2 (3) through a resistance of 100 ohms.

Set the antenna selector switch on the middle position - "asymmetrical" (coaxial) feeder.

Load the receiver output with one pair of low ohmic phones, to which a copper oxide voltmeter with internal resistance greater than 10,000 ohms is connected in parallel (If a tube-type amplitude voltmeter is used, the measurement of the sensitivity will be incorrect and will indicate values three times greater than the actual values.). Set the audio-frequency gain knob at position "10," which corresponds to maximum volume; regulate the gain with the radio-frequency gain control knob.

Switch off the ASC (automatic sensitivity contol), the noise limiter and the crystal calibrator. Set the bands at an intermediate frequency of "3" kilocycles and an audio frequency of "2.5" kilocycles.

Measuring Telegraph Sensitivity: Switch on the third local oscillator; set the "Continuous Tone" control knob at about 1,000 cycles. Establish a receiver noise voltage of 0.5 volt on the phones. If the receiver sensitivity is normal, the receiver output voltage will not drop below 1.5 volts when a high-frequency voltage of 0.5 - 1.0 microvolt is supplied from the standard oscillator.

Measuring Telephone Sensitivity: Switch on the third local oscillator, Establish a noise voltage of 0.5 volt on the phones while a 3-microvolt, unmodulated high-frequency signal is being fed at input. If the receiver telephone sensitivity is normal, the voltage at receiver output will not drop below 1.5 volts when the standard oscillator is modulated (400 or 1,000 cycles per sednd FM, 30% modulation).

4. REPAIRS

Small repair jobs, such as exchanging faulty fixed capacitors and resistors (other than wire-wound), can be done on the spot by experienced repairmen.

The replacement of potentiometers and switches, and the repair and tuning of circuits, should be done in repair shops by experienced specialists.

General information on the detection of faults in the receiver and rectifier is given below.

			...thod of Correction
1. Calibrator does not operate after being switched on.	a) crystal-calibrator tube not functioning b) calibrator toggle switch faulty v) fault in circuit	a) change tubes b) check feed voltages at sockets of calibrator tube board. v) check circuit	Replace toggle switch. If tube shows no plate voltage, the toggle switch has disconnection in position "Off"
2. When the radio-frequency gain control knob is rotated, the currents of tubes 4,7,8 and 9 do not vary.	Fault in radio-frequency gain control	Check the radio-frequency gain control potentiometer.	Replace potentiometer.
3. The audio-frequency gain-control knob does not regulate the gain, and output signal is barely audible.	Disconnection in the audio-frequency gain-control potentiometer, or circuits connected to it.	Check the audio-frequency gain-control potentiometer. Check circuits connected with gain control	Replace potentiometer.
4. Receiver operates normally, but a check of currents shows deviations from normal in certain positions, or currents of certain tubes are lacking entirely.	Fault in current-checking switch or its circuits	Check current-checking switch. Check the shunting resistors in the corresponding tube circuits	Replace the faulty shunting resistors.
5. Receiver operates poorly or not at all.	One of the tubes is out of order	Check tube currents.	Replace faulty tube with a good one.

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6. One of the sub-range does not operate.	a) first local oscillator not functioning; b) fault in circuits of drum switch of the particular sub-range	a) check first local oscillator according to current of tube 3. Current will be the same with drum switch on or off, if faulty. Short in trimmers of cell 1 of local oscillator also possible. (Check trimmer) b) check the installation of radio-frequency circuits (in the drum switch) of the particular sub-range; possible short in circuit (check trimmer) or faulty fixed capacitor.	Replace trimmer. Correct short. Replace trimmer. Replace capacitor. Correct short.
7. In swtiching from the intermediate frequency of one pass band to that of another, audibility vanishes.	a) No contact with one band in intermediate frequency band switch, or b) shorting in one of t the trimmers of the particular band.	a) check contacts of band switch at intermediate frequency. b) Check trimmer.	Correct ("tighten") faulty contacts. Replace trimmer.
8. Image of numbers of optical dial obtained on the reading line is illegible (not to be confused with illegible image of numbers along edge of screen of optical dial).	a) improper regulation (shift) of objective of optical system or b) loose attachment of dial disk.	Check: a) tightness of screws holding optical system to capacitor block, b) attachment of dial collar on axle of capacitor block.	Tighten screws. Tighten screws.

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optical dial illumination.	of lamp of optical system.	screw which holds the bracket and hinged joint of lamp together and, by rotating the lamp a little at a time, find the correct position.	...ld lamp in correct position and tighten screws.
10. When rectifier is switched on, there is no plate and no filament voltage, and signal lamp does not light.	Power line fuse of the rectifier has burned out.	Remove and check the fuse.	Replace fuse.
11. Rectifier shows filament voltage, but no plate voltage.	The 5Ц4С (5Ts4S) hot-cathode rectifier tube has burned out.	Remove rectifier from housing and test the rectfier tube.	Replace the faulty rectifier tube.
12. Rectifier shows normal filament voltage, but reduced plate voltage.	Faulty electrolytic capacitor (No 9 on the principal circuit diagram for the rectifier)	Unsolder the capacitor; check the value of plate voltage supplied by rectifier.	Replace faulty capacitor.
13. Rectifier shows normal filament voltage, but no plate voltage; rectifier tube functions; the filter choke (No 2 on principal circuit diagrm of rectifier) heats up.	Short in the circuit following the filter has cut out the electrolytic capacitor (No 6 on the principal circuit diagram of rectifier).	Unsolder the electrolytic capacitor and check plate voltage supplied by rectifier.	Replace faulty capacitor.

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NOTE: The above indicated characteristics of faulty condition, together with a check on the normal operations (resistances, voltages and plate currents of tubes), afford the possibility of an accurate location of any equipment failures.

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LIST OF PARTS

No.	GOST VTU Drawing	Designation and Type	Rating	Quantity	Remarks	Unit
1	II4705000Sp	Transformer		1		
2	682-1002	Anode Choke	10-15	1		
3	682-1018	Filter Choke	1.2 mh	1		
4	682-1018	Filter Choke	1.2 mh	1		
5	1952 MPSS Catalog	Type 14 Miniature Tube	6.3 v 0.28 amp	1		
6	GOST 1880-44	5 II, 4 C (5Ts4S) Tube		1		
7	1952 MPSS Catalog	Capacitor KBM-1.54		1		
8	VN MPSS 624-52	Capacitor KEG-1-N $\frac{450}{20}$ M		1		
9	VN MPSS 624-52	Capacitor KEG-1-N $\frac{450}{20}$ M		1		
10	GOST 6119-52	Capacitor KSO 5-500-A 6800-Sh		1		
11	GOST 6119-52	Capacitor KSO 5-500-A 6800-Sh		1		
12	GOST 5010-49	Fuse 43PK-2	2 amp	1		
13	GOST 5010-49	Fuse 43PK-2	2 amp	1		
14	631-84	Two-direction Two-Band Switch		1		
15	631-84	Two-direction Two-Band Switch		1		
16	635-1457	Stabilizer Switch		1		
17	4100-0111	Plug		1		
18	635-1447	Panel with Clamps		1		
19	635-1075	Two-wire Socket		1		
20	673-1006	50-ohm Resistor	22 ohms 3 watts	1		

Drawing 331-1854

RECTIFIER

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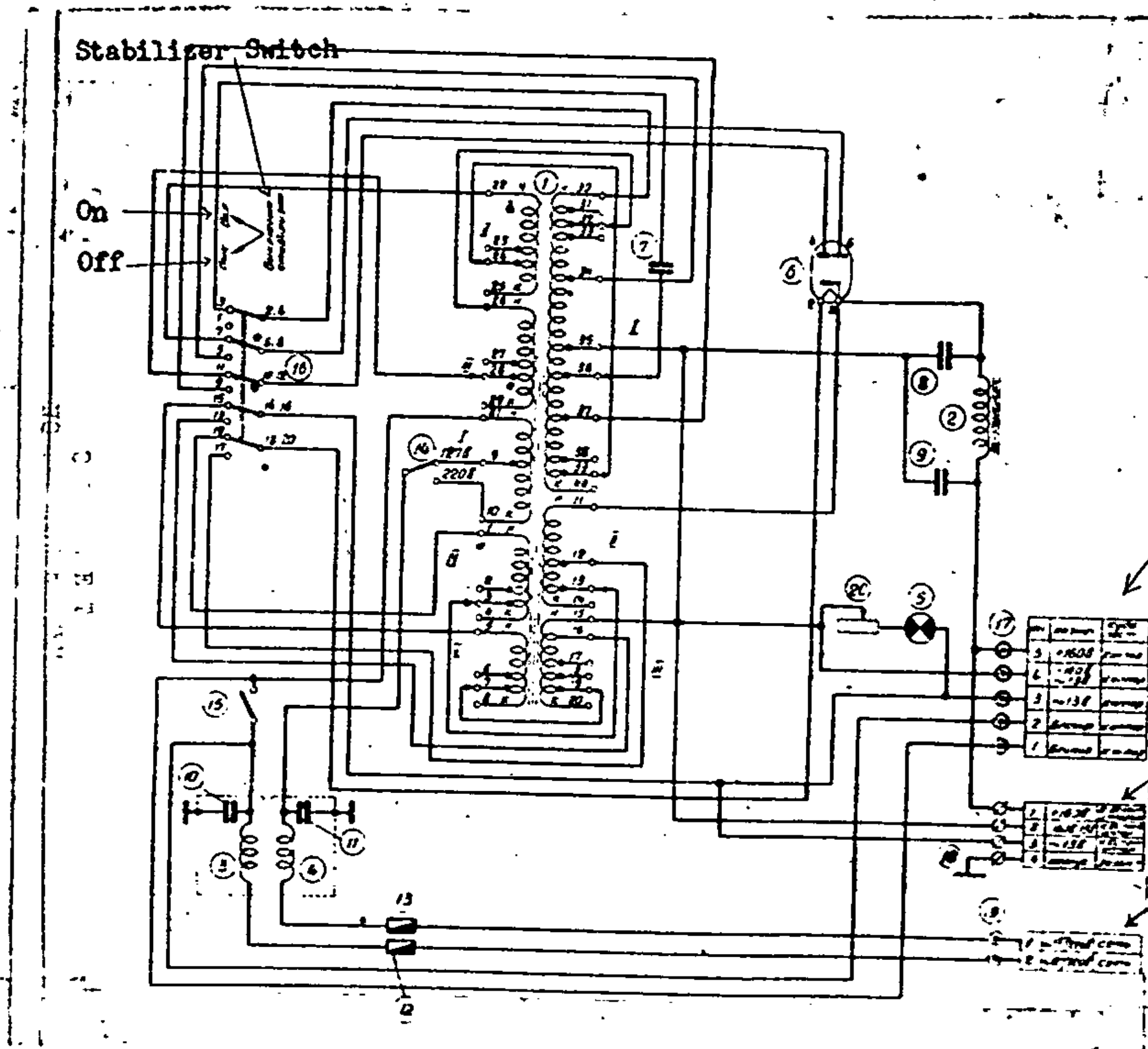

No.	Purpose	Leads to:
5	+ 1608	Receiver
4	{-1608} {~138}	Receiver
3	~138	Receiver
2	Blocking	Receiver
1	Blocking	Receiver

1	+ 1608	Auxiliary
2	-1608 ~138	Auxiliary
3	~138	Auxiliary
4	Chassis	Ground

1	~127/220 v	Mains
2	~127/220 v	Mains

Drawing 331-1854 RECTIFIER Principal Circuit Diagram

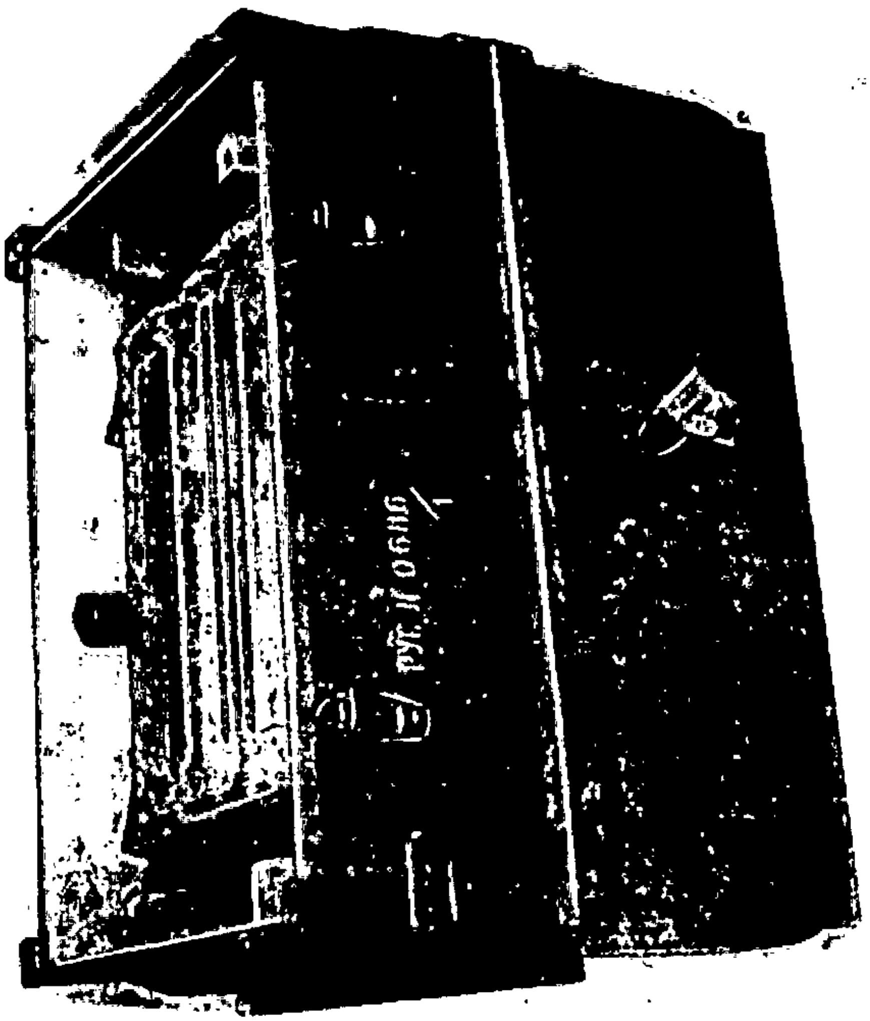

Рис. 61. Укладочный ящик №1.

Fig. 61. Packing Box No 1.

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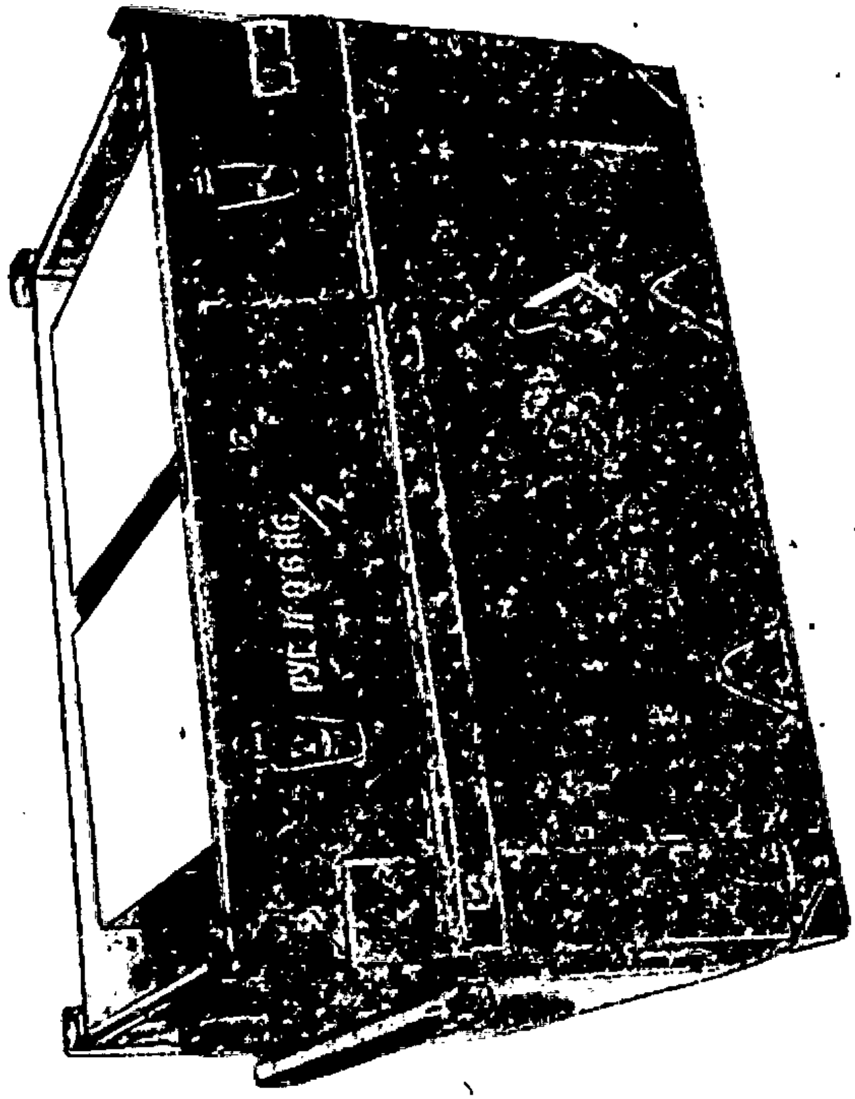

Рис. 62. Укладочный ящик № 2
Fig 62. Packing Box No 2.

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Page

Enclosures

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