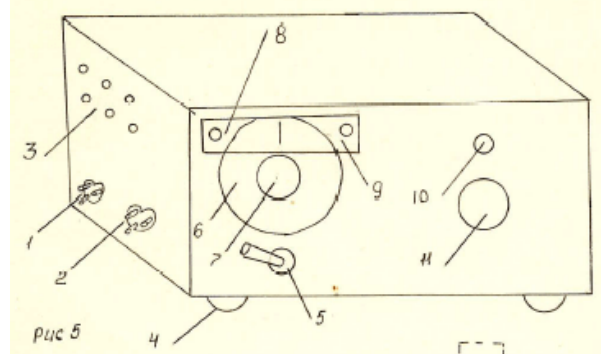


## Tube-Semiconductor- Transceiver (TST)

Transceiver TST was published in my book- “QRP Transceivers and PAs from Accessible Parts “  
The book was published by me (on my own expenses) in 1991, in Belgorod, Russia. I had printed 2000 samples of the book. The book describes kits which my own company (“Vibrissa”) produced at the times. First such kit was transceiver TST. Were produced 400 kits of TST (Tube- Semi- conductor- Transceiver) near 50 of them were assembled by me for customers. Of course, may be some design of the transceiver seems to be old for the days, but what I can say, the transceiver works, and works not bad.

**72/73! I.G.**



**Transceiver TST**

### **Tube- Semiconductor- Transceiver (TST)**

The transceiver consists of from two parts: there are RX part and TX part. Let's see how it is worked beginning from the TX part.

#### **TX**

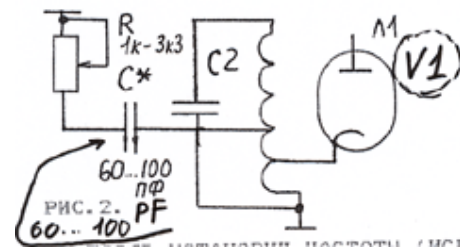
**Figure 1** shows the circuit of the tube's part of the transceiver TST.

VFO made on tube V1 (grid- cathode part). Zener diode VD1 (100V/ 20mA) provides the stable voltage to the tube. V1 works not only as VFO. L2C5 (switched in anode circuit) doubles the VFO frequency that depends on L1C2. Driver is assembled on V2, PA made on V3.

In my case the VFO worked very stable when Russian tube 6J2P was used in it. However, at 160- 20 meters pentode 6J1P works not bad. Inductor L1 is coiled on Russian resistor MLT-2 or WS-2 (it is depends on used band). The coil is uniformly spread on the form. The inductor should be coiled by wire that provides coiling turn to turn. To provide stability of the VFO the inductor coiled on the form firstly coated with neutral glue. I used Russian glue BF-2. Wire of the inductor is coiled (above the glue) with a small tension. After coiling the glued inductor is dried at + 150 C- degree while 2 hours. After that the inductor one more time is coated with the glue. After that the inductor is dried at room temperature for 24 hours. Remember, from the quality of the L1 depends the frequency stability of the TST. I had reached at 10- meters band the drift 200 HZ/hour with my home made inductors (and proper C2,C3).

Of course, if you managed use a ready- made inductor from an old VFO- use it. Tap to cathode goes from 1/4 from the “cold end.” (At my kit a special ceramic form for L1 was included)

If you can not get good air- dielectric Cn for the VFO - use a variable resistor that is switched on as the **Figure 2** shows. Resistor may have whole resistance in 1... 3-k. Tap to the resistor is taken from middle of the inductor. C\* (27- 100-pF) is required picking to desire frequency range. The schematic provides less stability compare to air- variable capacitor. However, it is very possible to get a good stability just picking the capacitors (around L1) having different Temperature Coefficient of Capacity.



**Figure 2** Variable Resistor instead Variable Capacitor

#### **Adjusting and Tuning VFO**

At first tune the tank L1C2 (with help a receiver or digital frequency meter) to needed frequency. Do not forget that the circuit is tuned to 1/2 or 1/3 frequency from used one. Then tune receiver to used frequency and tune L2C5 to maximum strength of the signal. Of course, you may use an RF voltmeter to do it. Then tune L3C8.

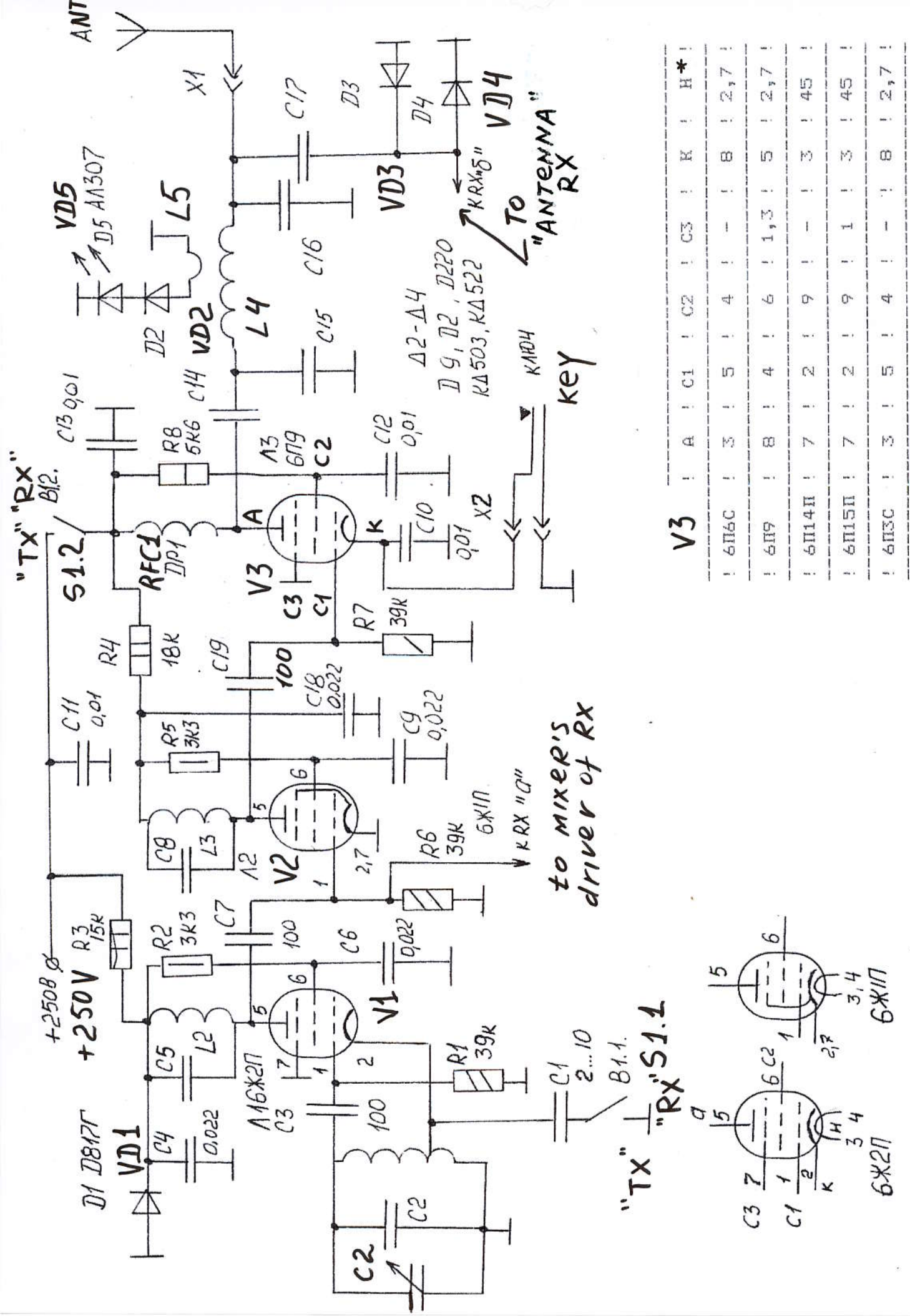


Figure 1  
Schematic diagram of the tube's part of the TST

It is possible to do in two different ways. First, use a receiver and tune to maximum strength. Second, turn on an amperemeter between R4 and C18 and tune to minimum current. Current at resonance L3C8 fall but voltage across resistor R7 (it is measured by a high-ohms voltmeter, preferably electromechanical (not digital) is raised.

**Note:** V3 at the measurement the voltage across R7 should be in the socket, heater turn on but the voltage from anode and grid- 2 should be removed.

After the final tuning L3C8 turn on anode voltage to V3, turn on an antenna to X1, and tune the PA (with help of C15, C16) to maximum power going in to the antenna.

LED VD1 shows the power, the brighter it glows the more power is going in to the antenna. Coupling loop L5 should be placed at proper distance at L4, LED should not glow too bright that may cause fault for this one. As usual the circuit (L4,C15,C16) is being tuned at the center of an amateur band does not require to be retuning to the edges of the band. So, if only one antenna (or several antennas having the same input impedance, for example 50 Ohms) is used, it is possible use fixed capacitors C15, C16. At the PA a Russian tube 6P3S, 6P6S, 6P14P, 6P9, 6P15P works well. First three work well at 160 through 20 meters, the last two work well at 20- 10 meters. **Table 1** shows data for all inductors of the TX.

**Table 1** Data for inductors of the TX

ТАБЛИЦА 1 ДАННЫЕ КОНТРОЛЬНЫХ ТХ											
ДИА- ПАЗОН	1,8	3,5	7	10	14	18	21	24	28		
L1 *	-	-	28	18	15	13	14	11	11	МЛТ-2	
	120/30	70/20	-	-	-	-	-	-	-	BC-2	
C2	1000	800	600	600	500	400	300	300	200	***	
L2 *	-	-	25	19	15	14	11	10	10	МЛТ-2	
	120/20	60/20	-	-	-	-	-	-	-	BC-2	
C5	200	200	180	150	120	100	100	90	60		
L3 *	-	-	25	19	15	14	11	10	10	МЛТ-2	
	120/20	60/20	-	-	-	-	-	-	-	BC-2	
C8	200	200	180	150	120	100	100	90	60		
L4 *	53/45	27/45	14/40	10/45	8/45	7/45	7/45	6/45	6/45	**	
C15	150	150	120	120	100	80	80	50	30		
C16	2000	2000	1500	1200	1000	600	600	500	300		
C14	1500	1000	1000	1000	470	470	390	300	300		

\* First column- numbers of turns, second column- length of winding. Otherwise inductor is wound uniformly on to the form.

\*\* Inductor L4 is coiled on a form in diameter 34 millimeter. For 160- 80 meters use wire 0.8 mm (20 AWG), for 40- 20 meters use wire in 1.0 mm (18 AWG), for 17- 10 meters use wire 1.0... 2.0 mm (18- 12 AWG).

diameter 0.1- 0.2 mm (37- 32 AWG), for 40- 30 meters may be wound by wire in 0.25- 0.5 mm (30- 24 AWG), for 20- 10 meters may be wound by wire in diameter 0.5- 0.8 mm (24- 20 AWG).

\*\*\* L1, L2, L3 are coiled on Russian resistors WS2 or MLT-2. Resistance for these ones should be more than 100-k for L1 and L2. For inductor L3 the resistance should be more the 27-k.

L1 for 160- 80 meters may be wound by wire in

**Note:** Capacitors C1 and C5 may need be chosen to your implementation of the L1 and L2. Use a variable capacitor with a big marked limb to determinate the value of C1 and C5. Then install a fixed capacitor instead the variable.



L2 for 160- 80 meters may be wound by wire in diameter 0.1- 0.2 mm (37- 32 AWG), for 40- 30 meters may be wound by wire in diameter 0.25- 0.5 mm (30- 24 AWG), for 20- 10 meters may be wound by wire in diameter 0.5- 0.8 mm (24- 20 AWG)

L3 for 160- 80 meters may be wound by wire in diameter 0.1- 0.2 mm (37- 32 AWG), for 40- 30 meters may be wound by wire in diameter 0.25- 0.5 mm (30- 24 AWG), for 20- 10 meters may be wound by wire in diameter 0.5- 0.8 mm (24- 20 AWG)

When TX is assembled and tuned, it is possible try to do QSOs using this one and separate receiver. At this case increase the capacity of the shift – frequency

**Part List TX**

**Tubes:**

V1: Russian Tube 6J2P- small RF Pentode with short characteristic

V2: Russian Tube 6J1P- small RF Pentode with short characteristic

V3: Russian Tube 6P15P- RF Power Pentode

**Resistors:**

R1: 39 k/ 0.25 W\* (27- 100 k)  
R2: 3.3 k/ 0.5 W\* (680  $\Omega$  – 5.6 k)  
R3: 15 k/ 2 W\* (12 – 18 k)  
R4: 18 k/ 2 W\* (12- 24 k)  
R5: 3.3 k/ 0.5 W\* ((680  $\Omega$  – 5.6 k)  
R6: 39 k/ 0.25 W\* (27- 68 k)  
R7: 39 k/ 0.25 W\* (27- 51 k)  
R8: 5.6 k / 1 W\* (3.3- 6.8 k)

\*Recommended

() In brackets- may be used

**Capacitors:**

C1: 2... 10 pF\*  
C2: See Table 1  
C3: 100 pF\*\*  
C4: 0.022  $\mu$ F\*\*\*  
C5: **See Table 1**  
C6: 0.022  $\mu$ F\*\*\*  
C7: 100 pF\*\*  
C8: See Table 1  
C9: 0.022  $\mu$ F\*\*\*

capacitor C1 to 100... 300-pF. It makes the shift of the VFO frequency far away from the amateur band. Solder the C1 to another end of the S1.1 (compare to shown in **Figure 1**) to shift the frequency in the low edge of the frequency band.

**Note:** Do not stay V3 at high voltage when the VFO or/and driver does not work properly. V3 gets the grid bias voltage from detecting an RF by the part- “1-grid- cathode.” Without bias voltage (the same without an RF on the first grid) the tube may overheat (due huge anode current) and go off operation. After tuning TX tune the RX part.

C10: 0.01  $\mu$ F\*\*\*  
C11: 0.01  $\mu$ F\*\*\*  
C12: 0.01  $\mu$ F\*\*\*  
C13: 0.01  $\mu$ F\*\*\*  
C14: See Table 1  
C15: See Table 1  
C16: See Table 1  
C17: 27 pF\*\*  
C18: 0.022  $\mu$ F \*\*\*  
C19: 100 pF\*\*  
Cn: 10- 50 pF\*\*\*\*

\* Depend on frequency shift  
\*\* Tolerance +100- 30%  
\*\*\* Tolerance +200- 30 %  
\*\*\*\* Depend on used band

**Diodes**

VD1: Zener Diode, 100 V/20 mA, should be placed on a small heater sink, I had used a coin having dimension of a 25 cents US coin.  
VD2: Any small power RF diode  
VD3: Any LED  
VD4: Any small power RF diode  
VD5: Any small power RF diode

**Switches:**

S1: Any DPDT switch that can be used at 250 V/ 100 mA

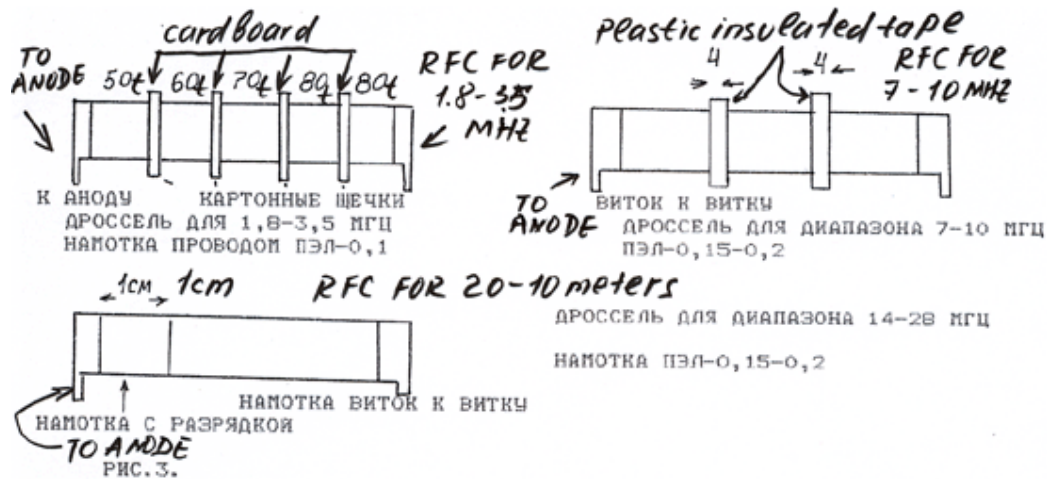
**Connectors:**

X1: Any RF Connector  
X2: 5- PIN Audio Connector



**RF- Choke:**

RFC1: Wound on Russian Resistor WS-2 (sizes: diameter 9.7-mm, length 49-mm), resistance more than 51-k. **Figure 3** shows the RFC implemented for different bands.



**Figure 3.** RFC for TST

- A) 180- 80 meters: 50+60+70+80+80 turns by insulated wire 0.1-mm (38-AWG);
- B) 40- 30 meters: 3 section wound turn to turn by insulated wire 0.2- mm (32- AWG);

- C) 20- 10 meters: 1 section is wound with step 0.3 – mm, second section wound turn to turn by insulated wire 0.2-mm (32-AWG).

**RX**

A DC receiver is used at the TST. **Figure 4** shows schematic of the receiver.

**Figure 4.** Circuit diagram for DC receiver of the TST

**RF Amplifier:** It has active component T1 and T2. VD1... VD4 are protected the input RF Amplifier from an overload by own transmitter or power signals coming from the Air. The diodes allow use for the transceiver a separately antenna (sometimes it allows to avoid AC hum in the head phones). Adjusting the RF Amplifier is simple. With help of R3 install at emitter of T2 half voltage compare to collector T2. Check current of T2. It should be 5- 10-mA. If the current is higher – increase R1 then check again voltage at emitter T2. If the current is lower, decrease the R1, then again check voltage at emitter T2. L1C1 and L2C5 should be tuned on working frequency.

**Driver for VFO:** It is made on T3. Check drain current when signal from VFO is applied to the gate of the T3.

It should be not more then 15-mA. If the current is more, play with R5 and C6. It is useful to play with R5 and C6 on to best reception.

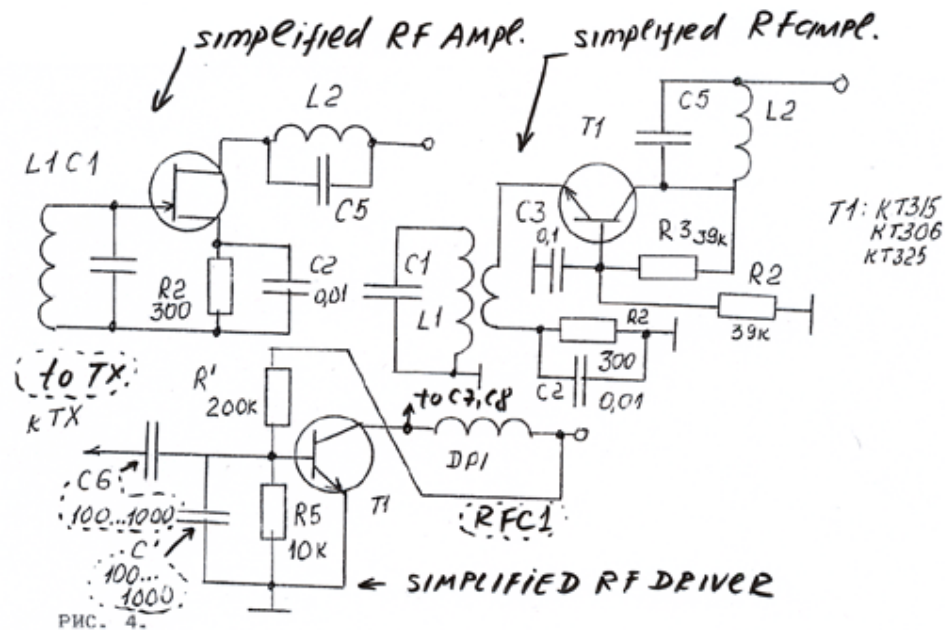
**RF Amplifier and Driver for low- bands:** At 160- 40 meters you may use simplified RF amplifier made on 1 transistor and driver made on usual bipolar transistor. However, at such design the AC hum may come to head-phones. It may come difficulties with adjusting the driver to obtain an optimal RF voltage at mixer. Frequency between TX and RX may drift. **Figure 5** shows the schematic for simplified RF Amplifier (A) and Driver (B).

**Quasi- Balanced Mixer:** It is made on diodes VD5... VD9. RF is coming through L2.2 to the mixer. R6, R7 and C7, C8 provide quasi - balancing. No tuning and adjusting at right parts.

**Audio Filter:** It is made on C9, R8 and C10. Cutting frequency is near 3.5-kHz. If you have a commercial made Audio Filter (for example, from an old TRX) – use it. Turn on this one instead R8, C10 may be deleted. It is possible turn on instead R8 an old Universal Magnetic Head (from an old tape recorder), however, in some case an AC hum may come. No tuning and adjusting at right parts.

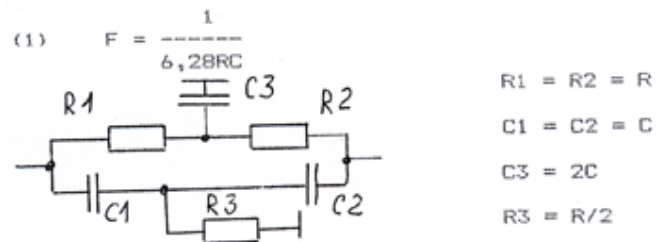






**Figure 5** Circuit diagram for simplified RF Amplifier (A) and Driver (B)

**Audio Amplifier:** It is made on T4, T5, T6, T7. It is preferable to use a low noise high – gain transistors. It may be any low power old- made germanium or modern silicon transistors. Adjusting is a very easy. With help of R9 install at collector T4 the voltage 4.5-V. With help of R21 install at collector T4 the voltage 6.0-V. If audio amplifier has self-excitation, increase R11 (for example to 6.8-k or more).

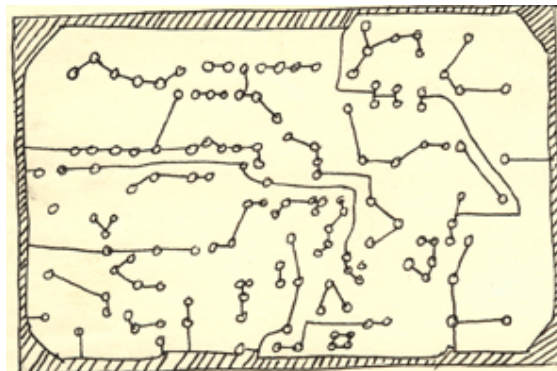


**Figure 6** Bridge Wien

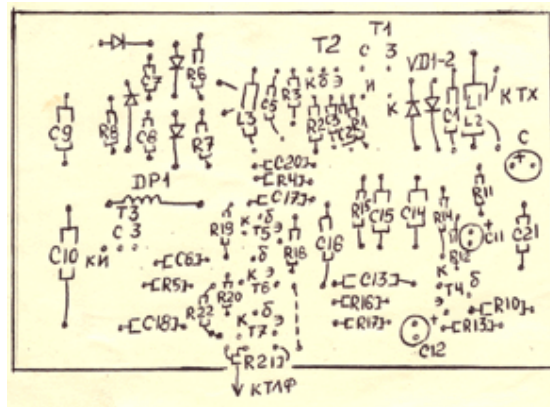
**Bridge Wien:** Bridge Wien (detailed shown on **Figure 6**) does rejection of the 50-Hz. The frequency is used at AC in Europe. It is possible re-count (using equation from the **Figure 6**) both as rejection frequency as parts for the bridge. Parts should have as possible small tolerance as can.

It is possible to use a precision potentiometer instead R3 (on **Figure 6**) to adjust the rejection frequency.

**Figure 7** shows PCB (from side of the foil). PCB has sizes 100 x 70 mm. **Figure 8** shows view to montage of the RX. Board made by through- hole montage.



**Figure 7** PCB of the RX



**Figure 8** Montage of the RX  
(Arrow shows to “Phones”)

### Part List RX

#### Resistors:

R1: 300/0.25 W\*  
 R2: 39 k/ 0.25 W\*  
 R3: 39k/ 0.25 W\*  
 R4: 220 /0.25 W\* (200- 1000 Ω)  
 R5: 39k/0.25 W\*  
 R6: 360/0.25 W\* (470- 1000 Ω)  
 R7: 360/ 0.25 W\* (470- 1000 Ω)  
 R8: 2.2k/0.25 W\* (1k- 3.9k)  
 R9: 100k/0.25 W\*  
 R10: 10k/0.25 W\* (5.6k- 10k)  
 R11: 3.9k/0.25 W\*  
 R12: 8.2k/ 0.25 W\* (5.1k- 10k)  
 R13: 1k/0.25 W\*  
 R14: 150k/0.25 W\*\*  
 R15: 150k/0.25 W\*\*  
 R16: 150k/0.25 W\*\*  
 R17: 150k/0.25 W\*\*  
 R18: 220k/0.25 W\* (39k- 300k)  
 R19: 39k/0.25 W\* (27k- 51k)  
 R21: 10k/0.25 W\* (8.2k- 12k)  
 R22: 3.9k/0.25 W\* (3.9k- 6.8k)

\*Recommended

\*\* Tolerance 2%

() In brackets- may be used

R6 must be similar to R7

#### Capacitors:

C1: [See Table 2](#)  
 C2: 0.01 uF\*  
 C3: 0.01 uF\*  
 C4: 68 pF  
 C5: [See Table 2](#)  
 C6: 68 pF

C7: [See Table 2](#)

C8: [See Table 2](#)

C9: 0.5 uF

C10: 0.1 uF

C11: 5.0 uF\*\*

C12: 5.0 uF\*\*

C13: 0.022 uF\*\*\*

C14: 0.022 uF\*\*\*

C15: 0.022 uF\*\*\*

C16: 0.022 uF\*\*\*

C17: 0.022 uF\*\*\*

C18: 0.1 uF \*

C19: 3300 pF\*

C20: 50.0 uFf\*\*

C21: 0.1 uF \*

C22: 1.0 uF \*

\* Tolerance +200- 30%

\*\* Electrolytic

\*\*\* Tolerance 5%

C7 must be similar to C8

#### Diodes

VD1- VD10: Any small power RF diodes

VD5- VD8 must be similar

#### Connectors:

X1: 5- PIN Audio Connector

#### RF- Choke:

RFC1: Wound bulky by insulated wire 0.1-mm (38-AWG) on Russian Resistor WS- 0.5 (sizes: diameter 5.5-mm, length 26-mm), resistance more than 51-k. For quantity of turns see [Table 2](#).



**Semiconductors**

VT1: Small power N- channel RF FET  
 VT2: Small power NPN bipolar RF transistor  
 VT3: Small power N- channel RF FET

VT4: Low noise high- gain PNP audio transistor  
 VT5: Low noise high- gain PNP audio transistor  
 VT6: Low noise high- gain PNP audio transistor  
 VT7: Low noise high- gain PNP audio transistor

**Table 2.** Data for inductors for the receiver

ТАБЛИЦА 2 ДАННЫЕ КОНТУРОВ РХ												
ДИА- ПАЗОН	1,8	3,5	7	10	14	18	21	24	28			
L1, L2	68	38	22	17	17	17	17	17	17	*		
C1, C5	360	300	270	240	120	100	91	51	30			
C7, C8	1000	680	510	390	330	240	200	120	100	**		
ДР1	300	250	200	180	120	120	120	80	80	***		

\* Inductors for 160- 80 meters is wound bulky by insulated wire 0.1-mm (38-AWG) on Russian Resistor MLT- 2 (sizes: diameter 8.6-mm, length 18.5-mm), resistance more than 51-k. For others bands (40- 10 meters) the inductors are wound uniformly by insulated wire 0. 5-mm (25-AWG) on Russian Resistor MLT- 1 (sizes: diameter 6.6-mm, length 13-mm), resistance more than 51-k.

\*\* C7 and C8 may have tolerance -60 +100%, however, C7 must be similar to C8

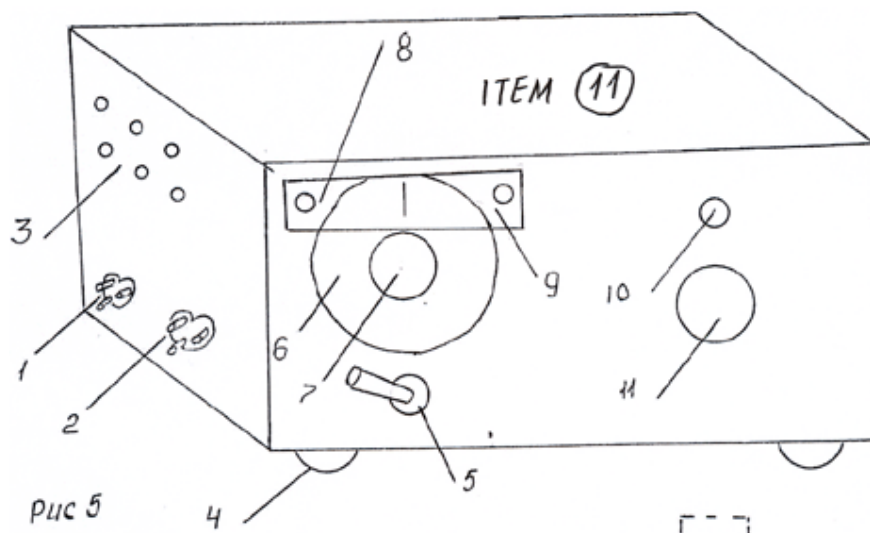
\*\*\* RFC1: Wound bulky by insulated wire 0.1-mm (38-AWG) on Russian Resistor WS- 0.5 (sizes: diameter 5.5-mm, length 26-mm), resistance more than 51-k.

**Figure 3.** RFC for TST

**Note:** Capacitors C1 and C5 may need be chosen to your implementation of the L1 and L2. Use a variable capacitor with big marked limb to determinate the value of C1 and C5. Then install a fixed capacitor instead the variable.

**Design TST**

Experience shows that design in DC transceiver plays the same role as the schematic does. Perform the transceiver strictly to the draft and you obtain good result. **Figure 9** shows design of the TST.

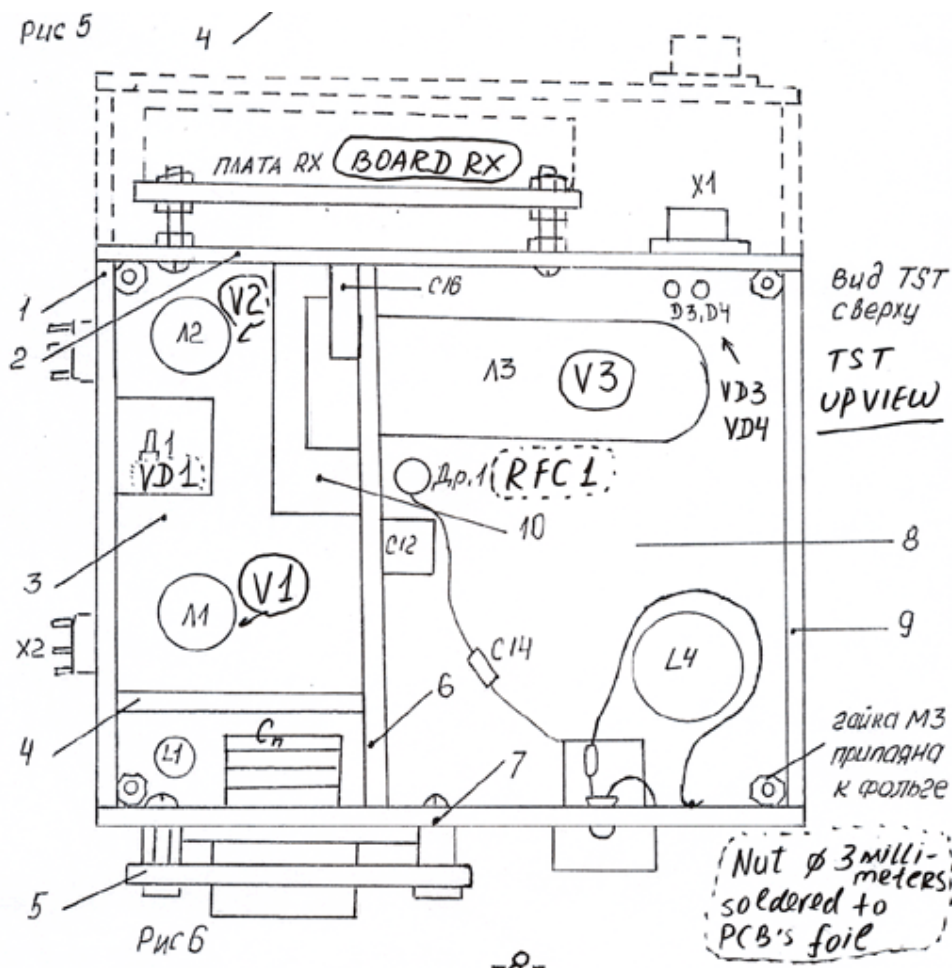
**Figure 9** Design of the TST

According to **Figure 9**:

1. Connector + 250/+12/ AC 6.3V
2. Key
3. Ventilating holes
4. Stipes (may be made from a cap of toothpaste)
5. Toggle - Switch TX-RX
6. Tuning Dial, made from a PCB stuff
7. Tuning Knob (may be made from a cap from a plastic can), glued by "Crazy Glue" to item 6
8. Wide Strap (made from transparent Plexiglas)
9. Support Pole
10. LED TX
11. Tuning PA

**Figure 10** shows the view upside to the montage of the TST. Montage must be done strictly to the figure.

**Figure 11** shows view to inside of the TST. Drafts with sizes (in millimeter) for items 1- 11 are shown below. Leads of the TX's parts are soldered to pad (the pad dimension on 4x4 mm are cutting on the PCB at parts position). L4 made from a heavy wire (for 20- 10 meters) may be just soldered by its leads to X1 and C15. L4 for 160- 30 meters wound on a form (plastic or cardboard) may be fastened to item 8. Holes intended the Tube Plastic Socket have sizes a bit less the sockets. So the sockets are hard inserted to the holes then grounding leads soldered to PCB.



**Figure 10.** View upside to the montage of the TST

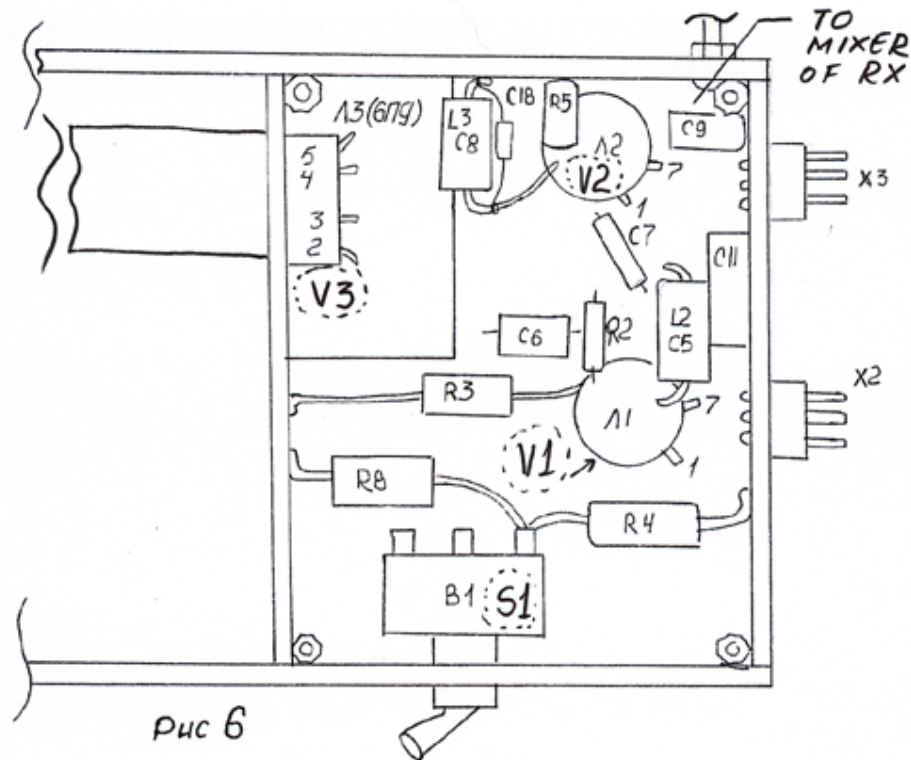
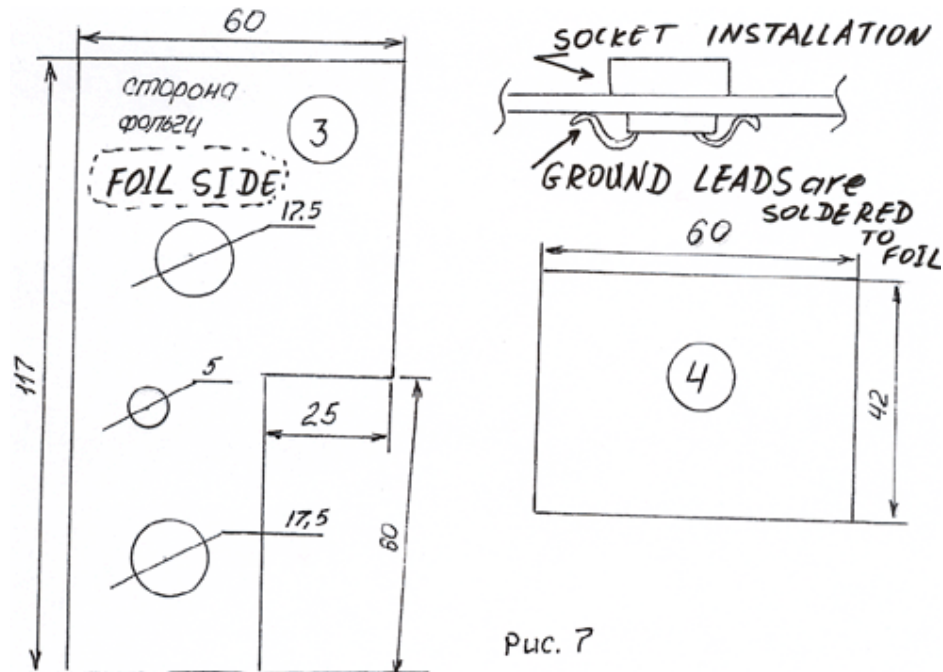


Figure 11. View inside of the TST

**Steps to assembling TST:**

1. Have done ready items 1- 11 (do not forget that item 6 made from a double- sided PCB)
2. Have checked that all holes are made and made correctly
3. Install tubes' sockets
4. Solder edges at items 1- 9
5. Do fastened in several points item 1,2,7,9



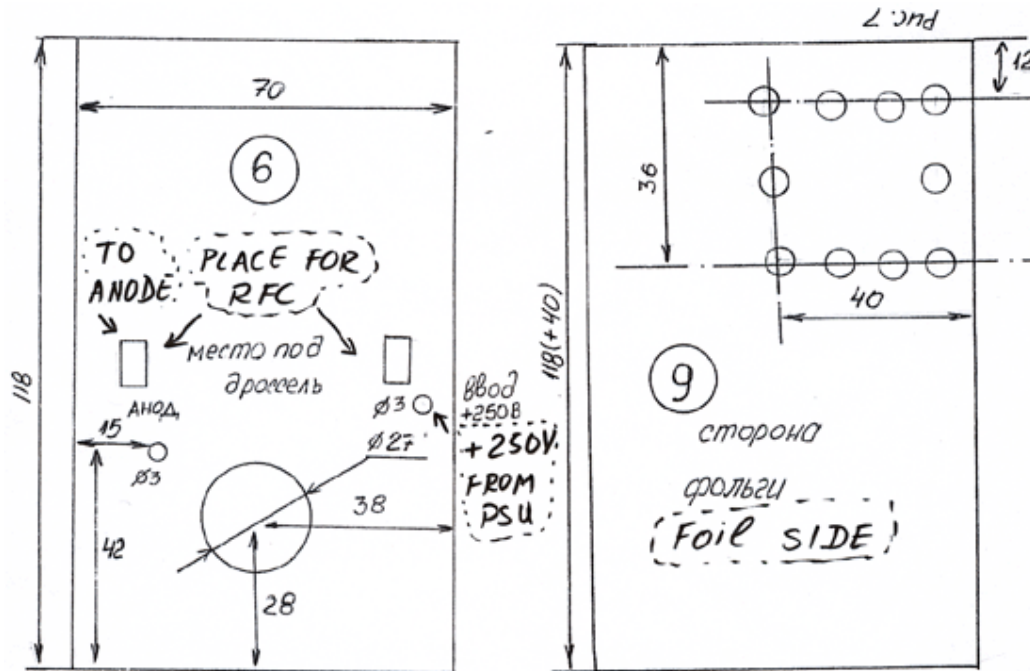
Items 3- 4



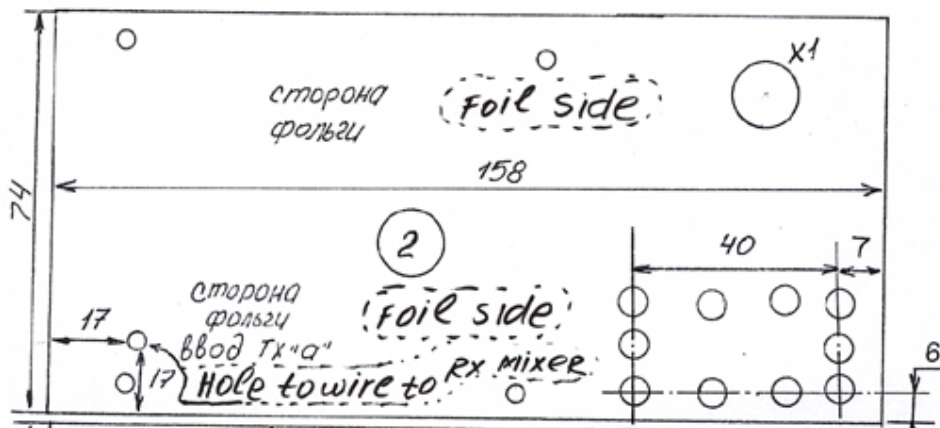
6. Do fastened in several points item 3,6,8
7. Do final soldering the (paragraph 5@6) items
8. Do montage TX
9. Tune the VFO to needed frequency range, then install item 4. VFO frequency may go down for a little.
10. Install a working board RX
11. Install item 5, do calibration of the transceiver

12. Install cover 10 and 11. Cover 11 is installed up the transceiver, cover 10 (consists from 2 parts) down the transceiver. Item 10a closes VFO, item 10b closes PA.

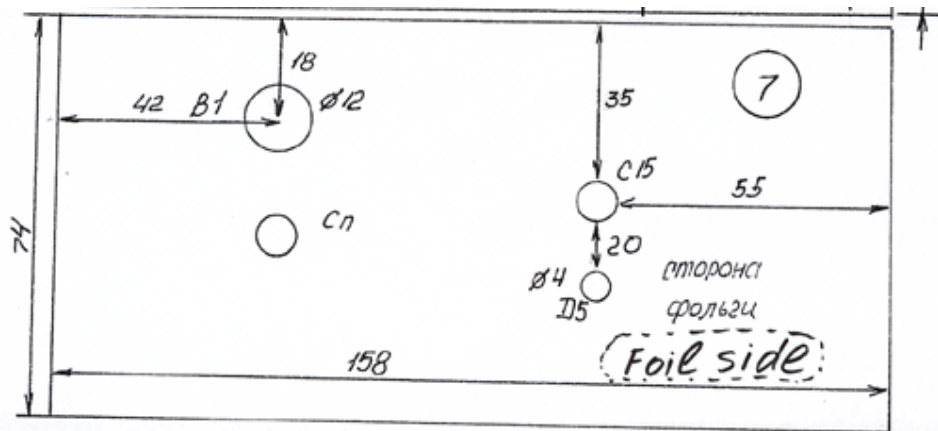
It is possible to do item 1, 9 10 and 11 a little bigger (shown in dashed line at [Figure 9](#)). In this case all sides of the transceiver will be closed. Transceiver will be work more stable at 20- 10 meters.



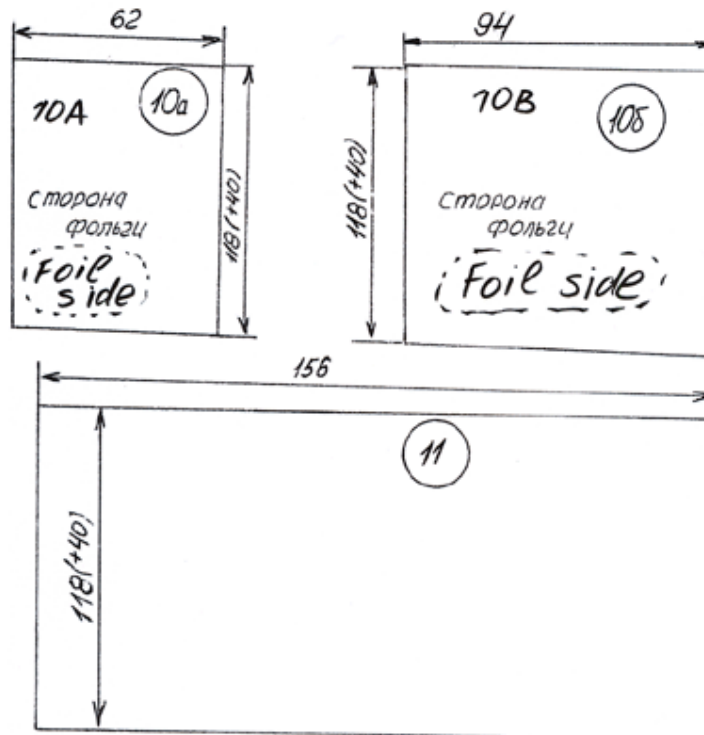
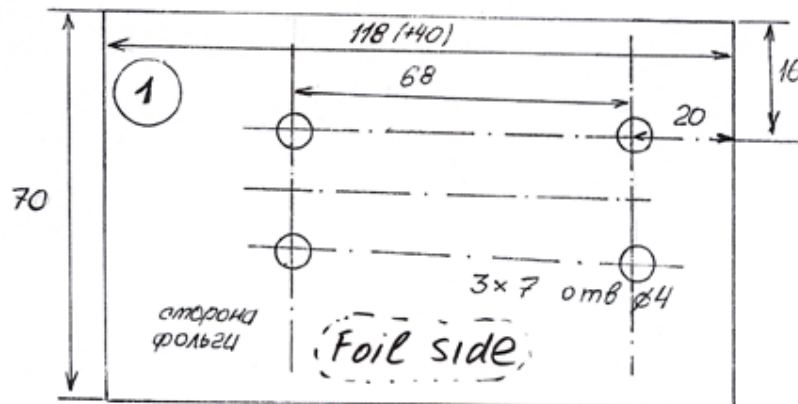
### Item 6, 9



## Item 2



Item 7



Item 1, 10, 11

