Simple Broadband P.A.

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Credit Line:

"QRP Transceivers and PAs from Accessible Parts ": by Igor Grigorov, UA3ZNW

The P.A. is very simple. It is usual push- pull (made on VT1, VT2) with some tricks which allows to make the P.A. in easy style.

How it is work: Transformer Tp1 provides matching 50-Ohm input of the P.A. with low resistance input impedance of the and makes symmetrical of the unsymmetrical50-Ohm input with the symmetrical push-pull input. Transformer Tp2 works something like RF-Choke plus Push- pull transformer. Transformer Tp3 provides matching "balance" push- pull output with unbalance output 50-Ohm. If you use to a symmetrical antenna (for example dipole, quad, delta) which is connected to the P.A. by a short length of a coaxial cable you may do not ground the pin "4" at the transformer Tp3. **Figure 1** shows the schematic diagram of the P.A.

(***Note I.G.:*** Generally speaking it is not correct description, but I leave it as is for some reason. The schematic is only first step for ham to the miracle world of the P.A. I would like to leave "academic" description for next steps…)

Correctly assembled (using right parts) amplifier requires a minimal adjustment. At first it needs to install collector current. It is equal 50-mA/ at power 20-Wtts, 100-mA/ at power 40-Wtts, 150-mA/ at power 60-Wtts. It is desirable to use a low- frequency (or resonated) filter before the P.A. and antenna.

For example, you may use filters from **References 1**. If a high impedance antenna will be used with the P.A., it is possible to install transformer 50/300-Ohm or 50/450-Ohm at the output of the transformer and feed the antenna through a two-wire line. At radio-amateurs source it is possible to find lots different designs for such transformers, for example in **Reference 2**.

Matched pair of the RF-power transistors should be used in the amplifier. Best way is to buy such matched transistors from supplier. However, if you have a stock of 10- 20 RF- power transistors, you may to find a matched pair from these ones. To provide this it is necessary to measure some parameters of the transistors. Transistor is switched on in the circuit shown in **Figure 2**. Install with help R2 collector's current equal to 50/100/200/500/1000-mA. Do measuring fast enough while the transistor should not be warm too much. Better way is to use a heat sink for the transistor. Transistors which plots are mostly close are the matched pair. Remember, that collector current divide to base current is amplification factor (gain). Matched pair should consist of from transistors with gain that do not differ more then 20% at different currents.

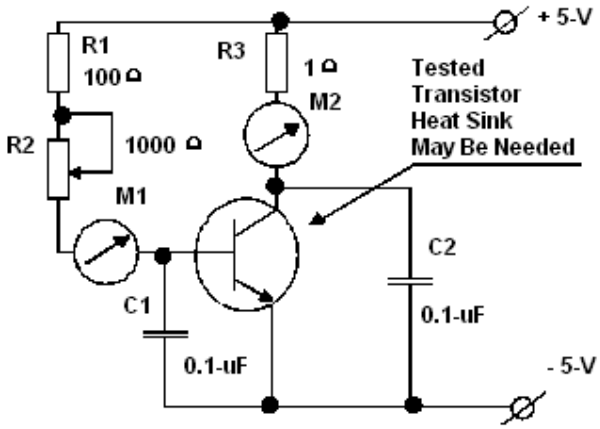


Figure 2 Circuit for finding of matched pair of the RF power transistor

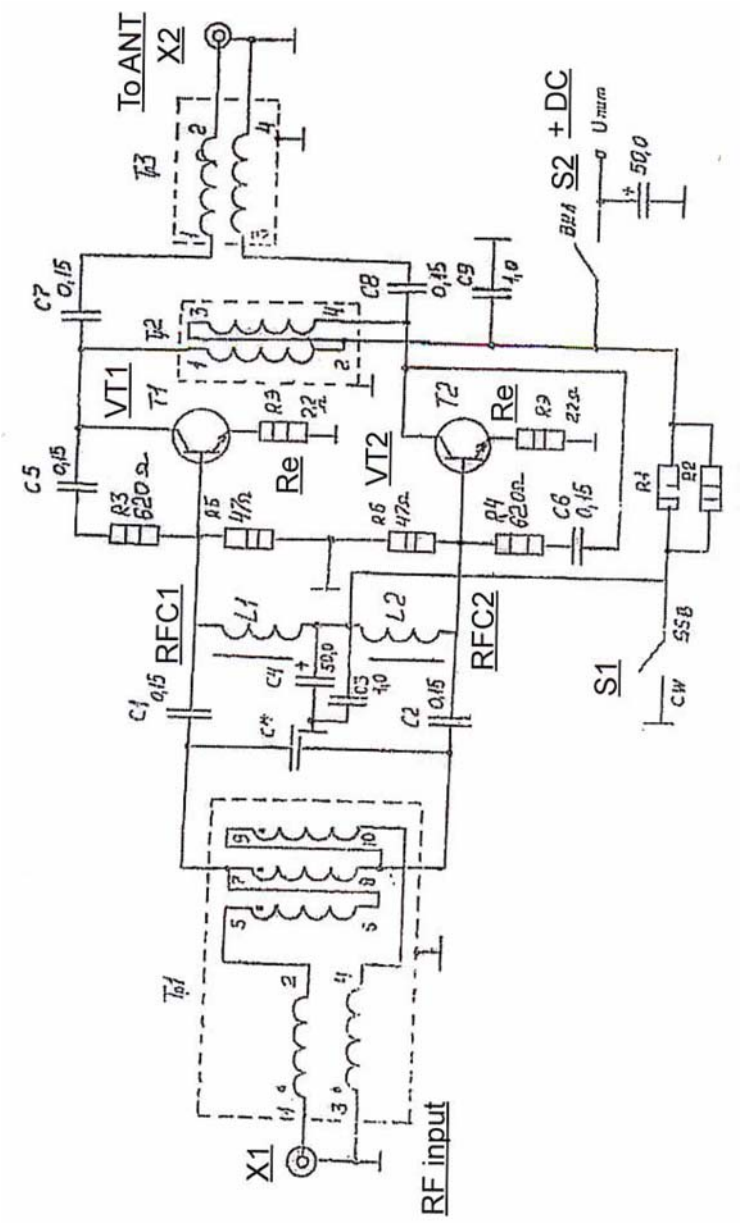


Figure 1 schematic diagram of the P.A.

(***Note I.G.:*** Generally speaking, 5 points it is not enough for normal selection of matched pair of transistors. It is desirable to do the selection using 7-10 points, thus the tolerance at amplification factor should be not more the 10%. I do not speak about selection of a matched pair using measuring of the transistor parameters at different frequencies because it goes away from the radio- amateur technology.)

It is possible to use non matched transistors but it needs install individual for each transistor biasing. To do this cut jumper between L1 and L2. A capacitor 50-micro- farads is soldered in bridge with C3. A capacitor 1-micro- farads is soldered in bridge with C4. With help of additional base resistors install equal current for each of the transistors. Turn RF power to the input of the P.A. With help of an oscillograph check the shape of RF- voltage on the Dummy Load and on the collector of each of the transistors.

Do the check at different frequencies. Adjust biasing on to minimum distortions. Capacitor C* (200- 600-pF) may help to illuminate distortions. However the method required some experience. Sometimes (when the transistors are too different) satisfied result is not possible.

Resistors Re have nominal from 1to 4 –Ohms, depend on output power. Less at high power and more at low power. Sometimes, when not matched transistor pair is used to the P.A. the resistors may have different nominal, it is possible to fond right value with help of oscillograph on to minimum distortions.

P.A. has two modes: SSB and CW. At CW mode the transistors work in mode "B'- the bases closed to ground (with help of S1) through RFC1 and RFC2.

Practically any RF transistors can be used at the P.A.

RFC1 and RFC2 are wound on a ferrite core 8-millimeter OD and 10 millimeter in length. The ferrite core is cut off from a ferrite rod using in "magnet antenna" for a transistor radio. RFC1 and RFC2 have 80 turns each wound by copper wire in 0.1- millimeter (38-AWG). Transformers Tp1, Tp2 and Tp3 are wound on a ferrite core. As usual for the P.A. I use to a ferrite from TV Flyback. Not bad work a ferrite core from a monitor Flyback. It is possible to use ferrite core from T.V. yoke. Transformer Tp3 works well when it is wound on a ferrite from yoke. All transformers are wound by insulated copper wire in diameter 0.5- millimeter. Transformer Tp1 is wound by twisted and tripled wires, one turn to one centimeter of the length. Transformers Tp2 and Tp3 are wound by twisted wires, one turn to one centimeter of the length. Design of the transformers is shown on **Figure 3**.

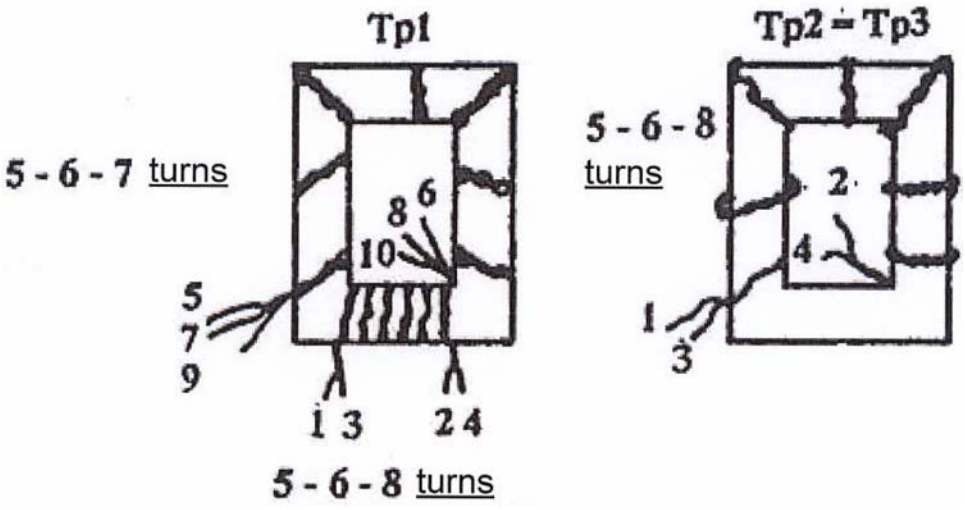


Figure 3 Design of the transformers Tp1, Tp2- Tp3

Ferrite core is wound by soft plastic insulation tape. After winding the coils also are wound by soft plastic insulation tape. Transformer is installed on the main PCB. Two PCB square are installed at the sides of the transformer. With help bare copper wire (1-millimeter or 18-AWG diameter) the squares are soldered between each other and soldered to the main PCB. Installation of the transformers is shown on **Figure 4**.

The heat sink for the P.A.'s transistors made from aluminum H- stuff. It is possible to by such stuff at a household shop (such like Home Depot). **Figure 5** shows the installation of RF-power transistor to the H-stuff. **Figure 6** shows PCB for the P.A.

The adjusted PCB is installed inside a cabinet made from two- sided PCB. Jointing of the PCB-stuff is carefully soldered. P.A.'s PCB may be soldered to the PCB – stuff of the cabinet. At four corners (up and down) of the cabinet a nuts M4 are soldered. To the nuts upper and low cover is fastened. Near the heat sink of the transistors (at cabinet and at covers) are drilled ventilation holes (3-4 millimeter in diameter). RF connector "Input" and toggle switches "SSB/CW" and "OFF/ON" are installed at front panel. Connector "Antenna" and DC power supply terminals are installed at back panel. **Figure 7** shows the design of the P.A.

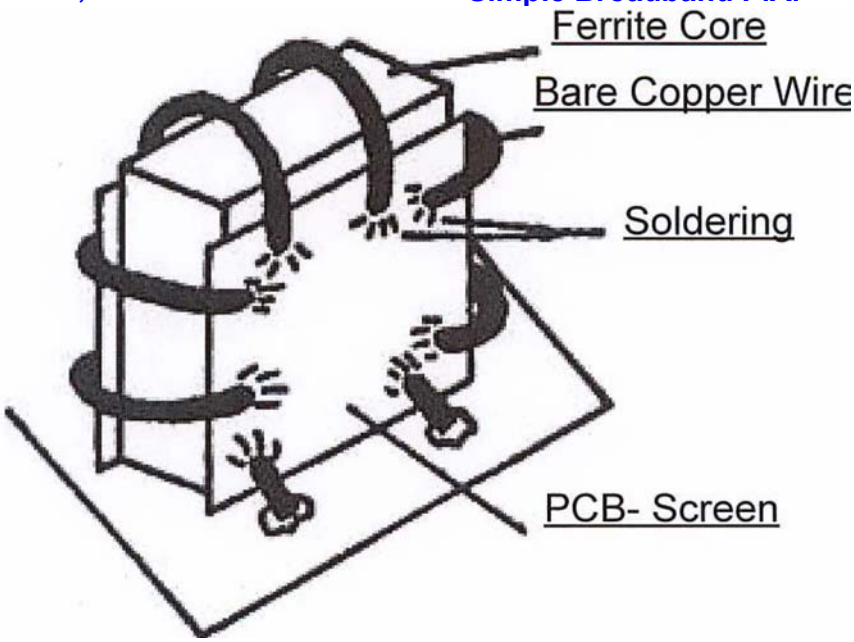


Figure 4 Installation of the transformers Tp1, Tp2- Tp3

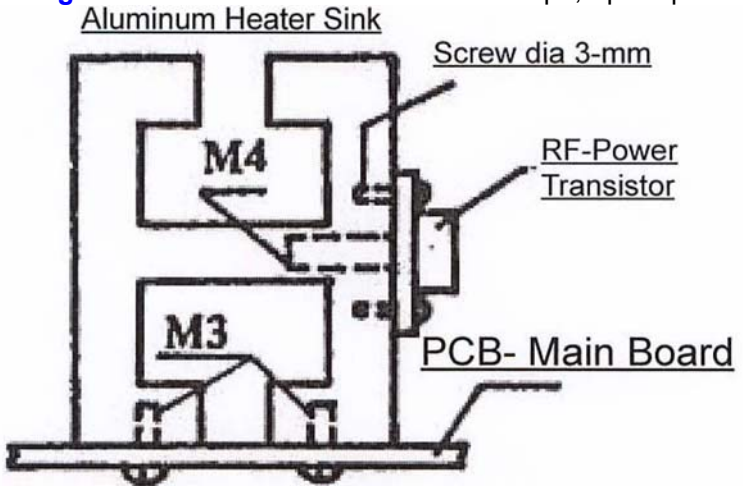


Figure 5 Installations of an RF-power transistor to a heat sink

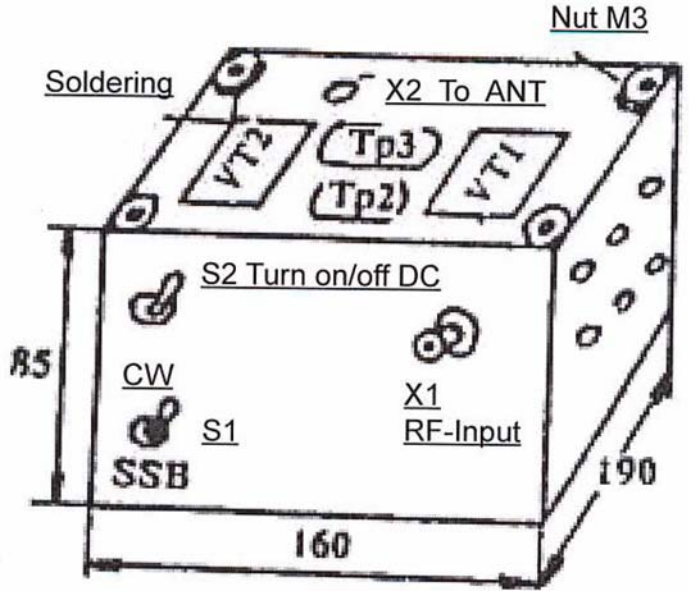
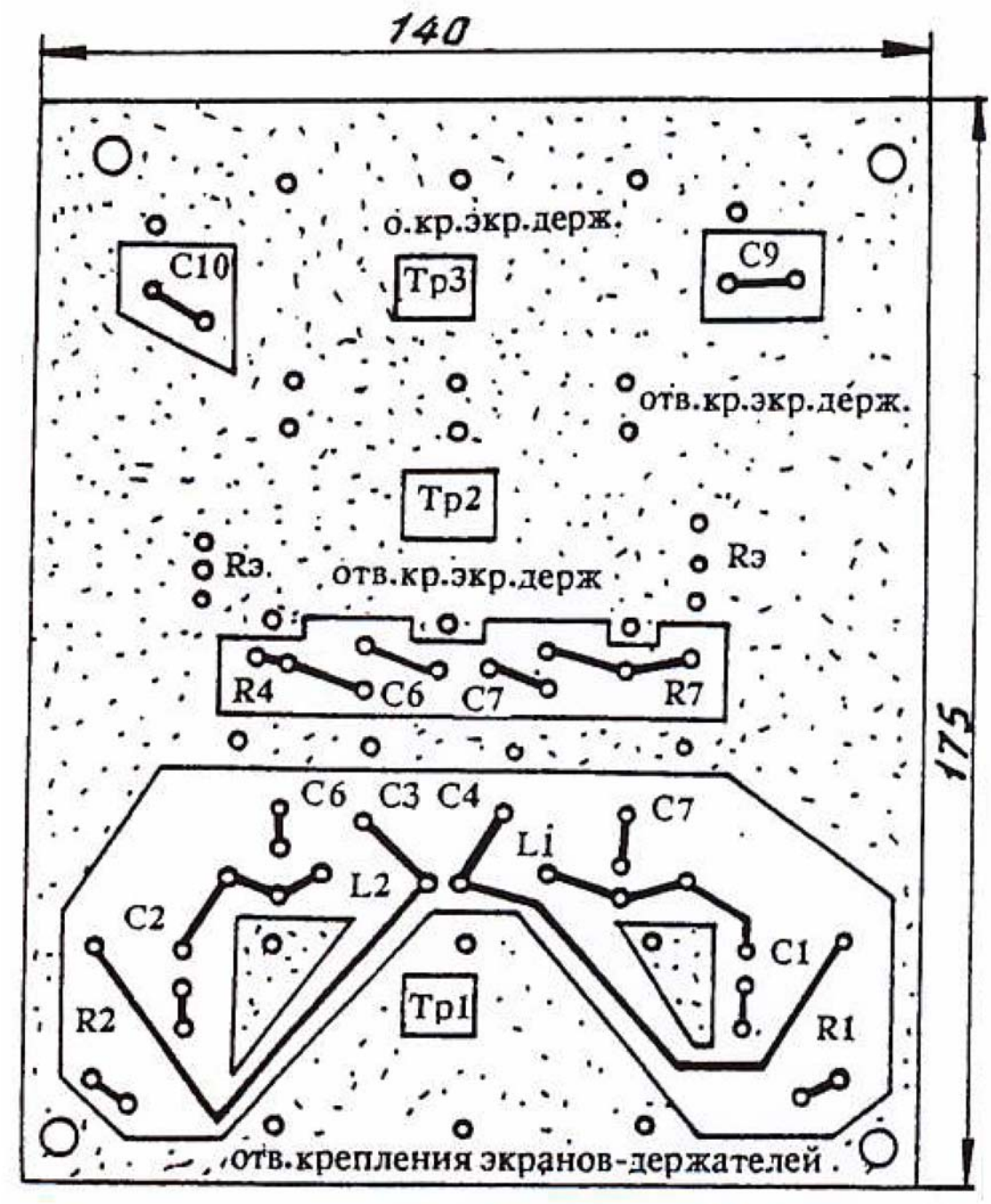


Figure 7 Design of the P.A.



Holes for Fastened
Transformer's Screen
(by bare copper wire)

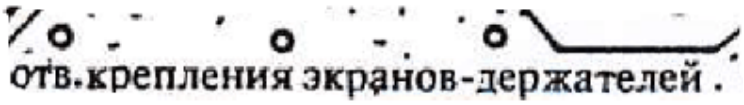


Figure 6 PCB for the P.A.

Home ferrite core made from a flat ferrite

The good results give transformers (Tp1, Tp2 and Tp3) wound on a home made ferrite core made from a flat ferrite. Such flat ferrite is used at some transistor LW/MW radio.

To make all three transformers it needs several such flat ferrites. I have bought a pile of the ferrites at a scrap-radio shop by very nice price.

Flat ferrite is cut on to pieces then the pieces are glued on to needed shape. It is possible to cut the ferrite with help a device shown on **Figure 8**. I cut ferrites having different shape (flat, round rod, toroid) with help of the device.

The device is very simple. It is an incandescent 40-Watts bulb (or simple soldering iron) that is turn on into the main. Any main -110 or 220-V works good, however, main on 220-V works better the 110-V. Two probes with hard steels sewing needle are inserting in one wire. To cut a ferrite it needs to mark the ferrite on to cutting line by a lead pencil.

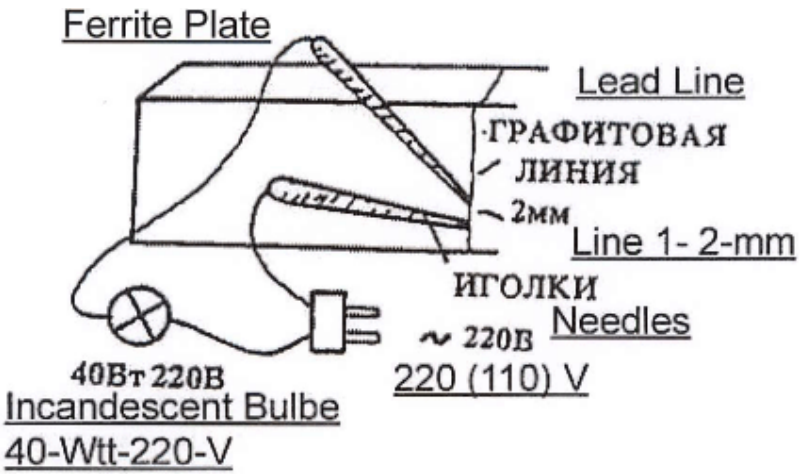


Figure 8 Cutter for ferrite core

(***Note I.G.:*** Lead pencil is very important at the process. Try several pencils at a scrap ferrite to find the pencil that helps cut the ferrite in the best way.) Turn on the cutting device in to the main. Touch by the needles the graphite line. Gap between the needles should be 1-2 millimeters. An arc going onto the graphite line will appear. The arc leaves a cavity on to the line. Move the probes and do the cavity on to all mark line. Then break the ferrite on to the line. It needs some experiences, it needs very quick to break this ferrite.)

(***Note I.G.:*** Be very careful because the PROBE IS SWITCH ON IN TO MAIN. Use good insulator for the probes and be very careful.)

The needles are heat up at the process, so, use heat-resistant stuff for the probes. After cutting several ferrites the needle's point should be sharpened or the needles should be changed.

As usual a flat ferrite used at "magnetic antenna" of a transistor radio has length in 90… 12- millimeters. At the case length for Tp1 is 1/3 from the length of the ferrite. Length for Tp2 is 1/2 from the length of the ferrite. Tp3 made like a double Tp2 or has the same design like a Tp2**. Figure 9** shows design of the transformers.

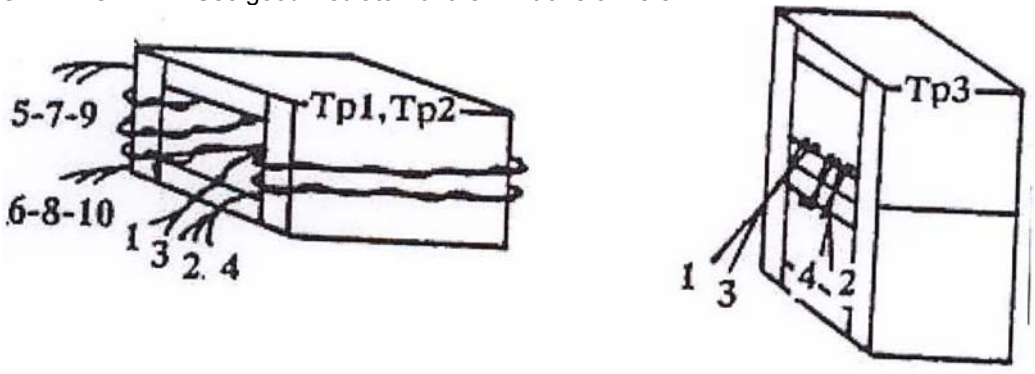


Figure 9 Design of the P.A. transformers

References:

1. S.G. Bunin, L. P. Yajlenko. Reference Book for Amateur Radio,- Kiev, Publishing House "Tehnika". 1978. (in Russian)

2. Igor Grigorov . Antennas: Tuning and Adjusting.- Moscow, Publishing House "RadioSoft", 2002, ISBN: 5- 93037-087-7 (in Russian)