Tuned radio frequency receiver

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This is a very simple reflex radio receiver for Middle Wave band. It needs no adjustment and consumes very low current (1..2 mA) in operational mode. The receiver is based on direct amplification circuit with one tuned tank circuit (fig. 1). The induction coil L1 and L2 is wound on a ferrite rod (a loopstick antenna) or a frame (a loop antenna). Variable capacitor C1 is used for tuning radio receiver.

RF signal from the tank L1C1 applied through the coil L2 to the three-stage direct coupled amplifier circuit based on transistors VT1-VT3.

The amplified signal is detected by diode detector VD1, RF part of the signal is suppressed by capacitor C2, and the audio signal through the coil L2 (the resistance of its coil for audio signal is almost zero) applied to the base of transistor VT1.

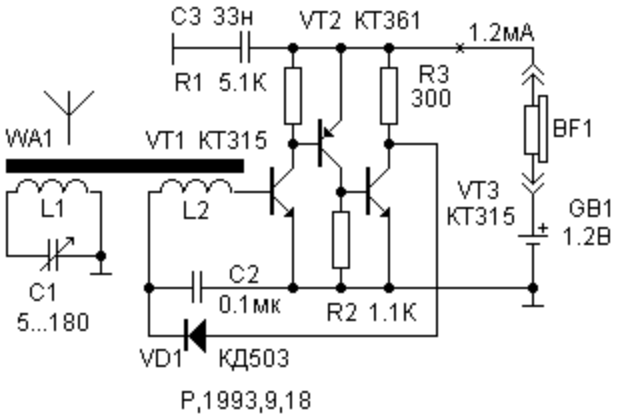

Fig. 1. VT1, VT3 (KT315) = BC547, VT2 (KT361) = BC557, VD1 (KD503) = 1N914,
C1 = 5..180 pF, C2 = 0.1 µF, C3 = 33 nF, Battery = 1.2 Volt.
R1 = 5.1K, R2 = 1.1K, R3 = 300

This is not a simple reflex radio circuit, because the diode VD1 is closing the negative feedback loop, and this negative feedback works for DC and AC. As a result the operating point of transistors is stabilized. With no signal applied, the collector voltage of the transistor VT3 equal to the sum of voltage across diode VD1 (about 0.5 V) and the cut-in voltage of the transistor VT1 (about 0.5 V). In this case the diode VD1 will work in the very beginning of its curve (the curve has maximum slope at beginning) because of the bias voltage of the transistor VT1, so we get a very good detector.

When RF signal is presented, the diode VD1 conducts a positive half-cycles, and the transistor VT1 starts to draw current. After that transistors VT2 and VT3 starts to draw current too. As a result, the

average voltage at collector of VT3 is dropping, and the current of all transistor is growing. The oscillogram of the signal at the collector of the transistor VT3 is shown on figure 2. We can see that positive half-waves of the modulated RF signal is tied up to the level of +1 volt, as in the same time the envelope (the audio signal) has a negative half-wave with doubled amplitude.

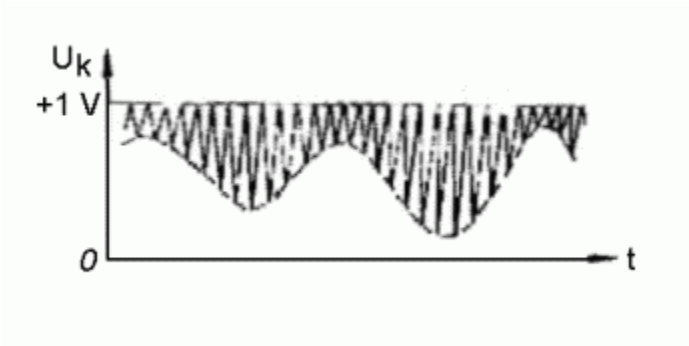

Fig. 2.

Because of the negative feedback we get very linear detector. If a level of the signal is too high and the negative half-waves of the envelope gets zero, then we get the distortion of the signal. It is can be fixed by detuning the L1C1 tank, or by changing the position of the loopstick, or by adding a resistor 20..100 Ohms to the emitter of the transistor VT1. But in this case the sensitivity of the receiver will be decreased.

For the audio signal all three transistors are current amplifiers and its collector currents is summing up in the power support wire, in which the headphone BF1 is connected. This circuit don't required a power switch, because the circuit starts to operate when the plug of headphone BF1 is inserted in the jack. The capacitor C3 prevents the RF signal to go to the headphone and battery.

Details. The transistors VT1 and VT3 - any NPN HF, VT2 - any PNP HF, with $I_{c\ max}$=100 mA, f_t=100 MHz. A value of a common-emitter current gain (h_{FE}) doesn't matter - if h_{FE} is high, then we get better sensitivity, but in any case the operating point of transistors will be stabilized. The diode VD1 - any HF common diode, but necessary are made of silicon. The variable capacitor C1 - any one with an air or a solid dielectric, but with maximum capacity not less than 180 pF.

The induction coil L1 and L2 is wound on a ferrite rod in a single layer. The ferrite rod has initial permeability of 400..1000, with section 20x3 mm, and with length of 50 mm and more. For MW band the coil L1 has 55..70 turns, the coil L2 has 5..7 turns of 27..30 gauge (0.25..0.35 mm in diameter) enameled copper wire. The gap between coils is about 5..7 mm. Instead of the ferrite rod can be used a loop antenna, it is wound on a frame 55x55 mm with 60 turns for L1 and 5 turns for L2. To receive LW band it takes to triple each coil turns (L1 =

165..210, L2 = 15..21 for the ferrite rod, and L1 = 180, L2 = 15 for the loop antenna).

The headphone BF1 has resistance of 50 ohms. With this headphone the receiver will work with the supply voltage of 1.2 volt and more. The current consumption is about 1.2 mA from 1.2 volt accumulator, or about 1.8 mA from 1.5 volt battery. It is possible to use headphones with resistance of 180 ohms, but it takes supply voltage of 2.4..3 Volt (if uses two accumulators or two battery). In this case the consumption current will be increased to 3..5 mA.

Excellent result has been achieved with headphones TDS-1 (8..16 ohms), connected in parallel, with supply voltage of 3 volt, it consumes 3 mA. It is possible to use high-resistance headphones of 4.4 kilohm, but it takes power supply of 4.5..9 volt. The current consumption is about 1..2 mA.

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