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Demonstration Of Acoustic Beats In The Study Of Physics

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Abstract — The article describes a device for demonstration of acoustic beats effect at the lecture on physics

Keywords—beating; acoustics; device; demonstration; physics

I. Introduction

Addition of two harmonic oscillations with close frequencies creates so-called beats. Oscillations must occur in the same direction. Beats in this case are periodic changes in the amplitude of the oscillations [1]. With acoustic waves, these are periodic oscillations of the sound intensity. Usually this effect is demonstrated by means of two tuning forks [2]. However, the volume level at such a demonstration is often insufficient for a large lecture hall (if you do not additionally use a microphone with an amplifier and loudspeaker). Since adjusting the tuning forks takes time, this method is also inconvenient for demonstration of the fact that the beats frequency equals to the difference of frequencies of the added oscillations. To eliminate these inconveniences, two separate generators of low frequency oscillations, an audio amplifier and a loudspeaker are often used. In this article, we describe a small-sized and convenient device, which combines all these functions.

II. Construction of the device

Schematically the device is quite simple (see Fig.1). It consists of a stabilized power supply, two identical audio frequency generators and an amplifier with a loudspeaker at the output. From the generator outputs the sound frequency voltage is connected simultaneously to the input of the amplifier. The frequency of one of the generators can be slightly changed by a regulator in relation to the frequency of the other generator. As result, we hear periodic changes in the intensity of sound, which is the beating. The beat frequency can be changed accordingly. The frequency of the sound itself is equal to the frequency, at which the generators are tuned.

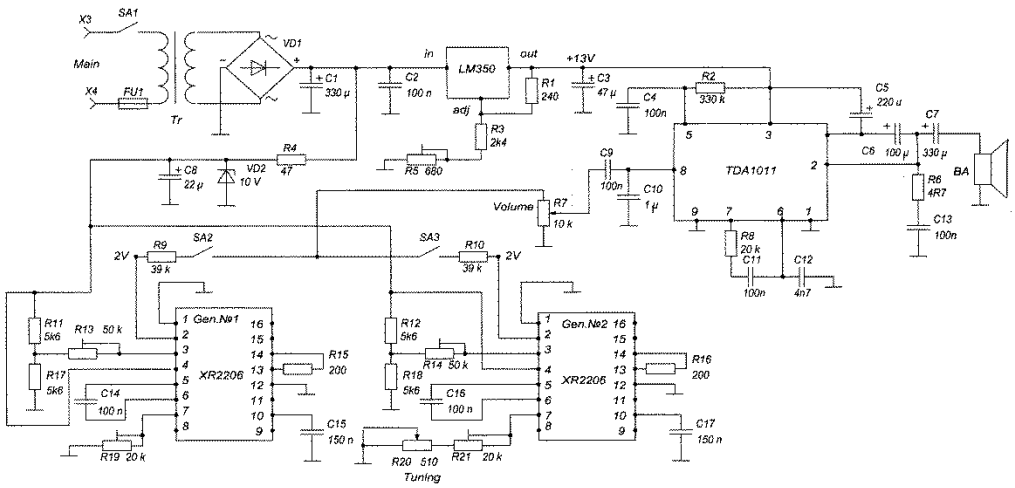

Fig.1 Electrical circuit of the device

The power of the transformer Tr must be at least 10 W. For a rectifier VD1 we may take almost any rectifying bridge with a load current not less than 1 A (for example, KBL01 . KBL10). At a load 0.5 A, the voltage value at the input of the voltage regulator (chip LM350) must be at least 16 V. With potentiometer R5 the voltage at the output of the voltage regulator is set at 13 V. It might happen that for this it would be necessary to slightly change the value of the resistor R3.

The audio amplifier (chip TDA 1011) provides under these conditions an output power at least 2 W. This chip, and the voltage regulator LM 350, must be installed on the heatsink. To the output of the audio amplifier there is connected a loudspeaker BA with a resistance of 4 Ohms. The volume of the sound is controlled by the potentiometer R7. If necessary, gain of the amplifier can be increased by decreasing capacitance of capacitor C10.

As generator No 1 and generator No 2 there are used monolithic function generators of the type XR 2206. Separately or together the outputs of these generators may be connected to the input of the audio amplifier using switches SA 2 and SA3. For the power supply of the generators at stabilized voltage 10 V there is used a Zener diode VD 2. Using potentiometers R13 and R14, the output of the generators (pins 2) is set at an effective voltage of 2 V. To achieve a symmetry of the alternating voltage at the output of the generators, it is possible to slightly change the value of the resistors R15 and R16. At one of the extreme positions of the regulator of the potentiometer R20, the frequency of each generator is set at 800 Hz using the potentiometers R19 and R21. Now with the potentiometer R20 we can change the frequency of the second oscillator by about 5 Hz.

When demonstrating the beating effect, first, each of the generators is connected alternately to the amplifier, using switches SA2 and SA3. Listeners get convinced that the frequency of sound of both generators is almost the same. After simultaneous connection of both generators, listeners hear beats, frequency of which can be adjusted approximately in the range of 0 .5 Hz.

The appearance of the assemblage device is shown in Fig. 2.

Fig.2 Appearance of the device

III. Conclusion

Schematically the offered device is very simple and easy to reproduce. We also note that the teaching of physics proves this device to be useful and convenient for demonstration of the above-described beat effect at lectures.

References

[1] Alvin Hudson and Rex. Nelson. University Physics. (second edition) , New York , 1990.

[2] http://americanhistory.si.edu/science/tuningfork.htm