Reproduction of Sounds from an Old Russian Wax Phonograph Cylinder by Various Optical Methods

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Abstract. The reproduction of sounds from old phonographic wax cylinders using a laser-beam reflection method was successfully developed at Hokkaido University about ten years ago. This development has made great contributions to the fields of folklore and philology because a lot of cylinders with culturally important contents remain in the world still now. That method was, however, limited to be applied to normal wax cylinders. Furthermore, an unavoidable noise problem caused by laser speckles occurs in this method. To overcome these demerits, active efforts have been made and, consequently, various methods for the reproduction of sounds are attempted. In this paper, the reproduction of sounds from an old Russian wax cylinder using various methods is introduced.

1 Introduction

After the invention of the tinfoil recording by Thomas Edison in 1877, a great progress has been made in the audio technology. Especially, the optical technology contributed a great deal to that technology such as CDs and MDs. It is evident that the analog audio has been overcome by the digital technology in audio markets. It is, however, recognizable that there are needs for the analog audio. In some cases, such needs come from a nostalgia or a maniac interest to an old technology. In other cases, there are academic needs for the analog audio because analog recordings include important cultural materials. The phonograph based on the tinfoil recording was invented by Edison in 1877. It was innovated until 1888 to a phonograph using wax cylinders and was used for both recordings and reproduction of sounds until about 1927. The most important characteristic of the innovated phonograph had the ability of recordings. Simply by replacing a stylus for reproduction with that for recording, it was easy to make recordings on a cylinder. Therefore, the phonographic wax cylinder system was used as a portable recording machine in the world. As a result, numerous kinds of recordings were made by field researchers at that time, and some of those recordings have remained until now and become important cultural inheritances.

The reproduction of sounds from old phonographic wax cylinders are easily realized by using an Edison-type phonograph. Although this phonograph is a proper way of the reproduction, it may cause damages on sound grooves of wax cylinders because of its heavy stylus pressure. The laser-beam reflection method was first developed at Hokkaido University [1] for the purpose of non-destructive

and non-contacting reproduction of sounds from Pilsudski's wax cylinders discovered at Mickiewicz University in Poland. This new method has made a great contribution to both philology and folklore of the Ainu people and originated various works on the optical reproduction of sounds from old phonographic wax cylinders and old disk records [2,3].

In this paper, the wax cylinders and the Edison-type phonograph are briefly introduced first. Next, the principle of the laser-beam reflection method is described as a basis for the optical reproduction of sounds from old wax cylinders. Furthermore, various attempts for the reproduction are shown. Finally, conclusive remarks are noted.

2 Wax Cylinders and Edison-Type Phonograph

The dimension of the standard type of wax cylinders are ≈2 inches diameter and ≈4 inches long. Sounds are cut on 100 grooves per inch. The playing speed is 90rpm for speech and 120–160rpm for music. Therefore, the playing time is about 4 minutes for speech and 2 minutes for music. There are cylinders of dense sound grooves(200 per inch) and of the longer dimension(150mm long) which are supposed to have been produced in order to cope with disk records.

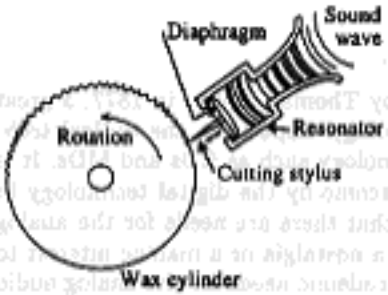

Fig. 1. Schematic diagram of the procedure for recording sounds on the wax cylinder

By using the Edison-type phonograph with a cutting stylus, the recordings were made on wax cylinders with a direct cutting method. Figure 1 shows this situation. Most of the phonographs did not provide an electric amplification system. Therefore, the cutting was performed only with the sound pressure transmitted to the stylus through the diaphragm and results in small variations of the cutting depth on sound grooves. The Edison-type phonograph had spread rapidly and widely all over the world after its invention. Although the major use of it was for amusements especially in the United States, its properties of portability and easy recordings made a great contribution to philology and folklore. The field workers at that time brought a phonograph with them and recorded various materials. In spite of the capability of easy recordings, the Edison-type phonograph gradually declined and was finally replaced by disk records until 1929.

3 Laser-Beam Reflection Method

Figure 2 shows an intersection of a wax cylinder and the principle of the laser-beam reflection method. Sound signals are recorded as vertical variations of the grooves. A laser beam is incident on the bottom of a groove of the wax cylinder and is reflected according to the law of reflection. Apparently, the direction of the reflected ray is proportional to the variation of the depth of the groove. Hence, by placing a position sensitive device (PSD) in the detecting plane, sound signals recorded on the cylinder are reproduced as the output signal of the PSD.

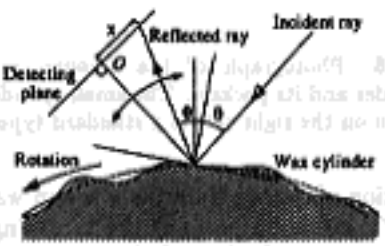

Fig. 2. Intersection of the wax cylinder and the schematic 2-D diagram of the laser-beam reflection method

The use of a laser source provides an ease of optical configuration. Especially, the focusing of a laser beam onto the bottom of a sound groove is easily establishable. On the contrary, some difficulties arise with the use of a laser. The major difficulty is a problem concerned to speckles. The surface roughness of sound grooves causes a speckling effect in the detecting plane and this results in an unnecessary noise for the reproduction of sounds because a PSD's output is proportional to the mean intensity distribution on its sensitive area. In addition to the noise problem described above, a tracking problem also arises inherently in the case of a non-contacting method. The larger radius of an illuminating laser beam spot causes an overillumination over the grooves of the wax cylinder and results in an echo problem for reproduced sounds. An adjustment error of the beam spot directly affects the direction of the reflected beam and produces an unrequired beam shift out of the detecting position.

4 Russian Wax Cylinder

A series of Russian wax cylinders were found at the museum of Petersburg and were considered to be the recordings of Chaliapin, a famous Russian Opera singer in the late 19th. But no notes concerned to the contents of the cylinder were found on the package. The dimensions of the cylinder are different from those of the standard type. The diameter is the same as the standard type, but the length is ≈6 inches, by which the playing time becomes longer. Figure 3 shows a photograph of the Russian wax cylinder and its package together with a standard wax cylinder on the right side. The phonographs which are available

still now for this type of cylinders are scarcely found and a prototype of the laser-beam reflection method is not available for the Russian cylinders because of the mechanical restriction. Therefore, a new system using the laser-beam reflection method which is applicable to various types of cylinders has been constructed.

Fig. 3. Photograph of the Russian wax cylinder and its package. The small cylinder shown on the right side is a standard type

By using the new system, the reproduction of sounds from the Russian wax cylinder has been successfully performed. There are 5 parts of the recordings which seem to be the readings of poetry. Various methods, including the use of an incoherent light source, the very low pressure contacting technique and the other attempts, have been applied to increase the quality of reproduced sounds. The main purpose is to establish a non-destructive and non-contacting method for the faithful reproduction of sounds from old phonographic wax cylinders. Each method successfully reproduced the sounds from the wax cylinder and the reproduced sounds seem to be good.

5 Conclusion

A new system which is applicable to various types of wax cylinders has been successfully developed. By using this system, various methods for the reproduction of sounds from old wax cylinders are investigated. Especially, the reproduction of sounds from the Russian wax cylinder with the longer dimension was made with this system. Although each method has its advantages and disadvantages, these methods will contribute to the non-destructive screening test of cylinders which have remained in obscurity in the world.

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