Experimental Studies on the Sound of a Japanese Temple-Bell ("Ojikichō" in Myōshinji-Temple)

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CITATION:

Aoki, Ichiro. Experimental Studies on the Sound of a Japanese Temple-Bell ("Ojikichō" in Myōshinji-Temple). Memoirs of the College of Science, Kyoto Imperial University. Series A 1932, 15(5): 311-313

ISSUE DATE:

1932-09-30

URL:

http://hdl.handle.net/2433/257016

Experimental Studies on the Sound of a Japanese Temple-Bell ("Ōjikichō" in Myōshinji-Temple)

By

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(Received August 3, 1932)

Abstract

The records of the sound waves of a Japanese temple bell belonging to Myōshinji-Temple in Kyoto, and known by the name of "Ōjikichō", were obtained by using a Low-Hilger audiometer. Analyzing them, the writer found six partial tones of frequencies about 129, 335, 550, 700, 900, and 1250. The strike-note is the 2nd partial, whose frequency is 335. About 10 secs. after the bell is struck, all the overtones disappear and only the fundamental tone continues.

In order to study the nature of the sounds emitted by Eastern bells, the writer recorded the sound waves of a large temple-bell, known by the name of "Ōjikichō," in Myōshinji-Temple in Kyoto by using a Low-Hilger audiometer, and analyzed the curves obtained into partial sine-curves. The method of investigation in this study was nearly the same as that previously reported by the present writer in these memoirs[1].

Fig. 1

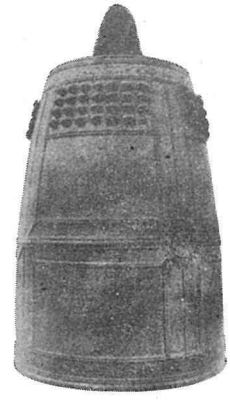
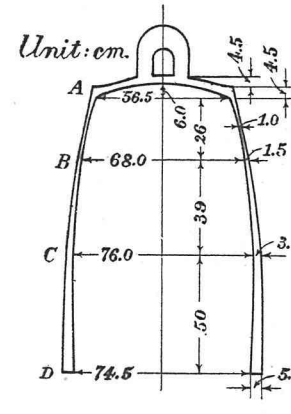


Fig. 2



The photograph and the dimensions of this bell are shown in Fig. 1 and Fig. 2. It is said that this bell was cast nearly 1300

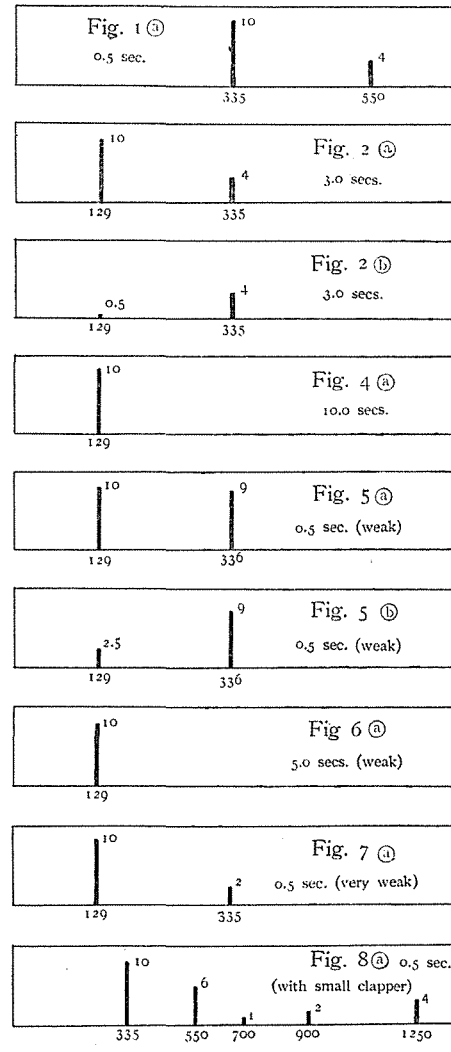
1. I. Aoki: Memoirs, Coll. of Sci. Kyoto, **14**, 213–218 (1931)

years ago. The striking seat where this bell is struck is situated somewhat higher than in ordinary Japanese bells. This is one of the characteristic features of old Japanese bells. The cross-section of this bell at the striking seat is more or less flattened elliptically, having its short radius in the direction of striking (long radius = 76 cms, short radius = 74.5 cms.). This is probably the effect of the bell's being struck for so many years. It is slightly elliptical at the mouth too (long radius = 74.5 cms., short radius = 74 cms.).

The bellstriker is a thin log of palm wood 205 cms. long and 5 cms. in radius. It is slung horizontally with ropes beside the bell. When it is desired to ring the bell, the striker is swung several times by means of another rope and finally made to give an impulse to the bell.

The records of the sounds are shown in the plate. Fig. 1–Fig. 4 were obtained by striking the bell somewhat strongly and changing the interval of time between the striking of the bell and the opening of the shutter of the camera. The horn of the recording apparatus was used to receive the sound in all cases, except that recorded in Fig. 1. Fig. 5 and Fig. 6 were obtained by striking the bell somewhat weakly, and Fig. 7 by striking it very weakly. Fig. 8 shows the record obtained when the bell was struck with a very small hand clapper.

The parts marked a, b in



these curves were analyzed by the method of periodogram analysis, and the forgoing diagram was obtained.

The letters ⓐ, ⓑ in this diagram correspond to the portions a, b in the plate. As is shown in this diagram, this bell has 6 partial tones, whose frequencies are 129, 335, 550, 700, 900, 1250 respectively. Among these partials, the 4th one (frequency = 700) is very weak and has very small amplitude, and it is not clear whether this tone really exists or not. In Fig. 1 and Fig. 8 the fundamental tone does not appear while the 2nd partial is highly predominating, which shows that the strike-note of this bell is the 2nd partial. This strike-note has 78 beats per sec., from which we see that it consists of two tones, whose frequencies are 296 and 374. About 10 secs. after the bell is struck, all the over-tones vanish, and only the fundamental tone continues, remaining for about 40 secs. with 5 beats per sec. Fig. 8 shows that when the bell is struck with a small clapper there appear still higher over-tones and that the fundamental tone does not appear at all.

The above results need some corrections due to the proper oscillations of the various parts of the recording instrument. It was found that the ratios of sensitiveness of diaphragm for 129, 335, 550, 700, 900, 1250 are 1, 3, 3, 3, 2, 1 respectively. Therefore the amplitudes of 129 and 1250 must be magnified about 3 times, and that of 900 about 1.5 times to get the right amplitudes.

In conclusion the writer wishes to express his great gratitude to Prof. K. Tamaki for his guidance and instruction, and to the staff of Myōshinji-Temple for the permission to use the bell for this study.

Plate

Fig. 1 0.5 sec. after it is struck.

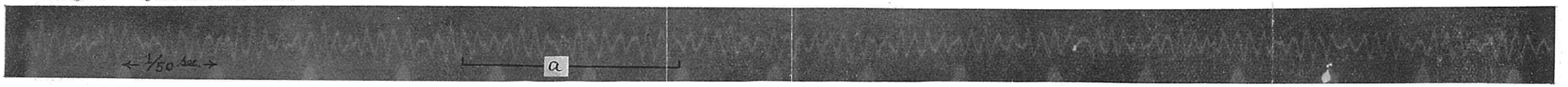


Fig. 2 3.0 secs.

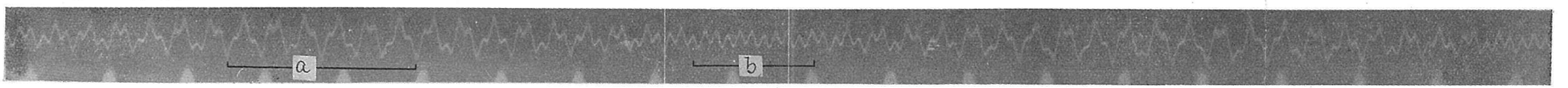


Fig. 3 6.0 secs.

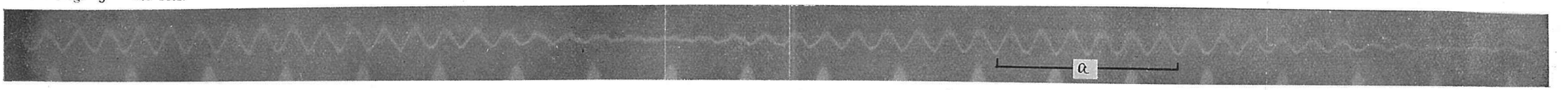


Fig. 4 10.0 secs.

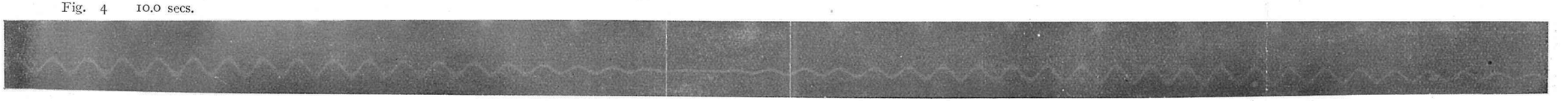


Fig. 5 0.5 sec. (weak)

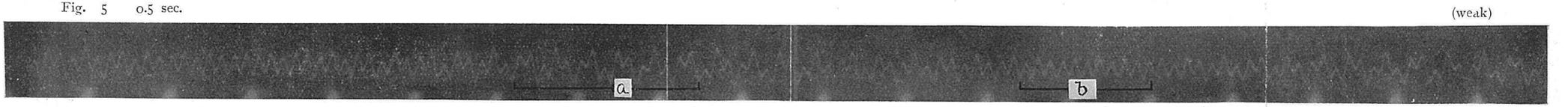


Fig. 6 5.0 secs. (weak)

Fig. 7 0.5 sec. (very weak)

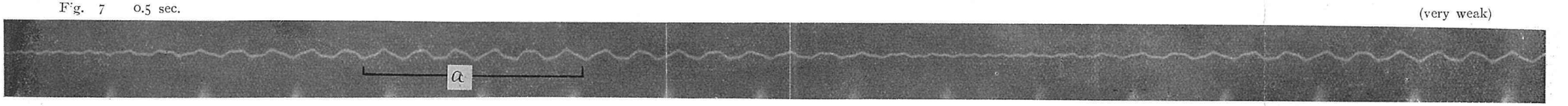


Fig. 8 0.5 sec. (with small clapper)