Acoustical Comparison Of Bassoon Crooks

D.B.Sharp, T.J.MacGillivray*, W.Ring**, J.M.Buick* and D.M.Campbell**

**Department of Physics & Astronomy, University of Edinburgh, Edinburgh, EH9 3JZ, UK.*
*** T.W.Howarth and Co. Ltd., Cheal's Mews, 17-19 Buckingham Rd., Worthing, BN11 1TH, UK.*

Abstract

The effect of the crook on the bassoon's playing characteristics has long been considered particularly significant. In this paper, acoustic pulse reflectometry is used to obtain internal bore profiles of a selection of bassoon crooks manufactured throughout this century. In an attempt to understand how the crook's profile affects the acoustical properties of the bassoon, impedance measurements have been carried out on two bassoon/crook combinations.

Introduction

Dating from the mid-17th century, the bassoon is a conical bore instrument which uses a double reed. The length of the bassoon's air column is just over two and a half metres but the instrument stands at approximately half this height since the air column is bent back on itself. The air column is made up of five sections: the crook, the wing joint, the butt joint, the long joint and the bell. In this paper, the evolution of the crook is examined and its contribution to the acoustical characteristics of the bassoon is investigated.

Measurement of bassoon crook dimensions using acoustic pulse reflectometry

To examine the development of the shape of the bassoon crook, the technique of acoustic pulse reflectometry has been applied to crooks of various ages.

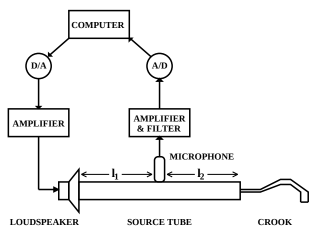

Figure 1. Schematic diagram of pulse reflectometer.

Figure 1 shows a schematic diagram of the pulse reflectometer used in the present study. An electrical pulse produced by a D/A converter is amplified and used to drive a loudspeaker. The resultant sound pressure pulse travels along a copper source tube into the bassoon crook under test. A microphone embedded part of the way along the source tube records the reflections returning from the crook. The microphone output is amplified and low-pass filtered to prevent aliasing. The resultant signal is then sampled by an A/D converter and stored on a PC. This procedure is repeated 1000 times and the samples are averaged to improve the signal-to-noise ratio. To obtain the input impulse response of the crook, the sampled reflections are deconvolved with the input pulse shape.

Once the input impulse response of a crook has been measured, the application of a suitable algorithm allows the changes in area along the crook's bore to be evaluated. If the crook is assumed to have cylindrical symmetry, the changes in radius can also be calculated.

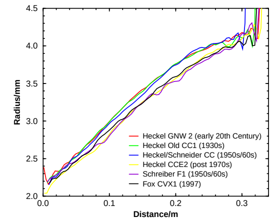

Figure 2. Six bassoon crook profiles.

Figure 2 shows six bassoon crook profiles measured using acoustic pulse reflectometry; a Heckel GNW 2 crook dating back to the start of the 20th century, a Heckel Old CC1 crook from the 1930s, a Heckel/Schneider CC crook made in the late 1950s/early 1960s, a Schreiber F1 crook from the same period, a post-1970s Heckel CCE2 crook and a Fox CVX1 crook manufactured in 1997. The crooks are all production examples by the respective manufacturers apart from the Heckel/Schneider crook which is unique. Ernst Schneider (who was one of the makers at Heckel) made this crook for use by William Waterhouse.

It appears from the profiles that the crooks fall into two groups. Although the crooks all have approximately the same initial and final radii, the two older Heckel crooks and the Heckel/Schneider crook are all wider in the middle section of the crook than the newer Heckel crook, the Schreiber crook and the Fox crook.

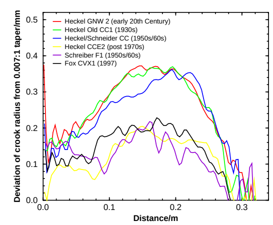

Figure 3. Six bassoon crook profiles plotted in terms of the deviation in radius from 0.007:1 taper.

In figure 3, the crook profiles are replotted in terms of the deviation in radius from a standard taper. The taper chosen was 0.007:1 with a starting radius of 2mm (i.e. for every 1mm increase in distance along the axis, the radius increases by 0.007mm). The grouping of the crooks appears even more distinct with the two older Heckel crooks and the Heckel/Schneider crook showing a maximum deviation of approximately 0.38mm from the 0.007:1 taper, compared with the maximum deviation of approximately 0.2mm shown by the Heckel CCE2, the Schreiber F1 and the Fox CVX1 crooks.

Further measurements (made on other early Heckel crooks and on more recent crooks by both Heckel and other manufacturers) appear to confirm this trend. All of the older Heckel crooks measured have a wider bore whilst almost all of the newer crooks exhibit the narrower bore.

Measurement of bassoon/crook impedance curves

In an attempt to understand how the profile of the crook affects the bassoon's playing characteristics, input impedance measurements were made on two bassoon/crook combinations. The measurements were made using a standard frequency domain method; the swept sine wave method As the name suggests, the bassoon/crook combination under investigation is excited at its input by a sinusoidal pressure wave. The frequency of the excitation wave is increased and the pressure response at each frequency is recorded. Provided the excitation wave has a constant volume velocity, the pressure response is proportional to the input impedance of the bassoon. No phase information is gained using this technique; only the magnitude of the input impedance is measured.

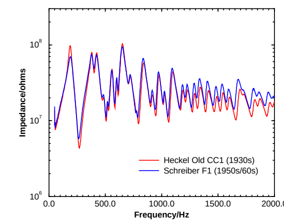

Figure 4. Input impedance curves of Heckel Old CC1 and Schreiber F1 crooks with Schreiber bassoon.

Figure 4 shows input impedance measurements made on a Schreiber bassoon with the Heckel Old CC1 crook and with the Schreiber F1 crook. The bassoon was set to the F3 fingering. The two curves show similar features but exhibit subtle differences. One such difference, most noticeable above 800Hz, is that the average impedance of the bassoon with Schreiber crook is greater than that of the bassoon with Heckel crook. This can be related to the profiles of the two crooks; the Schreiber crook has a narrower bore so provides slightly more resistance to the air flow. The amplitudes of the impedance peaks are also affected by the type of crook. With the Heckel crook, there is a 27dB difference between the peak at 190Hz and the trough at 270Hz. With the Schreiber crook, this difference has been reduced to 21.6dB.

Conclusions

The results presented in this paper show an apparent change in crook profile from the wider bore exhibited by the Heckel crooks manufactured in the first half of this century, to the narrower bore of the crooks made (both by Heckel and by other manufacturers) in the latter part of the century.

This evolution in shape has led to a change in the acoustical properties of the crook. Some of the subtle acoustical changes can be seen in the impedance curves presented in the paper. The most obvious difference is the lower average impedance of the older Heckel crooks compared with the more modern ones.

As a final comment, it is interesting to note that many players prefer the playing qualities of the the older Heckel crooks to those of more modern crooks. Further work, in conjunction with professional bassonists, is required to establish the significance of the wider bore to the playing characteristics of the older Heckel crooks.