The Effect of Interior Shape and Size of Clarinet Mouthpieces on Intonation and Tone Quality

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MANY FACTORS are important in the production of good tone quality and accurate intonation on the clarinet. However, most investigators have considered the mouthpiece to be of major importance. In this connection, the amount of air pressure generated against the reed, the embouchure of the performer, the facing of the mouthpiece, and the training of the clarinetist have all been studied. Many writers and clarinetists have mentioned the importance of the internal dimensions of clarinet mouthpieces, but precisely what effect various bore and taper sizes may have on intonation and tone quality has not been clearly defined. Some writers have objected to the importance usually ascribed to the facing in the production of good tone quality and accurate intonation. One writer stated that the internal section of the mouthpiece should be properly proportioned, but did not mention in what way this should or could be carried out.

Clarinetists and clarinet teachers accept the fact that all clarinet mouthpieces will vary in some way. Usually the variance is detected in an actual performance on the mouthpiece, after which a subjective evaluation is made. A group of mouthpieces selected at random all were found to differ when measured internally with telescopic gauges and micrometer. Mouthpieces made specifically for a particular clarinet were found to possess bore sizes different from that of the clarinet. In addition, a group of mouthpieces made by the same manufacturer to one set of specifications all varied as to bore taper, tone chamber, and depth.

The clarinetist and clarinet teacher usually select mouthpieces subjectively. A trained clarinetist develops a high degree of perception in regard to clarinet tone quality. He evaluates a mouthpiece by its responsiveness in actual performance.

The music educator who is not an expert clarinetist cannot evaluate mouthpieces in the same manner. He is nevertheless confronted with many teaching problems in connection with the clarinetists in his music organizations and classes. Can the teacher who is not a clarinetist objectively evaluate a mouthpiece for a student? How can he select one which will satisfy his student's needs?

This study was made in an attempt to supply the music educator and clarinet teacher with information that would make an objective evaluation possible. The study analyses the internal portion of the clarinet mouthpiece and endeavors to answer the following questions:

1. What effect do various taper sizes, bore sizes, and bore lengths have upon intonation when the tone chamber and facing remain unchanged?

2. What effect do various tone chamber sizes have upon tone quality and intonation when the bore taper, bore size, bore length, and facing remain unchanged?

3. Will the changes in tone quality produced with various tone chamber sizes be perceptible to expert clarinetists?

Summary of Procedures

The analysis of the effects of various mouthpiece bore tapers on intonation was made using two mouthpieces having the medium "French" facing. The bore measurement of these mouthpieces was identical with that of each of the clarinets used in the study, 0.591 of an inch, and 0.585 of an inch. Brass shim stock was used in the bore to form the various tapers and rubber cement was used to make the cone airtight. Tapers tested varied from 0.000 of an inch to 0.100 of an inch. Tones from each register of the clarinet were played and the deviations in pitch from equi-tempered tuning were recorded in cents. Each of the registers of the clarinet, chalumeau, throat, clarion, and acute, were tested separately. The deviations were total for each register and the average from each was reported tabularly.

To determine the effect of various bore sizes on intonation, a mouthpiece was selected having a bore measurement of 0.581 of an inch. This bore size was gradually increased by filing, and as each change was made the mouthpiece was tested with the two clarinets used in the study. The bore size was finally increased to an oversize of 0.595 of an inch. A Stroboconn was used which indicated the deviations in cents from equi-tempered tuning.

To analyse the effects of various bore lengths on intonation, an ebonite mouthpiece was cut lengthwise and the bore reamed out to an oversize measurement of 2.375 inches. The bore length was then varied with the use of red dental wax and reduced in size gradually until a measurement of 1.75 inches was reached. Notes from each register of the clarinet were played by an expert clarinetist and the total deviations for each register were averaged. This procedure was followed using the two clarinets and two mouthpieces having identical bore size measurements.

To analyse the tone chamber taper, a mouthpiece having an undersize taper of 0.030 of an inch was selected. This measurement was gradually increased by filing until an oversize dimension of 0.135 of an inch was reached. The effects of these changes were indicated when the wave forms were analyzed with a harmonic wave analyzer, and the deviations in pitch from equi-tempered tuning were obtained with a Stroboconn. Tape loops were made using an Ampex tape recorder, Model No. 600, and a Shure Unidyne unidirectional microphone, Model No. 5565. An expert clarinet player made the tape loops while standing approximately ten feet from the microphone. The same volume setting was used for all tape loops. The tones recorded were concert pitch f, f′, f″, and c‴.

This procedure was continued with the tone chamber depth analyses. The depth sizes were varied from 0.495 of an inch to 0.555 of an inch and the increase in size was accomplished by filing. The measurements were made with two telescopic gauges and a micrometer, which measure in thousandths of an inch.

The tape recordings made when using mouthpieces with changes introduced in tone chamber taper and depth were played for selected judges. An attempt was made to determine if the judges could perceive a difference when

hearing the same musical excerpt played with mouthpieces having different tone chamber specifications.

Finally, the information gathered during the study was used in an attempt to improve student clarinetists' performances. Fifteen students, who were reported by their teachers as having problems with intonation and/or tone quality, were selected to make the recordings. They used their original mouthpiece and a corrected mouthpiece. The corrected mouthpiece was selected for each student after an examination was made of his original mouthpiece and his clarinet. These recordings were then played for selected music educators to determine if a difference could be perceived between the two performances.

Findings

The Internal Dimensions and Intonation.—When an analysis was made on the effect of various bore taper sizes on intonation, it was found that as the taper was increased in size the intonation was gradually raised. Although the intonation in the chalumeau register was satisfactory when using bore sizes of less than 0.030 of an inch, the upper registers were quite flat. With bore taper sizes larger than 0.060 of an inch, the intonation was quite sharp especially in the chalumeau and the acute registers. The selection of mouthpieces with bore taper sizes between 0.030 of an inch and 0.050 of an inch would appear to be best for overall intonation accuracy.

In the analyses made of the effect of the mouthpiece bore size on intonation, it was found that the best intonation resulted when the mouthpiece bore size was identical with that of the clarinet used. If the bore was oversize in relation to the clarinet bore size, the tendency was to raise the pitch. When the bore size of the mouthpiece was undersize to the clarinet used, the tendency was for the pitch to be lowered slightly. However, mouthpieces having a bore size larger than the clarinet with which they are used have a more adverse effect on intonation than do those whose bore sizes are smaller.

Although the bore length does not affect the intonation as greatly as does taper or bore size, it was found that with a bore length of less than 2.125 inches, the intonation was slightly sharp. When a mouthpiece bore length of greater than 2.125 inches was used, the intonation was slightly flat. The bore length of 2.125 inches appeared to be best for both clarinets used in the study.

The analyses of clarinet mouthpiece intonation indicate that the mouthpiece can be proportioned to assure the least deviations from standard pitch. Every effort should be made to obtain a mouthpiece with identical bore measurements with that of the clarinet used by the performer. However if a mouthpiece of oversize or undersize bore measurement is used, the intonation can be improved by changing the taper of the mouthpiece bore. Thus, if an oversize mouthpiece is used and the intonation is slightly sharp, compensation could be made by using a bore taper measurement of less than 0.030 of an inch.

Since bore length does not affect the intonation as greatly as taper size or bore size, adjustments in length may contribute to the accuracy of the overall intonation. Thus, if the clarinet is sharp due to a bore size of the mouthpiece that is oversize in relation to the clarinet, a bore length of more than 2.125 inches may be used.

When the taper size of the tone chamber was changed, the pitch deviations remained relatively constant until an extreme measurement of 0.120 of an inch was reached. At this point the deviations from standard pitch became greater and the intonation became flat. All of the taper sizes in the tone chamber from 0.030 of an inch to 0.105 of an inch appear to be satisfactory in regard to intonation accuracy. Thus, it would appear that the tone chamber taper size is not as critical as bore size and bore taper size unless an extreme taper size is used. In such cases a compensation would have to be made within the bore to cancel out the resulting deviations from standard pitch.

The changes made in depth within the tone chamber showed that the intonation was affected somewhat as the depth was increased. The greater the depth, the sharper the intonation became. The best depth measurement for producing intonation accuracy in the two clarinets used in the study was found to be between 0.495 of an inch and 0.505 of an inch. Again, if an extreme size is used in the tone chamber depth, the bore size, or bore taper could be altered to compensate for the higher intonation which would occur.

The Internal Dimensions and Tone Quality.—When the wave forms were measured with a harmonic wave analyser, all tones which were used in the study showed a similarity in their patterns of partial strength. However, the analyses made when the tone chamber taper size was changed showed that the partials present in the upper registers were stronger when using a mouthpiece with a taper measurement in the tone chamber of from 0.045 of an inch to 0.105 of an inch. The taper measurements in the tone chamber of 0.030 of an inch and over 0.120 of an inch show a weaker strength level when measured in millivolts. In addition, the tenth partial was present within the 0.045 to 0.105 range and absent when the extreme sizes were used.

Because of the greater strength of the partials in the higher registers when using tone chamber taper sizes between 0.045 of an inch and 0.105 of an inch, the selection of a mouthpiece with a tone chamber taper size within this range would appear to be desirable. As the tones produced with these mouthpieces were very similar in the lower registers, the strength of the partials produced in the higher registers should be considered.

Changes made in tone chamber depth sizes did not greatly affect the wave forms when measured with a harmonic wave analyser. In the case of c''', the partial strength was slightly greater when using the tone chamber depth sizes of 0.495 of an inch and 0.505 of an inch. In general, the effects resulting from the introduction of changes in the mouthpiece tone chamber seem to be very subtle.

The perception of effects produced when changes were introduced in the tone chamber of the mouthpiece was tested using tape recordings. The first testing procedure was concerned only with the selection of expert judges who could perceive a difference in clarinet tone qualities at a significantly high level. When the selection was made, the second testing procedure was carried out.

The judges preferred a mean size tone chamber taper size of 0.075 of an inch. This indicated that a significant difference was perceived between the mean size and the extreme sizes. The judges, however, could perceive no significant difference between the mean size and the sizes next to it, which

were 0.060 of an inch and 0.090 of an inch. The analyses made of the wave forms showed the upper partials of the extreme sizes to be slightly weaker in millivolt strength.

The judges also found a significant difference existing between the mean size tone chamber depth size, which was 0.525 of an inch, and the more extreme sizes. Although the upper partials of tones produced with mouthpieces having sizes of 0.495 of an inch and 0.505 of an inch were slightly stronger in the acute register of the clarinet range, this slight difference evidently did not produce a significantly perceptible difference when heard on a tape recording.

When a difference was perceived in the tone qualities, the judges preferred the mean size a significant number of times. This would indicate that the tone quality produced when using clarinet mouthpieces with tone chamber taper and depth sizes which are not extreme would be more satisfactory to a qualified listener than the tone quality resulting from extreme sizes.

Recordings of students performing a musical excerpt using their original mouthpieces and the corrected mouthpieces were played for selected music educators. The judges selected the performances produced with the corrected mouthpieces a significant number of times. When students who were having tone quality and/or intonation difficulties were supplied with a mouthpiece which was fitted to their clarinet, an improvement was noted in their performances.

Conclusions and Recommendations

Providing a correct mouthpiece with each clarinet should be the responsibility of the manufacturer. However, the clarinet teacher and music educator should check the measurements of each mouthpiece in relation to the clarinet used by the student to determine if intonation and tone quality difficulties are attributable to the mouthpiece. The actual measurements can be taken with telescopic gauges and a micrometer. An evaluation of each mouthpiece in the clarinet section would be especially valuable in attempting to maintain accurate intonation throughout a large group of performers. An evaluation would contribute to better understanding between teacher and student. The information gathered and reported here can be used as a guide for the clarinet teacher and music educator to indicate what intonation and tone quality difficulties can be expected from each mouthpiece considered for the student's use.

Certain dimensions used in the internal portion of the clarinet mouthpiece appear to be better than others for intonation accuracy. Also, there appear to be some extreme sizes which should be avoided in the interests of good tone quality. The following list of recommendations indicate the desirable internal dimensions for the clarinet mouthpiece when used with each of the clarinets used in the study:

1. Every effort should be made to obtain a mouthpiece with an identical bore size to that of the clarinet with which it is used.

2. The best mouthpiece bore length for both clarinets used in the study was 2.125 inches.

3. A mouthpiece should be selected having a bore taper size between 0.030 of an inch and 0.050 of an inch.

4. The most desirable tone chamber sizes are between 0.045 of an inch and 0.105 of an inch. The best tone

quality, as selected by the judges, resulted from the mouthpiece with a tone chamber taper size of 0.073 of an inch.

5. The most desirable tone chamber depth size in regard to intonation was found to be within 0.495 of an inch and 0.505 of an inch. Concerning tone quality as affected by tone chamber depth, the judges selected the mouthpiece tone chamber depth size of 0.525 of an inch as best.

The music educator and clarinet teacher should consider the mean sizes of the tone chamber taper (0.060 to 0.090 of an inch), and tone chamber depth (0.515 to 0.535 of an inch) as being the better potential in regard to the achievement of good tone quality by the student clarinetist.

During the course of this study, a number of factors appeared which possibly could have an effect on clarinet tone quality and intonation, and, perhaps, should be considered for further study.

1. A number of barrels found on various clarinets have a cylindrical bore whereas others are conical. The barrels recommended by the leading clarinet manufacturers are made in the form of an inverted cone. This is the type used in this study. However, what would be the effect produced when combining the various internal measurements of clarinet mouthpieces with a cylindrically bored barrel?

2. Clarinet reeds vary in the manner in which the profile is placed on the reed. Although only one style of reed was used for all the tests in this study, what is the effect produced when using a number of styles in combination with various sizes of mouthpieces?

It is hoped that this study will provide information which will be helpful in instigating further study, so that eventually clarinet mouthpieces can be evaluated in a more objective manner.

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