The Development of the Tuning and Tone Colour of an Instrument made in Venice about 1500

by Michael Thomas

INTRODUCTION

This article is based on the early maple harpsichord from Venice that I found in Sweden. Instead of having divided keys it has divided guides to give a fourteen-note scale. It is almost identical to the 1503 instrument in Milan and the Venetian instrument in the Fitzwilliam Museum in Cambridge. I will first trace the complex tuning cycles which may have developed from it, and secondly suggest that the different slides may have suggested different tone colours to the maker, which were used later in the Fitzwilliam instrument and later still by Faby Bononiensis in 1677 and other makers.

It was Thurston Dart who first made the distinction between resonant music and highly articulated music. Naturally most harpsichord music belongs to the latter category; but if any harpsichords belong to the resonant type, they are the simple hollow-sounding, relatively deep-cased instruments, which by their decoration appear to come from Venice. Although these instruments were probably very lightly strung (see list in previous article), they were probably played in very resonant rooms. The utmost sonority was sought at the time, so that the echo of the building did not reinforce any mal-tuning of the instruments. Those who have tried to tune the mixture stops of an organ in a big cathedral, will know just how the echo tells you only too clearly what you have done wrong.

It is quite inappropriate to consider the tuning of these instruments, (many have divided sharps) separately from the other factors which give these smooth, highly cultivated and distilled effects. In the last article, I tried to show that a group of ideas:

1. Venetian instrument with the guides restored for D sharp/E flat and G sharp/A flat.

2. Venetian instrument showing jacks in position.

the legato fingering, the curved pattern of the changing notes in the music, the lack of accented passing notes, the perfect tuning of the thirds, the simple hollow barring of the soundboards, which gives a mellow sustaining tone, all form a pattern, a *Gestalt,* in which each factor enhances the others. Students of scientific method will realize that I am not trying to deduce at this stage. We should still be inducing, which means seeing and hearing all the examples known, and trying to see tendencies which belong together.

In this article, I am going to start with the harpsichord with divided jacks for E flat/D sharp and A flat/ G sharp. This instrument was interpolated into the last article rather awkwardly, as it was only discovered while the article was being written and was only playing for the first time about the time the article went to press. Photo 2 shows the instrument after restoration. The instrument is made entirely of maple, which we have noted is a feature in instruments made about 1500. It is usually associated with the single-barred resonant soundboards and instruments which are single-strung. Unlike the Milan instrument of 1503, the soundboard of this is

Also of maple, a unique feature to date. The tone is remarkable and the treble matches up to the rest of the instrument. This is perhaps because the bridge is well placed between the gap for the jacks and the side, which gives it a good vibrating area. Perhaps maple is very good for treble tone (an idea I have discussed in my book 'Experiments with soundboards', MS).

The name board reads: *lavdate dominvm in cymbalis benesonantibvs* (Praise Him on the well-tuned cymbals), in letters which art-experts say are renaissance. It is the well-tuning of this clavi-cymbal that is of interest, for it has divided registers for the extra notes, not the more common divided keys.

In 1482 Ramos de Pareja describes the old tuning used by his friend Tristan de Silva. This tuning had a divided F sharp, but Ramos says the two F sharps are out of date. He is almost certainly referring to the series of Pythagorean perfect fifths, starting at F sharp and continuing: C sharp/ G sharp/ D sharp/ A sharp F C G D A E B, in which B is the sharpest note and F sharp the flattest. This F sharp is fine as a third in the chord of D, which is perfectly in tune, but too flat to serve as the fifth of B. So an extra F sharp was sometimes added in order to give a fifth for the chords on B.

There is a tuning in which the thirds are tuned perfectly, at the ratio 4:5, the note E is perfectly in tune with C. This means that the fifths C-G-D-A-E are all made a little flat, till the E becomes exactly right as the third of C. The note E is said to be a comma flat (80:81) of the pitch it would be if it had been arrived at by perfect fifths. As the comma is spread over four fifths, each one is said to be a /£ comma flat.

If, however, a tuning of true thirds (% comma meantone) is used the G sharp/A flat becomes a more appropriate note to be divided, the G sharp being a true third above E and the A flat a true third below C, D sharp and E flat being divided in the same way. I should mention that this % comma meantone was not fully described until the time of Gioseffo Zarlino (1517-90) a century later; but it seems to me a fairly natural tuning, that they are likely to have used instinctively. Ramos does not think it is necessary, for reasons beyond the scope of this article, to divide these notes, but he does mention the existence of these divided notes in 1482. In 1473 these notes had already been used when the organ at Lucca, which was said to be mal-tuned, was rebuilt with a divided D sharp/E flat and G sharp/A flat.

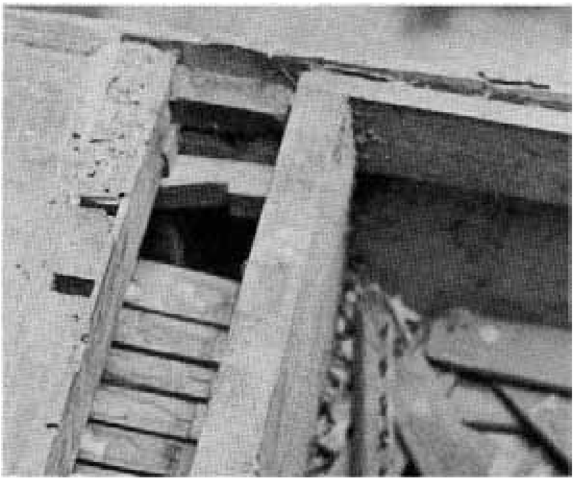
Most instruments with these notes divided have a divided key at the front, but the jacks are evenly spaced in the rack at the back. In the instrument found in Sweden, which we are discussing, they are not arranged in this way. It is possible to trace the old pin holes in the bridge, and they are for single strings, except for the extra strings close to one of the others, for D sharp or E flat and for G sharp or A flat. The holes for the tuning pins follow the same irregular pattern.

At the front of the gap, next to the wrest-plank, there is a guide which contains the two extra notes for each octave, which go (unlike the Franciolini keyboard mentioned in the earlier article) right to the top. There is an extra hole also for bottom F sharp, but this is probably to do with the short octave. It is interesting that this guide could never have moved, because it had, as can be seen in Photo 1, a moulding over each end of it. So it must have been originally rigid and cut into what was in fact the solid wrestplank.

The fixed mortices are for the usual notes D sharp or E flat and G sharp or A flat in the usual small-compass Venetian instruments, which go from C/F to c or d^3. As these notes are alternatives, the notes with which they alternate must be included in a different guide. This next guide appears to have been a moveable one. The third guide must contain the ten notes which are always the same, and there is no need for it to be moveable.

It was possible to trace out the original single pins on the eight-foot bridge, although there were some new holes for an extra stop which was added later — this stop appears to have been a four-foot and an eight foot at different times. The original holes however were stained dark and showed that the strings were not evenly spaced, but that where an alternative note occured there was a double pair of strings close together. There would have been no room for a jack to go between these closely spaced pairs of strings i.e., the alternative A flat and the normal A. There was only room for the G sharp and A flat jacks to sit between the same pair of strings, so presumably they both went to the same key. A key of half normal thickness, which was normal when the keys were divided, would not be feasable. It therefore seems that this instrument must originally have been designed and could only have been designed fpr divided guides and normal keys.

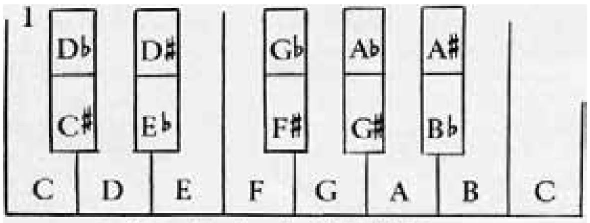
The row of extra jacks nearest to the player appears always to have been fixed and it is unknown whether, when these jacks were to be used, they were to be taken from the instrument or whether perhaps they sat on a little shelf. Certainly, as can be seen in photo 3, there used to be two little levers under the wrestplank and above the keyboard, which appear to have moved the second row of jacks, which would be the alternative notes. Perhaps these two levers were joined by a little shelf on which the extra jacks could sit when they were not being used, with some sort of notch like a dog leg on them. However the exact mechanics of what these levers did need not concern us here. What is really important is that the extra jacks nearest to the player have a very different tone. Before we consider the different effect of these plucking positions and its possible development, let us consider more complex ways



3. The end of the wrest plank showing the 'lever' which worked the guide from below.

which were developed to try to get a perfect tuning of the harpsichord in Italy. 1. The pursuit of perfect tuning Normal keyboards, in which the keys, not the guides, are divided, are usually arranged as in diagram 1:

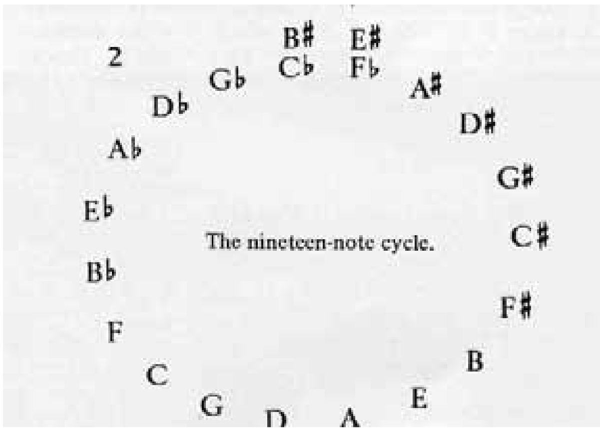
These instruments were called *chromatica,* or by the



Normal keyboard with divided keys.

more educated, *enharmonica.* The arrangement above is that of my own virginals, dated (I think wrongly) 1770, which are now with Dr. Luckett at Cambridge. D flat, G flat and A sharp are not included in my virginals, but they are included in some other instruments. It is interesting that at a later date all the pins had been altered to give the sharps at the front and the flats at the back. And still more recently the keyboard had been completely repinned. On this occasion it had been to extend the compass, and the extra holes which had been used for D sharp and A flat had been utilised for this, taking the range up to f^3. This of course may be the reason for the C/E - f^3 compass in a number of other sixteenth-century instruments, which appear nowadays to be greater than they were originally.

If one adds two more notes, C flat or B sharp and F flat or E sharp between the two diatonic major semitones B-C and E-F, one produces a nineteen-note scale (Diagram 2). This scale is said to have been invented by Salinas who came to Rome in 1539, and it was also discussed by Zarlino. Each tone is



The nineteen-note cycle.

divided into three parts, a major semitone, say D to E flat of two parts, and a minor semitone, say E flat to E. If the divisions are equal, the major semitone is exactly twice the small semitone. This is not really a good approximation to the harmonics. When using simple whole numbers we get the ratio 93.75 : 96.100.

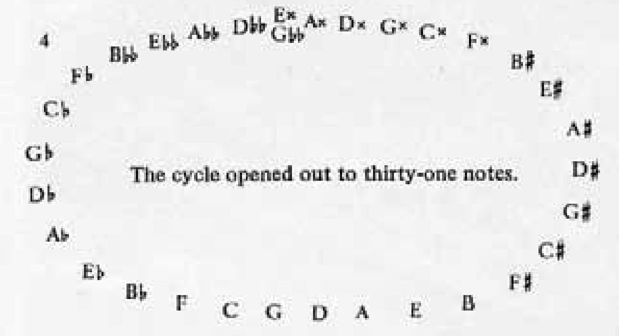
To get a better tuning for minor thirds the major thirds have to be very flat (about % comma) and the fifths so flat that they begin to sound bad. It is interesting that Zarlino also advocated a 2/7 comma tuning. Although a /4 comma is perfect for major thirds, e.g. C to C, the A in the A C E triad is sharp, because of the small tempering of the fifth. The 2/7 comma slightly raises the C, improving the minor third, but makes the fifth worse than tunings with perfect major thirds *(V4* comma), but not quite as bad as the fifths in the 1/3 comma, which he seemed prepared to tolerate in the nineteen-note cycle.

With such a cycle equally spaced, it is possible to modulate up thirds (as in Brahms's Fourth Symphony) and get, not to C but to C flat' (or B sharp)' and repeat the process again 1/3 of a tone lower. Such a system is enormously useful for composers with a perfect harmonic sense. However, I shall argue that the keyboards in which the sharps are mixed up between the back and the front, also the flats, are far too complicated for this type of composition, and that was not what the early makers intended.

Another way of looking at the nineteen-note cycle is shown in diagram 3, with the extra notes added, which at the moment I am calling double sharps and double flats. It is important to add that this is not the old nomenclature. Opened up, this becomes the 31-note cycle (fig. 4). Nicola Vicentino (1511-1572)

Vicentino describes an archicembalo with six rows of keys or orders. The first three orders are the same as described above, for the common keyboard with divided keys. The fourth row ^contains the same keys as the first only a diesis higher (that is a fifth of a tone in a meantone with perfect thirds). The fifth order is G A B D E, all a diesis higher than the

The nineteen-note cycle in two rings. The rings become the same if the notes are equally spaced.



The cycle opened out to thirty-one notes.

second and third rows. The sixth order is like the first, but a comma (half a diesis) higher. This is enormously complicated, and I understand is being dealt with in a separate article which I have not yet seen.

Guido de Trasuntino

The archicembalo of Guido de Trasuntino (photo 4) has often been taken to be of the 31-note cycle. In this cycle the tone is divided into five parts. The minor semitone C to C sharp is two parts and the major semitone C sharp to D is three parts. In this space would come D flat which would be three fifths up the tone. This leaves two gaps — they are a fifth of the way above C (a diesis higher) and a fifth of a tone below D (a diesis lower). In the monochord (photo 5), I have called these D double flat for the lower and C double sharp for the higher, because on the keyboard (photo 6), the double sharp is always placed away from the player when the sharp is so placed. Conversely the double flat is always away from the player when the flat is away also.

It has often, if not always, been assumed that this instrument was for ¼ comma tuning, which gives, an equal division to the 31 notes, with perfectly tuned major thirds. However, it would not appear that 31 equal divisions and the continual modulation which would result from it, was the intention of the maker. Rather, some system which revolved round the common notes of the octave, was intended, and he tried to get all the possible tunings related to them.

This is suggested by the inscription on the front of the instrument (photo 7).

The reasons for this are the following:

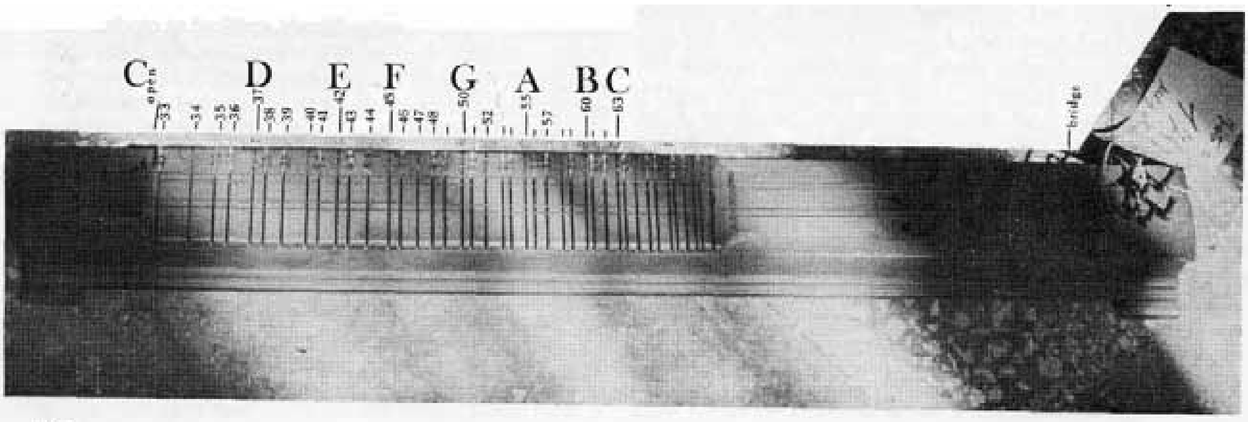
1. The divisions on the monochord are not equal, as can be seen from the photo (5).
2. The keyboard is still arranged like the common keyboard with divided keys - while C sharp is at the front, D sharp is at the back, and the double sharps and flats follow the same pattern.
3. The inscription (7) says that it will fulfill all sorts of tunings, 31 even divisions would be correct for major thirds, but the fifths and minor thirds would be flat.

It is perhaps for 2/7 comma tunings, a flat E above C, but good minor thirds. I have fed the measurements of the thirds to a computer and most are below ¼ and nearer 2/7 comma tuning. But the mystery is that, if so, it is not cyclic and should instead contain some fifths to give the Pythagorean tuning as well. If we look at the monochord again we notice that all the notes just above the naturals (e.g. the notes I call D double flat above C, A double flat above G etc.) are much closer to the principal white notes than the sharps are below the principal white notes. It is therefore possible that the true fifth is given by playing C and A double flat. Yet if this is so, it really only works for the two fifths - F-C and D-A - which are really well in tune. Therefore exactly what this tuning means is, I think, a nut which has still to be cracked. All we can say is that the 31-note equal division is not what was intended. All the measurements are accurately tabled beside the picture, so that anybody who wishes may go on and try to solve them further.

The instrument, which was made in 1606, is a large Venetian harpsichord with a tail at about 45°, which is usual on the larger instruments, although the smaller ones usually have more pointed tails. It has a relatively heavy bridge made out of a section about 2 cm. square. This bridge goes parallel to the case at about 3 ins. from the side, which is the same narrow distance as in the Pisaurensis in Paris, and is presumably to stop the large instrument from sounding too hollow. The distance of the bridge from the jacks goes from 15 cm. in the bass to 5 cm. in the treble. Unlike the smaller Venetians, by tapping it sounds as though it is cross-barred, but tapping is deceptive. The instrument is in very good condition, needing only some woodwork repairs to the tail and some strings, especially in the treble, replacing. The strings go from .016 in. to .008 in. in the treble, which is a little thicker than the strings we have usually found on these Venetian instruments, one gauge thicker, for instance than the Torriglio of 1704 made in Mestre. What is interesting about these strings, if they are original, is that they are of brass. This is probably because brass stretches more than iron when pulled and would need a larger turn of the tuning key to tune it, and this would give the

4. Trasuntino's Archicembalo 'Clavemusicum Omnitonum' (1606).

accuracy of tuning required. We have usually found traces of iron in these old Venetian instruments, although instruments that we have found in Florence, also the ones in Portugal, probably the early short-scaled instruments in France and the one original string in the treble of the Theeuwes, all had strings of brass. So brass seems to have been used quite commonly away from Venice.



5. The monochord (or rather, *tetrachord)* for tuning Trasuntino's instrument. The numbers of the frets and letter names have been added at the side of the photo to facilitate identification.

3 The jacks are equally spaced, the compass is C -c and the keyboard fans out at each side to get them all in. All the jacks are complete. The scale is a little shorter than many Venetian instruments, but still the very common scale of 5^{1}/* ins. and 10% ins. for the two top C's.

What I think is really important is that the key-board is only suitable for playing in the simple well-known keys; for, supposing one started on the note C double sharp, then one would have to play a chord of numbers 36, 46, 54 and 67, a chord that is quite

6. The keys of Trasuntino's archicembalo, showing the numbering (photo: Musio Civico, Blogna).

Measurements from Monochord

Accuracy : better than ± 0.5 mm. Fret width : 1 mm. C-

	Open		53.15	53.20
	33	D bb	52.60	52.60
	34	C♯	50.75	50.78
	35	D♭	49.40	49.47
	36	C×	48.60	48.65
D –	37		47.30	47.33
	38	E bb	46.55	46.65
	39	D♯	45.55	45.63
	40	E♭	44.15	44.28
	41	D×	43.55	43.65
E –	42		42.45	42.55
	43	F♭	41.80	41.90
	44	E♯	40.75	40.83
F –	45		39.55	39.65
	46	G bbE×	38.90	38.95
	47	F♯	37.95	38.00
	48	G♭	37.10	37.17
	49	F×	36.40	36.50
G –	50		35.40	35.52
	51	A bb	34.90	34.98
	52	G♯	34.10	34.20
	53	A♭	33.15	33.24
	54	G×	32.70	32.78
A –	55		31.85	31.92
	56	B bb	31.35	31.42
	57	A♯	30.65	30.72
	58	B♭	29.75	29.83
	59	A×	29.22	29.32
B –	60		28.40	28.47
	61	C♭	28.05	28.10
	62	B♯	27.30	27.36
C –	63		26.55	26.65
	64		26.20	26.27
	65		25.50	25.60
	66		24.85	24.95
	67		24.40	24.48
D –	68		23.65	23.76
	69		23.35	23.43
	70		22.75	22.85
	71		22.25	22.30
	72		21.90	21.95
E –	73		20.30	21.30

impossible under the hand. The intention would certainly not seem to be unending cyclic modulation on such a complex keyboard. It is interesting to compare the shape of this instrument with the only large Venetian instrument I know, by J. Celestini, 1605, (photo 8), that has the same bridge position on the soundboard, parallel wrestplank and general lines as the smaller Venetians.

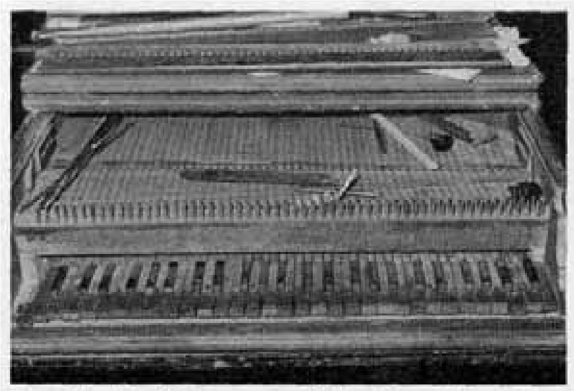
8. Venetian harpsichord by J. Celestini, 1605 (Collection Haags Gemeentemuseum - The Hague).

7. **The inscription on Trasuntino's archicembalo.**

For us the end of this deviation to perfection should be 1640; for in that year Frescobaldi was nearly persuaded to tune an organ in a church in Damascus in equal temperament. Modulation had been impeded because it could not cross the comma, or wolf-note, in an uncyclic mean-tone tuning. Frescobaldi, who was criticized for not knowing the difference between a major and minor semitone, simply made them the same, C — C sharp was the same size as D flat to D and C sharp was the same note as d flat. The comma had nearly been eliminated as an obstacle by spacing it over a number of notes. It would be possible to use nineteen notes in modulation, but as some notes were the same as others, there would be only twelve keys. It would appear that some of Froberger's suites (and Froberger was a pupil of Frescobaldi) required this cyclic temperament.

2. The evidence for complex big bridge arrangements in later instruments (not necessarily Venetian)

There is a large black Florentine or Roman harpsichord (c. 1600 - Photo 9), which used to be in my collection and had the scars of two wrestplank bridges and two soundboard bridges. It is referred to in diagram 6 of the last article. It used to be thought that the two inner bridges were to give a



9. **The 'black' instrument which had four bridges, before restoration. A crude effort has been made to extend the compass.**

higher pitch. However, examination of the string lengths, the one factor in which Italian instruments seem fairly consistant, shows that such an arrangement does not make sense. If, however, the nearest bridge on the wrestplank is strung with the nearest bridge on the soundboard and the distant bridges are also taken as a pair, a reasonable scaling is produced.

c'''	c''	c'	c	C
5	10½	20	41	78 (usual)
5	10½	20	42½	80

The approximate measurements are:

This scaling is so accurate and usual that it leaves little room for doubt but that the two 8' stops were intended, differing only as to plucking positions. There are pedals for quick stop changing, similar to those on the 1746 F. Weber and later Weber harpsichords.

Because the Italians were so strict about string lengths, they usually preferred to use four bridges and not three. According to our experiments this was a tonal mistake. Two soundboard bridges are much more detrimental to the tone, giving a bright reedy harmonic, than the slight variation in string length, between the registers, which occurs when only a single soundboard bridge is used to vary the tone.

However, some Italian instruments do have three bridges only. One such instrument with two on the wrestplank and one on the soundboard is the Faby Bononiensis in Paris. This is shaped like the Venetian

10. **The wrestplank bridges of the Faby Bononiensis in the Paris Conservatoire.**

with bridges far from the side, but is cross-barred (photo 10).

The instrument by De Quoco in the Claudius collection in Copenhagen appears to have had two soundboard bridges. Diagram 8 shows the string gauges of this instrument.

This is an interesting instrument, as the string guages are marked (even for the short octave) and both stops

Notes	C	F	D	G	E	A	Bb	c	c'	c''	c'''
String gauges	4(?) 4(?)	5 5	4 4	5 5	4 4	5 5	6 6 --->	7--->8--->9	--->10--->11	->12 -->	

The string guages marked on the wrestplank of the de Quoco instrument. Writing on lowest note is not clear. Corresponding thicknesses were given in the previous article.

appear to have had the same thickness of wire. This suggests that all the bridges were strung to give two stops with strings of 8' pitch but contrasting plucking positions.

The upright harpsichord by F. Weber (early eighteenth century) in Dublin has a second 8' bridge on the wrestplank to give a third string plucked near its end in exactly the same way. The Izzard of 1622 had three wrestplank bridges. Remaining pieces of wire show that the same note would be strung with the same guage for all bridges, which suggests that they were all 8' stops. The plan drawn on the bottom boards of the Izzard shows a rose in a position which would have made a 4' bridge really impossible to position.

These slightly later examples of contrasted tone colours produced by different bridges, in Italy and England seem to be fairly numerous. So it may well be that the idea of multiplicity of 8' tone was known early. There is one early Venetian instrument which suggests this.

Early Venetian with Complex Bridges

In the Fitzwilliam museum there is a harpsichord, beautifully decorated (photo 11), shaped like the other early single-strung Venetian instruments. It appears to have scars of four bridges and three 8' strings. It is possible that the strings from the wrestplank bridge near the gap passed through slots or holes in the other bridge to the tuning pins. Such an arrangement was used in Sweden arid Germany by Broman in 1750 and Hass in 1723 to give a third 8' stop so that there was a chorus on both manuals.

Nowadays we use an independent damper on the dogleg jack so that both 8' stops can be played on both manuals. This gives the effect of a third 8' string, like the early Italian instruments or the Hass and the Broman, but without actually overloading the instrument. This Fitzwilliam museum instrument may be the earliest example of a trend towards a complex arrangement of 8' stops. It is Venetian and early.

Conclusions

The Fitzwilliam Museum instrument, which years ago was identified by Dr Bryan as being Venetian, appears to have similar mouldings to the one we have discussed and also the 1503 instrument in Milan. This dates it very early, so it is probably the first known instrument with a multiplicity of 8' tone.

F. Weber, who worked in both Dublin and London, seemed well aware of these Italian models. His

11. The Venetian harpsichord with four bridges in the Fitzwilliam Museum, Cambridge (reproduced by permission).

upright harpsichord uses the third bridge method to get a lute stop. For this reason it probably precedes the 1746 single manual in which Weber seems to have copied pedals of the type used in the black instrument from Florence or Rome, now owned by Dr Mirrey. This instrument is shown in photo 9 before restoration. Later Weber used pedals using an inclined plane (as Shudi did for fine adjustment on his leather stops) in the instrument in the Dublin Museum. It is possible that Weber, who produced such complex mechanisms, always used pedals, although the instrument in the Royal College appears to have lost them. Unfortunately Weber did not understand the coefficient of friction. His upright could never really work well as the two antagonistic pressures, one from the finger and the other from a spring, are placed at opposing ends of the mechanism. The whole action is under side pressure, which no amount of black lead will eliminate. In the same way his inclined plane and stop mechanism jams up.

Until recently the idea of contrasted colours has seemed important in harpsichord tone and we are only just getting used to the idea of playing on one or two neutral 8' stops and not changing them.

The ideas of delicate tuning seems to have led nowhere. Who would sacrifice the solid tone of two 8' stops on a Kirkman for extra tunings as Dr Smith did? Yet the various cycles aroused interest in the nineteenth century and may yet be used in the future again for those who have not so much a sense of perfect pitch, which is necessary to appreciate twelve-tone music, but for those who like perfect modulations based on a true third.