Signatures for 1978 are now due. See the separate leaflet.

I hope that this emphasis, and the use of a separate leaflet, will avoid a repetition of last year's chaos, when the January issue went to about half the membership, the rest receiving a reminder instead - the trouble is, their printing and posting the reminder cost us over a dozen subscriptions, which wastes your money and our resources. We are sorry that the leaflet wasn't up, and with such a bang. Partly it is inflation, of course, which seems to be affecting printing and especially paper (which includes the envelopes in which we post to you) more than most things. Partly it is that the Fellows have decided that the new printing process which we tried in the last issue (and will use again for this) is worth the extra money that it costs. Thus, the new rate covers both inflation and a somewhat more expensive printing process.

One further point: I have changed the wording slightly. Members who pay in foreign currencies are asked, as before, to include a supplement of £1 (Al. 50 at today's rate) for the conversion charges that the bank makes. This ALSO applies to those who send us Eurocheques even when they are expressed in sterling - it seems crazy, but the bank is charged a commission by the issuing bank in Hamburg or wherever, and passes the charge on to us. As far as I know, the only methods of payment by which we receive all that you send us are: cheques on English banks, foreign cheques drawn on an English bank (ie your bank has an arrangement with a bank in London), Post Office Mandats (which can often take a month or more to come through), some forms of Giro which arrive here through our Post Office (we haven't a Giro account but this doesn't seem to matter), and finally, and illegally, currency notes. This last method is not recommended because you have no redress if your letter goes astray and also because while I buy them in at the current rate and keep them till I go abroad, there is a limit to the amount that I can afford to pay over to PoMHRH - if I take them to a bank to change, once again there is a conversion charge). So use whatever method is cheapest for you and that will produce the right amount here.

And while you are at it, do let us have any comments. It's no use saying to yourself "Why don't they include ....?" - say it to us and we'll try to do something about it. You know what you want from us - we can only guess.

16th CENTURY SEMINAR: Response for this has been good and we are looking forward to a successful three days. Anybody who has already returned a form does not need to return another - anyone else interested is asked to do so, a) to give us a rough idea of numbers (if you don't return one you're still welcome to come) and b) so that I can let you know if there are any last minute changes of time or place. The enclosed new form is pretty vague, and quite deliberately. We know we shall start at 10 am each day, and we know that we intend to go on through the day into the evening, but while we have a schedule planned in case it is necessary, we would prefer to keep it vague so that we can tailor it to suit the participants. What we would like is to have everyone talking and discussing on the first day, because these subjects concern us all, and then to have string people talking on the second day (with some practical playing also) while the wind people are playing and trying out new instruments and techniques and approaches, and the reverse on the third day, with again everyday people together for the final session which again concerns us all. So here is the chance to compare your theories, instruments, techniques and on with your colleagues. The cost will be low - I'm still not committing myself, but it will be the cost divided between the number participating (a total of about £70) and should be well under £5.
NEW FELLOWS: Lyndsay Langwill has been elected (I said in an earlier issue that the 5th edition of his Index of Wind Instrument Makers was in preparation; it is now with the printer and, judging by the speed with which the last edition sold out, you would be well advised to order from Lyndsay now). Guy Olsson has resubscribed.

EARLY MUSIC EXHIBITION: This was an enormous success. More exhibitors, more space, more customers and more members for FoMRHI, and the opportunity for me to have the pleasure of meeting many of you and for all of us to see our friends and colleagues as well as our customers. We owe a great deal to Richard Wood, who first thought of it, and to John Morley and the other officers of EMIMA who organised it all with Richard.

EMIMA have issued their first Newsletter, sending it to everyone they know of (presumably only in the UK) involved in the making of early instruments. If you haven’t had one, write to them and ask for a copy. They do not put any address on the Newsletter (nor was there one in the Exhibition Catalogue) but their registered office is: Early Musical Instrument Makers Association Ltd., 30 West Street, Haslemere, Surrey.

NEW MEMBERS: There is a bumper crop; see the list following the Bulletin. As last time, I have included address changes there, marking them in the left-hand margin with an *; since they are probably more useful there than in the Bulletin itself. I regret to tell you that there is one deletion: Rik van Pelt, who was one of the most active members of our Dutch fellow organisation, Bouwers Kontakt, has died. You will find a communication from him elsewhere in this issue and a shorter comment further on in this Bulletin. We shall miss his help.

MICAT: You should by now have received a copy of the first issue of MICAT News. This is an especially welcome venture because our conservation and restoration colleagues have, hitherto, been very hesitant about publishing outside their own specialist journals. They have many advantages over us, not least the use of laboratories and equipment which most of us can neither afford to pay for or house, and they have considerable knowledge and expertise from which we can learn. Their journal (in full, The Musical Instrument Conservation and Technology Journal) will appear twice a year, beginning at the new year, and further issues of the News will appear spasmodically; both will go henceforth only to subscribers, and I would urge any of you involved in conservation or restoration to subscribe. The first issue of the Journal will include some of the papers from the Nurnberg Restorers Conference, to which I have referred frequently in Early Music and to which I have referred also in a review herewith. Future FoMRHI members who join after this initial circulation of MICAT News can get a copy by writing to: MICAT, c/o Musikhistoriska Museet, Slottshacken 1, 111 70 Stockholm, Sweden.

I would add the passing note if anyone else would like to give our members anything free, or up-to-date lists of Nuremberg is always obtainable from me.

GAM: One of our nearest neighbours at the Early Music Exhibition was Jacques Leguy. As well as making various instruments, he runs a book and valve shop where he is the agent for the bulletins of the Groupe d’Acoustique Musicale coordonnée (GAM). If you can read French these are very interesting and many of them relevant to us. We propose to send you a complete list, but as I am not sure if all that I have in a simplified version in which any may not reference well enough to include here I’ll send it to those on chance, but in case it doesn’t, I’ll
that the list includes Labor pipe, Regals, Arnault de Zwolle's Harpsichord, Gorrell & Gorrell, Temperaments, Lute, Celtic Harp, Recorder and early instruments. The snag is that they are expensive, most of them being 15£ (about £2) for 25-30 pages of duplicated type script.

TREY, ABBOTT & CO: This firm wrote to me a couple of months ago, saying that one of our members wrote to them asking if they could supply Bensoin, L.ner and other resins in small quantities. Would whoever it was get in touch with them because the answer was "yes" but unfortunately they have omitted the enquirer's name, which was why he or she never got an answer. They have sent me what seems to me to be a remarkable list of such materials, which again I'll send to Djilda in case she thinks it worth printing. They offer to quote delivered prices for any quantities, large or small (and the firms ready to quote for small quantities grow fewer all the time). Their address is: Flodden Works, 270 London Road, Wallington, Surrey SM6 7DJ.

BERLIN MUSI CAL INSTRUMENT MUSEUM: This Museum is now a member and they have sent me two volumes of their new catalogue (reviewed herewith) and a list of their drawings (a rather pale xerox but I hope it will reproduce adequately). The prices do not include postage and packing. The prices are a bit odd - if a drawing of an alphorn mouthpiece (no.38) costs DM6, how much detail of a double harpsichord (no.1 b) does one get for DM 10? Perhaps anyone who orders any of these might like to give us a report for the next issue.

It just occurs to me that I have three crumhorn drawings and a curtal; they are pretty summary but they are life-size so that one can take measurements from the drawings; these are all by Steinkopf and they bear little resemblance to his reconstructions. You certainly would not produce reproductions to 0.1mm or whatever from them, but they would serve as a guide. How typical they are I don't know.

PLANS: We are always happy to include reports on plans for the guidance of other members. Since they will not be reviews (though we would welcome plans for review from museums or others) keep your comments polite and descriptive (i.e. not libellous). Such reports would be particularly valuable when they, or the resulting instrument, could be compared with the original.

JOHN BARNES: John has sent me a list of the plans he has available; see further on here. He also sent me a copy of the hurdy-gurdy plan on plastic, saying: "...in case you would like to review it...or just look at it or pass it on to someone who would like it. I find the plastic so superior to paper that I hope to use only plastic and bring down the price to not much more than paper." I don't think I'm qualified to review it, beyond saying that it seems very clear and seems to include all the necessary detail, but I do like to look at it and anyone who wishes to consult it in welcome to do so here. If anyone else would like to review it, let me know and you can borrow it, but I'd like it back.

STANESBY FLUTE: A few years ago Andreas Glatt measured my Stanesby Junior Ivory Flute. Bill Elliott and a friend have now drawn this out as a plan. Copies should be available soon (probably from NRI Design if I can persuade them to have the nuisance of making copies rather than me) at copy plus postage cost. If you want one urgently let me know and I'll tell you as soon as they're available; otherwise and preferably wait for a further report here.

STEARNES COLLECTION: Paul Kemner says that they will soon be offering plans of their recently restored "Giusti" harpsichord. It has a range of 65-f, no short octave. It looks like the 1789 Antunes harpsichord illustrated in Russell, Harpsichord & Clavichord. Anyone interested
I must say that I'd be glad to see some of these, and that I'm sorry that there weren't any at the Early Music Exhibition. We badly need such things.

VIOLE DA GAMBE: Mel Sartain reports that he has had useful drawings from the Conservatoire in Paris. "They supply drawings and a booklet for a Henry Jaye division bass, a John Rose tenor (probably a lyra) and a Nicolas Bertrand 7 string consort bass. I made a satisfactory instrument after the Jaye drawings, but the information on thicknesses leaves a lot to intuition." Their address is: Conservatoire National Supérieur de Musique, 14 rue de Madrid, 75008 Paris. We have two members there, Pierre Abendence and his wife Florence, and Mathias Jaquier (alright, I can't count), any of whom might be able to answer any queries on such details as thicknesses.

Mel says also that the Museum of Fine Arts in Boston (see Barbara Lambert in List of Members) publishes a "Manual of Instruction for Detail and Assembly Drawings for Bass Viola da Gamba, Division size", drawings and instructions by Donald Warnock, based on a Barak Norman. This is presumably the 1713 Barak Norman (Bessaraboff no.274) which has a 1936 Boston repairer's label in it.

HARPSICHORD STRING TENSION: Rik van Pelt wrote: In PoMHI Bull.no.7 Dudley Hanson is in pains about his harpsichord's string tension. I can inform him that Bouwbrief VII (September '77) will contain an article by me about practical exercises with the "string formula", with special consideration of the harpsichord. In the small Flemish harpsichord (kit-build) string tension (in 8') varies from 5.8 kg (c') to 8.2 kg (D). The formula for string tension F (in kg) is:

\[ F = \frac{4L^2NQ}{10000} \]

where L is swinging length in meters, N is frequency in Hertz, Q is surface of cross-section of string in square mm, S is specific weight of string material. Q is derived from diameter in mm:

\[ Q = \frac{\pi D^2}{4} \text{ or } 0.785 D^2 \]

The article makes it clear that in instruments with one string length (violin etc) each string should be made of a different material or have a different construction (simple or overspun). As to instruments with a different string length for each note (harpsichord), the need for a different material arises only for foreshortened strings, e.g. the lower half of the compass. Thickness of strings doesn't affect tone quality but loudness only. Decisive in choosing the right string material and/or construction is the tensile strength as a percentage of the ultimate stress, and this relation differs from material to material. The apodictive sound of what is concluded here is derived from the material only. But I agree fully with Jahncl "Die Gitarre und ihr Bau" that more is needed for an ideal string.

FIBREGLASS: John Whone writes: With regard to your fears (in Bull.5) about loose fibres, dust and uncomfortable mouthpieces, my school instruments— shawms, crumhorns, corduns, racketts, have had no such troubles. After all there are no loose fibres nor dust in a crash helmet. It can be arranged that the end of a mouthpiece is pure resin with no fibres at all. This can be polished when cured and there is then no discomfort. I have even made a tuba and euphonium in fibreglass with valves in brass. My 10-11 year old boys have made and played a "brass" instrument constructed by similar methods (I made the valves!). There is no reason why they should not make early instruments too.
SCHOOL VIOL: There was an interesting article in the March/April issue of Strings in Education by Sheila Marshall on Strings in Schools stressing the value of the violin as an instrument for children, especially for small children. I commend it strongly to our violin-making members, especially to those who think that they could produce a good and responsive but inexpensive instrument and buy it in bulk. I am sorry to report this so late, but I only received a copy recently; if you have any trouble in finding a copy in your library it might be worth writing to Macmillan Journals Ltd, 4 Hindi Road, London WC2R 3LF — I got my copy as part of a promotion for the Journal so they might be willing to send you a copy. I will send them a copy of this Bulletin, which might help.

REVIEW PROFILES: Bob Marvin writes: Concerning Rod Cameron's excellent reamer profiler, a word of safety: gripping freshly-turned steel with a gloved hand may result in the turner becoming the turned. By all means use leather gloves, as Rod suggests, and use wax or grease to insure against catching.

ACCURACY: Bob also had a comment on this: One's measurements needn't be any more precise than the variation another person gets in measuring the same item using the described method. There must be a special reward in afterlife for people who rattle off 7-place measurements that are repeatable to only two places. Maybe 1,000.5875 years in purgatory. (I'm not sure whether this comment was for me or for publication!).

HORNIMAN WIND INSTRUMENTS BOOK: Carl Willetts says: re Comm. 45, p.44: p.75 Tabor pipe, M.Fabre, date uncertain. Enquiries I made a few years ago for the Register of Early Instruments showed M.Fabre maker of tabor pipes living at Banjole, France.

AN ARABIAN LUTE: With reference to a Comm. in this issue from Jon Downing (I am taking an unfair advantage in being able to see some Comm. pre-publication). Jon refers to fret positions which are indicated by inlay. I queried this because the Arab 'ud is unfretted and, as far as we know, has been unfretted for several centuries (as John is well aware). In the course of an interesting correspondence he has sent me the measurements of those inlay indications and the correspondences between them and the "rule of 10" or the "rule of 17.84" is seldom more than 1% and usually a good deal less. Formerly various articles suggest that it is impossible that those positions are the vestigial remains of Arab fretting (trees or the misnomer of alternative frets), so what have we here? Is it a true carlo feature, differing a European cousin? (There are 24 frets, remember, in the neck and 1 on the belly). Any suggestions will be welcomed and we will pass on any queries or have access to an 'ud are asked to write to Jon Downing - and has no time of them.

L I T E R A T U R E : Alfred Music, a review of the Festival concert of this, Andrew Furthman wrote to me that it was one of the finest and only a few people were left. However, that at the EIM Exhibition that there were very good but to date we are not stands had tickets — I only remember whether it was by Richard or Brian Jordan, or both. Anyway, whichever
was, act now if you want a copy, though if you write to Picton Press, Citadel Works, Chippenham, Wiltshire SN15 2AA, it might encourage them to reprint (perhaps even with corrections). I've heard nothing from them, but I had a very nice letter from Paddington Press about the Diagram Group book expressing the hope that they might be able to produce a revised version one day.

OFFERS: Ricardo Brane offers to translate articles for the bulletin from Italian or Spanish into English, preferably concerning stringed instruments rather than winds, but he's willing to try anything. Any members preferring to write in those languages (or presumably to read in them, since I imagine he might be willing to work the other way) should get in touch with him.

He offers also to obtain materials which are common in Italy but may be rare here. He would prefer to send a large package to me (or to NRI if they would be willing to handle it) rather than trek into Florence and then make up parcels and trek into the Post Office. So if you want any of this, write to me please: Shark skin: "I don't know the exact zoological species of the donor because every fishmonger calls it with a different name and they are all colloquial... A skin is about 60-80cm long, fine along the edges and coarse in the middle (more coarse than fine); cost about a pound each a couple of years ago. Parchment: they sell it for goat's but it could also be sheep's. Skins are roughly 30x40 cm and cost little less than a pound per sq.ft., average £10 per skin." The craftsmen don't use gauges so you'd have to send a sample of the thickness you want; I think myself (JM writing) that you'd be as well off with H.Band of Brentford for this one – not much more expensive and more accessible. "Bowls turned out of sheet metal for early percussion; there are a good number of artisans in Florence who will do this work in almost any material. Of course a wooden form has to be turned first and shipping might be expensive, so bulk orders would be best." If interested, send Brane a sketch and he'll get a quote. "Propolis: can be had at a horrible price, I would rather explain to those interested how they can obtain more from their bees. Lavender oil: I know of a good source at a low price if anyone is travelling to southern France... If there are other products or skills that you are interested in, please write."

Remy Gug offers red copper harpsichord strings which have been developed following a series of analyses of original strings. Diameters from 0.68 mm to 0.46 mm for 8', and to 0.32 mm for 4', by steps of 0.02 mm. Free samples of any three diameters available on request; price per reel of 50 meters; 95 French francs, with a 50% reduction on all orders received before January 1st, 1978. Ultimate tension, 52-58 Kg/mm², these are designed for originals or faithful copies at A-415. He is working on strings for Italian harpsichords and fortepianos. He has sent a Comm. on wire strings but it's a rather rough photo-copy that I don't think will reproduce – I've asked for a better copy but it's not yet arrived, so if it's not in this issue, it will be in the next.

REQUESTS: We have a lot of these, so I'll separate them by names.

BILL ELLIOTT: works like Eremus or some institution to make available plans of complete key/place sets of instruments, eg Bach at Cöthen, Mozart in Salzburg, Bach in Potsdam, Saint-Georges at Brussels, Haydn at Esterhazy, etc., etc. There's a lot in this; at the moment all early music groups are using a random collection of instruments you should have seen the 'full enti' orchestra for the Renee Princesse de Navarre, and you've never seen a music of the Collegium Armavi?; there is a need for lots of instruments that can be used together by place and time. Any comments or suggestions also for instruments as well as to Bill, please.
CARL WILLIAM: Carl asked for help with every substitute - what he wants, he says, is a chunk big enough to make a renaissance racket, i.e. about 10" diameter and about 2" long. Can anyone help him?

CHRISTOPHER PAGE: (note his new address, please). He wants to contact anyone who has worked on Graeco-Roman instruments in late antiquity; in particular he is after late Antique representations of the kithara.

He is in the process of compiling a book on musical instruments in 12th century France. Would members please let him know of any m/sculpture/sculpture? Why they have seen, photographed or seen photographed that shows instruments? He says that rather than take up FMHAR space with a list of what he already knows, he would prefer to welcome any information that you have. All the same, I think we can assume that he knows Kinsky and carry on from there.

OKECHUKWU NDOHUSI: Okechukwu is working at the London College of Furniture and has main interest in keyboards. He comes from Nigeria and there is a considerable problem there with the climate; either the dry wind is blowing, which carries a very fine dust and literally blows up every trace of moisture out of the air and everything in the houses, or in the wet season when, in ordinary houses, there may be an inch of water on the floor. How does one keep instruments from melting up and failing apart in such a climate? He is doing some thorough research into various methods of control and would welcome contact with anyone else interested in the problems. If any of you have any export trade into that sort of climate, you can probably learn from him, also.

LAWRENCE LINDY: He would like someone to write a Conc. on turning tuning pegs, if possible with a range of techniques from first-class to on-the-cheap. He would like to know if anyone has tried circular bits in cutting the heads.

He also asks whether anyone can supply him with maker's drawings or information on making a good psaltery, either porco or demi-porco; his speculations based on pictures have all produced rather heavy instruments, and he wonders whether in fact they were heavy or whether there is an approach to a lute-like (in mass) psaltery. In particular, can anyone tell him anything about the psalteries in the Memlinc triptych in Antwerp. What is the curved line under the bass strings? At first glance it appears to be a bridge, but on closer inspection he says it seems to be a series of pins. Are they pins for sympathetic strings, or might they be buzzers? My own impression was that this was a 4' bridge for the bass strings, as on some cembali, but I've never really thought about it. If anyone has made notes in Antwerp, or has a slide that they can project large enough to see, both he and I would be grateful. Unfortunately the plate in my book is too coarsely screened to allow detail magnification, and as is usual with colour plates, the transparency was hired and returned. He also asks for notions on the tuning of such an instrument; perhaps 2-plus double course chromatic arches?

RUTANA IMAGE: Have anyone know where he can buy or have made a good arch of Rutana archos? With reference to his access to bowl images (previous page), a working drawing and a set of measurements about or similar than nothing.

PAUL KAPLAN: Can anyone provide him with detailed measurements of the famous bourdon porcupine guitar in the Brussels Conservatoire no. 126 and/or a detailed photo or drawing of the rose? And does anyone have a good photo or drawing of the rose of the 1675 Vorosam in the Paris Conservatoire (no. 947)? I don't know whether he has tried the museums. He offers to link outlines and measurements of other baroque guitars.
IAN WATCHEY: I've just been asked to make some notes about some questions on early music. Can anyone give me an information on early music? Information on early music is needed on such questions as strident, violins, probably. We need to know when they were used and whether they were used on early music. There have been articles published in early music, but we don't have anything new. As far as I know, these will be the first notes.

MEL SARTAIN: Mel would be grateful for measurements of 17th-century four-point violins with one key, either early or late. He has made an effort here and wants to try some later models. Mel mentions in a recent note what's not a 17th-century AAB which is not typical: what has anyone else got?

JAMES TUCKER: Jim wants information enough to make fairly faithful reproductions of 17th-century early works, Seibon, Deimagore (I've never heard of this); tromba marina; rotta, turnaround (period unspecified by from the context, presumably early); these renaissance works in the collection of Nicholas of Montecour (I've suggested he write to him for that).

LOTTE'S NEWS

BRYAN TOLLEY writes that he has got an early music group going in the school he is working in. Initially it was recorder lessons with a bit of percussion, but now they have crumhorns, cornamuses, flutes, lute/pipes, tromba marina, rotta, turnaround. They have started making their own instruments and have so far produced six psalteries and one medieval pipe, all made by five girls the oldest of which is not yet 14. On top of that, they beat two well-established adult brass bands in a music festival, coming top in the open contest and winning the highest marks at any instrumental ensemble. This ties in with what I wrote above about school violins and so on. These kids are the future of early music and if we want to keep early music going, this is the sort of enthusiasm we need. The schools need all the help and encouragement that we can give them, and we need to convince far more schools that music did not begin with Vivaldi (or as is more usual, with Mozart).

WALTER HERMANN SALLAGAR has sent me the plans for next year's courses at Sendbe Besenherich. July 2-16, wind chamber music (classical on old instruments and modern music on modern instruments) and double reed and renaissance wind instrument making. July 16-20, workshop in renaissance music: workshops in medieval and renaissance dance; making as before. July 26-August 20, making clarinets and prototive oboes (no kits - traditional techniques). All with a good team of instructors (John Hanchet, Helga Hill, Peter Kukelka, Graham Lyndon-Jones, Sallagar himself of course, David Skalski, Barbara Stanley, Anne Marie Tyle, Josef Merlin, Bernard Brandili, and others).

MARTYN BANKS is running an instrument making course at the Polley Punter Education Centre, mainly on string instruments. If you know anyone in the Leeds/Bradford area who wants to learn and who would be content with the means that they would get in an evening class, put them in touch with me. The class meets on Thursday nights. Who else can persuade an Evening Institute to let them run classes in early instrument making?

UTA HENNING and her husband have produced another of their excellent calendars, with illustrations of early musicians for each month. It is available from her for DM 17.80 (she doesn't say whether that includes postage).
ALDUS MURTON has devised a thickness sanding attachment for his belt sander which will sand lute ribs to a tolerance of 0.09mm and which can be made at a relatively small cost. I've asked him to write it up for...

JACK WILKIE has a technique for free-form lute shell construction, using a wedge of wood and a block shaped to half the curve of the lute back. He also in writing this up, I hope.

KARY KAMP has a brief Comm. in this issue on music wire. A fuller 10 page report on the subject is available (title: Wrought Iron Music Wire) from him at the museum. It is free and I hope that the response will encourage the museum to produce more such technical papers in our field.

CONTRABASS RECORDER: Someone has sent me a leaflet from the instrument makers HALL in Munich. The whole thing is made in plywood, a square-section bore like an organ pipe with massive plywood plates instead of finger-holes or keys. I am sorry that we cannot run to illustrations or I'd put the leaflet in to entertain you. Sometimes we get a bit too solemn about authenticity and it needs something like this to cheer us up.

HUMBER-KOOP: Their latest issue arrived while I was typing the previous page. It includes some fairly detailed reviews of plans from various sources. A 'fantasy-fiddle' by Karl Frank, a Zuckermann Italian violin, A children's hurdy-gurdy by Karl Frank, an Italian harpsichord by Dennis Wright if I read the Dutch correctly all by George Sandberg. He might consider doing the same for us also. There is an annotated bibliography on organ-building etc. There is a response to, or perhaps a translation of, the controversy that has been going on in our Bulletin on accuracy of measurement. There are the usual lists of suppliers etc. There is the paper I referred to earlier by Rik van Pelt. There is another on strings by Leen van Assendelft. One on types of wood used then and now by Geert Jan v.d.Heide, with a fair amount of detail about each species of wood. One on the construction of the Flaterspiel with detailed plans (a bladder-pipe with single-beating reed); this article is in German. One on making wooden organ pipes by J.A.Simons. And one on planes and planing with good illustrations by C.van de Kaay.

I'll send it all up to Djilda as usual. If you want copies write either to them or to Toon Moonen. If you think any of the articles of sufficient interest to us, let me know and I'll ask Toon if we can translate them and use them. Perhaps he will encourage some of his members to write first for him and then to do an English version for us, as Rik van Pelt did; the more information is interchanged the better.

FINALLY: I think this is the longest Bulletin yet; the longer the better, for it means that you are using PMRRT as it should be used, to exchange information.

Remember to renew your subscriptions - if you don't, you won't get the next issue and you'll waste your own money in sending out reminders.

Deadline for the next issue, January 3rd, but try to get it in before the post gets clogged with the Christmas rush.

Look forward to hearing from you all and to seeing some of you on Dec 29-30 at the 16th century Seminar (non-member friends are welcome, especially if they might cease to be non-members).

Jeremy Montagu
7 Pickwick Road
Dulwich Village
London SE21 7JR
I've received notification of a JOINT MEETING OF INSTITUTE OF ACOUSTICS - MUSICAL ACOUSTICS GROUP and INSTITUTE OF MUSICAL INSTRUMENT TECHNOLOGY on Tuesday 13th December 1977 at the London College of Furniture. The lectures scheduled so far are:


Further information from J. Lincoln, Department of Musical Instrument Technology, London College of Furniture, Commercial Road, London, E1 1LA. The fee is £2.00 for members and £2.50 for guests. If anyone runs into problems through not being a member of either of these institutions I will gladly sponsor any FOMRHI member as my guest.

A list of DRAWINGS FROM BERLIN was too faint to print. We will ask for a better copy for next time. Meanwhile, for those who can't wait, the address is:

Staatl. Institut fur Musikforschung, Preussischer Kulturbesitz Musikinstrumenten-Museum, 1000 Berlin 15, Bundesallen 1-12

Also a list of PUBLICATIONS from Jacques Leguy, LE DROIT CHEMIN DE MUSIQUE, 5 rue Fondary - 75015 Paris.

LIST OF SUBSTANCES available from THEW, ARNOTT & Co. Ltd, Flodden Works, London Road, Wallington, Surrey SM6 7DJ phone 01-669 3131

(A)

ACACIA GUM
ACACIOIDES GUM
ACETIC ACID
ACETONE
ACRYLIC RESIN
ADHESIVE WAX
AGAR AGAR
AMMONIA ALUM
AMMONIA LIQUID
AMMONIUM CHLORIDE
AMYL ACETATE
ARABIC GUM (Lump & Powder)
ASPHALTUM POWDER

(B)

BALSA (Various)
BARIUM SULPHATE
BARYTES
BEECH WAX (Yellow & White)
BEECH WAX SUBSTITUTE
BENZOIN GUM
BITUMEN POWDER
BLEACH
BLOCKING POWDER
BOILED OIL
BONE GLUE
BORAX
BOTTLE WAX

(C)

BRITISH GUM
BURGUNDY PITCH
BUTTON POLISH
BUTTON SHELLAC
CALCIUM CARBONATE
CALCIUM CHLORIDE
CALCITE
CAMPHOR
CANDIDILLA WAX
CANDLE DYES
CANDLE WAX
CANDLE WICK
CARRAUBA WAX
CARRAGEEN
CHALK (Lump & Ground)
CAROB GUM
CASTING WAX
CAUSTIC SODA
CERA ALBA
CERA FLAVA
CERESINE WAX (White & Yellow)
CHELLE FRENCH (in Powder, Sucks and Slices)
CHALK (Lump & Ground)
CHALK NEUBERG
CHALK PRECIPITATED
CHALK PREPARED WHITING

(D)

CHALK TAIL
CHINA CLAY
COLOPHONY (see Resin)
COPAL GUM
COPPER SULPHATE
COPPERAS (White, Green & Blue)
COUMARONE RESIN
CRAYONS (Chalk & Wax)
CRETA FRPR

(E)

DAMAR GUM
DEPILATORY WAX
DEXTRINE
DOLOMITE
DYES (Candle)
DYES (Spirit & Water Soluble)

(F)

EARTH WAX
ELMENI GUM
ENCAPSULATING WAX
ENGRAVING WAX
EPSOM SALTS
ESPARTO WAX
ESSENTIAL OILS
ESTER GUM

(G)

FERROUS SULPHATE
FIBRE WAX

- II -
FORMIC ACID
FOSSIL WAX
FRANKINCENSE
FRENCH CHALK
FRENCH POLISH

(G)
GAMBOGE GUM
GARNET LAC
GELATINE
GHATTI GUM
GLASSPAPER
GLAUBER SALTS
GLUE
GLUE SIZE
GLYCERINE
GRASS TREE GUM
GUAR GUM
GUMS (listed alphabetically)

(G)
GUM LAC
GUM RESIN

(H)
HENNA POWDER
HYDROCHLORIC ACID
HYDROFLUORIC ACID
HYDROGEN PEROXIDE
HYPO

(I)
INSTANT CALGON
INSULATING VARNISH
INSULATING WAX
IRISH MOSS
IRON SULPHATE
IRON SULPHIDE

(J)
JAPAN WAX
(J)
JUNIPER GUM

(K)
KAOLIN
KARAYA GUM
KAURI GUM
KELTROL
KIESELGUHR
KORDOFAN GUM

(L)
LACQUERS
LANOLIN
LINSEED OIL
LITHOPONE
LYE

(M)
MAGNESIUM CARBONATE
MAGNESIUM CHLORIDE
MAGNESIA POWDER
MAGNESIUM SULPHATE
MAHOGANY STAIN
MANGANESE CARBONATE
MANHOLE GREASE
MANILLA GUM
MASKING WAX
Mastic GUM
 METHYLATED SPIRIT
(M)
MICA

MICROCRYSTALLINE WAX
(M)
MICROCRYSTALLINE WAX
(WHITE & YELLOW)

MINERAL WAX
MODELING WAX
MONTAN WAX
MOULD RELEASE
MURIATIC ACID
MUSCOWITE
MYRRH GUM

(N)
NAPHTHALENE
NEATSFOOT OIL
NITRIC ACID

(O)
OAK STAIN
OIL OF VITRIOL
OLEINE OIL
OLIBANUM GUM
OLIVE OIL
OURICOURY WAX
OXALIC ACID
OZOKERITE WAX
(WHITE & YELLOW)

(P)
PALM KERNEL OIL
PARAFFIN WAX
(PLASTS & PELLETS)
PETROLEUM JELLY
PHOSPHORIC ACID
PINE RESIN
PITCH BLACK
PITCH BURGUNDY
PITCH OPTICAL
PITCH POLISHING
PITCH SWEDISH
POLISHES FRENCH BUTTON
POLYESTER RESIN
POTASSIUM CHLORIDE
POTASSIUM QUADROXALATE
PRESERVATIVE COATINGS
PUMICE

(Q)
RED GUM
RESIN ACRYLIC
RESIN POLYESTER
RESINS WOOD, GUM
COLOPHONY, COUMARONE, etc
ROTTENSTONE
RUMBLING WAX

(S)
SAL AMMONIAC
SALT
SALPETRE
SALTS EPSOM
SALTS GLAUBER
SALTS OF LEMON
SALTS OF SORREL
SANDRAC GUM
SEALING WAX
SHELLAC BUTTON
SHELLAC
(Orange, Lemon & White)
SHELLAC POLISHES/VARNISH
SHELLAC WAX
SHELLAC WAXED & DEWAXED

(S)
SILICA GELL
SMEARING WAX
SOAP POWDER
SODA ASH
SODA BICARB
SODA CRYSTALS
SODIUM CARBONATE
SODIUM CHLORATE
SODIUM CHLORIDE
SODIUM DICHROMATE
SODIUM HEXAMETAPHOSPHATE
SODIUM HYDROXIDE
SODIUM HYPOCHLORITE
SODIUM SESQUICARBONATE
SODIUM SILICATE
SODIUM SULPHATE
SODIUM SULPHITE
SODIUM THIOSULPHATE
SPERMACETI WAX
SPIRIT THINNERS
SPIRITS OF SALTS
STAINS (Water & Spirit Soluble)
STAUFFER GREASE
STEARIC ACID
STEARINE
STICK WAX
STOCKHOLM TAR
STOPPING WAX
SUGAR SEEDS
SULPHURIC ACID

(T)
TALC POWDER (Sticks & Slices)
TALHA GUM
TALLOW
THUS GUM
TITANIUM DIOXIDE
TRAGACANTH GUM
TRIPOLI POWDER
TURPENTINE (Genuine)
TURPENTINE (Substitute)

(U)
UREA

(V)
VANDYKE POWDER
VARNISHES (Various)
VISCOUS WAX

(W)
WALNUT STAIN
WASHING SODA
WATTLE GUM
WAX DYES
WAXES (listed alphabetically)
WHITE CAUSTIC
WHITE SPIRIT
WHITE WAX
WHITING

(X)
XANTHAM GUM

(Y)
YACCA GUM

(Z)
ZINC OXIDE
ZINC STEARATE
ZINC SULPHATE
ZINC SULPHIDE
FELLOWSHIP of MAKERS and RESTORERS of HISTORICAL INSTRUMENTS


P in left-hand margin denotes Fellow.
* In left-hand margin indicates a change of address from the main list or from the first supplement.

Thomas C. Baine, 1710 Winnebagc St., Madison, Wisconsin 53704, USA (flute, recorder; M,P).

Martyn Banks, 8 Ladywood Road, Leeds, Yorkshire LS3 2QZ; tel: Leeds 698585 (rebec, hurdy-gurdy, psaltery, percussion; M,L).

Robin Barber, Box B, 25 Lytton Grove, London SW10 2EZ (flute, recorder, woodwind; M,D).

Charles Barker, 71 Ryland Road, Welton, Lincoln LN2 3LZ (lute; M).

Koen Begu, Den Eekhofstraat 12, B-2520 Blegem, Belgium (stringed instrs; M,P).


Ture Bergström, Hastrupvej 2, Héløringe, DK-4720 Præstø, Denmark.

Henrik Bøggild, Kroghagade 6, DK-2100 København V, Denmark; tel: (01) 38 4730 (harpsichord; M,P).

Riccardo Antonio Brancé, San Polo in Chianti, SQ020 Pirenze, Italy (lute; M).

Cameron, 57 Gladys Street, San Francisco, California 94110, USA (flutes, recorders, curtals; M).

David W. Cantrell, P.O.Box 713, University, Alabama 35480, USA; tel: (205) 759-2929 (viol, lutes, med. fiddles, harpsichor).

Chris Challen, 21 Clifford Road, New Barnet, Hertfordshire; tel: 01-449 8017 (lutes, guitar, citlerns; M,R).

E.W. Chapman, 12 Woodside Road, Beaconsfield, Buckinghamshire HP9 1JW; tel: Beaconsfield 6555 (keyboards; M,R).

W.E. Cleland, 5550 Marlborough Road, Pittsburgh, Pennsylvania 15217, USA.

Olive Cole, 41 St. John's Hill Grove, London SW11 2HP; tel: 01-226 9260 (lute, viol; M,P).

Patrick H. Corran, National Institute for Biological Standards & Control, Holly Hill, Hampstead, London NW6 6RR.

Caroline Dalton, Whetstone Grove Farm, Whetstone, Leicester LE5 3LX; tel: Leicester 775130 (Celtic harp, M, vin, rol).

Trevor P. Dibben, "West View Cottage", 69 Corfe Road, Storrathought, Wareham, Dorset; tel: Wareham 5767 (lute, guitar, reedflute; M,P).

Peter Dallimore, 11 Elm Bank Avenue, Arkley, Hertfordshire EN5 5DU; tel: 01-449 9606 (keyboards, early wind; P).

Paul Egcholm, 451 Long Riding, Basildon, Essex; tel: Basildon 281 426 (lute, viol; M).

Andrew Fairfax, Flat 1, 60A Beacon Hill Road, Newark-on-Trent, Nottinghamshire.


Brian J. C. Galpin, St. Bruce House, Charteris Road, Tuningdale, Berkshire; tel: Ascot 20284 (woodwind; C).

Joël Hamlet, 55 rue Bonneau, 67000 Strasbourg, France; tel: (88) 77 23 45 (bagpipe, hurdy-gurdy, harp; M).

Giorgio Grassetti, Piazza di Ferrari 5, 50134 Torino, Italy; tel: 011-506663 (stringed instrs; M).


H. Guy, 2 rue des Éravains, 67000 Strasbourg, France; tel: (88) 55 65 00 (samba, wire strings; M, Dealer).

Romey, Hadaway, Coombe End, Manor Road, Tregaron, Ceredigion, Wales (lute, cittern, organone, etc; M,R,W).
<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Telephone Number</th>
<th>Instruments-Taught</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Nicholson</td>
<td>Bream House, Hungershall Park, Tunbridge Wells, Kent</td>
<td>01-450 7265</td>
<td>(viol, hurdy-gurdy; M)</td>
<td></td>
</tr>
<tr>
<td>Guy Oldham</td>
<td>10 Newton Grove, Chiswick, London W.4</td>
<td>01-995 9029</td>
<td>(all instra, esp. organ; C,P,W)</td>
<td></td>
</tr>
<tr>
<td>David E. Owen</td>
<td>Ravensmoor House, Ravensmoor, Nantwich, Cheshire CW5 8PN</td>
<td>0270 65304</td>
<td>(mainly woodwind, esp. baroque; M,R,C,P)</td>
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<tr>
<td>Christopher Page</td>
<td>Jesus College, Oxford</td>
<td></td>
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<tr>
<td>John Pringle</td>
<td>67 Stuart Road, London SE15 5BA</td>
<td>01-639 8066</td>
<td>(med. &amp; ren. stringed instr; M)</td>
<td></td>
</tr>
<tr>
<td>Malcolm John Prior</td>
<td>Southernwood, Headley Down, nr Bordon, Hampshire</td>
<td>01-252 5181</td>
<td>(recordio, string; positive, chimebells, pfte; P,W,L)</td>
<td></td>
</tr>
<tr>
<td>Mary Remnant</td>
<td>15 Fernshaw Road, Chelsea, London S.W.10</td>
<td>01-252 5181</td>
<td>(all instr, esp. organ, harp, crust; C,P)</td>
<td></td>
</tr>
<tr>
<td>David Rolfe</td>
<td>77 Doncaster Av., Narellan, New South Wales 2567, Australia</td>
<td></td>
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</tr>
<tr>
<td>Carsten Roepke</td>
<td>Fraestevangen 3, DK-5610 Assens, Denmark</td>
<td></td>
<td>(lute; M)</td>
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<tr>
<td>Roy Sayer</td>
<td>Welsh Folk Museum St. Pagan</td>
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<tr>
<td>Amhedda Werin Gawr</td>
<td>Welsh Folk Museum, St. Pagan</td>
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</tr>
<tr>
<td>Michael Saunders</td>
<td>1 Waterloo Cottages, Waterloo Lane, Letton, Herefordshire</td>
<td></td>
<td>(reber, psaltery, harp, crust; M)</td>
<td></td>
</tr>
<tr>
<td>Christopher Sayers</td>
<td>75 Dorset Road, Merton Park, London SW19 3HE</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Othmar Scennann</td>
<td>Cobleskugasse 29, A 1090 Wien 9, Austria</td>
<td>01-25 114</td>
<td>(keyboards; C)</td>
<td></td>
</tr>
</tbody>
</table>
David Pilgram, 119 Spring Garden St., Greensboro, North Carolina 27401, USA; tel: (1-704) 232-9795 (lute, vihuela, guitar; M).

Elsa Elenyé, 5154 Rembrandt Street, Tacoma Park, Maryland 20271, USA.

Aiseth Sparr, Victus 15, S-820 26 Ljusnars, Sweden (lute, vihuela, guitar; M).

Melinda Ann Bolinger, 47 Field Lane Mansions, Bromford Street, London W4 2HX (viola, lute, tar, guitar, cittern; M,P).

Peter A. Turner, 17 Cypress Drive, Bradford, West Yorkshire BD10 9AW; tel: (01254) 615737 (harp, keyboards; M).

Jill Vandishill, Little Oakfield, The Park, Cheltenham GL50 2EW; tel: Cheltenham 77744 (lute; M).

W. van Vaerenbergh, Vander Vekenstr. 117, B-1185 Wemmel, Belgium.

Brian Vale, "Hastwoodside", 90 South Lane, Heaton, Bradford, West Yorkshire BD9 6DQ; tel: Bradford 42964.

Colin Vale, 18 Moorfield Road, Manchester M20 6YJ; tel:061-445 0529 (vihuela, cittern; M,P).

Richard E. Wols, 2550 Dupont Ave.So., Minneapolis, Minnesota 55406, USA; tel: (112) 37 - 9977 (bar, violin, treble viol, basset viol; M,P).

Donald Wormald, P.O. Box 266, Walton, New Hampshire 03696, USA; tel:617-654 (lutes, vihuela, viola, etc; M).

Ian Watson, 6 Longdown St., Newtown, New South Wales 2042, Australia (lute, etc; M,P).

Welsh Folk Museum - see Amgueddfa Werin Cymru, alphabetically under 'Saint'.

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General Facilities:

Italian Translation: Riccardo Brandé

Spanish: Riccardo Brandé

Metallurgy: Gary Karp, Rémy Costé

Wood: Gary Karp

Museums: Parish, Musikinstrumenten Museum (Dieter Kriechberg)

St. Magnus, Amgueddfa Werin Cymru / Welsh Folk Museum (Roy Snaer)

Flutes: Laurence Bandy

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Epistemological Index:

All Instrumental: Guy Oldham (C,P,W)

Perusing: Mary Remnant (C,P)

Strong, Lectures, General: Koor Bani (M,P) Giovanni Guarnieri (M)

John Hunter (N,R,P) John Pringle (M) David Sheppard (M)

Singing: Rémy Costé (M)

Dulcimer: Peter Hayden (M,R,C,P)

Recitalists: Martyn Banks (M,L) Mary Remnant (C,P) Michael Saunders (M)

Keyboard, General: Eric Chapman (M) Peter Dallimore (P) Roger Kirby (H)

Oscar Rosenmann (C) Peter Turner (M)

Flutes: Gethin-Williams, Verdun (M) Mary Remnant (C,P) Welsh Folk Museum (C)

Guitarists, etc.: Henrik Bøggild, K (M,N) David Cartrell, K (M)

Rémy Costé, K (M,P) Kenneth Honer, K (M)

Christopher Jones, K (M) Richard Vale, K (M)

Clarions: Kenneth Honer (K) Christopher Jones (K)

Lute: Charles Barker (K) Ricardo Brandé (K) David Cartrell (K)

Chris Challen (K) David Cole (M,P) Trevor Dobbs (M,F)

Paul Kehrlein (K) Robert Hadaway (K,N,W) John Hoiz (K,S)

Wim Jekshoven (K,M,F) Thomas Kniffert (K,N,C,P) Malcolm Prior (K)

Carsten Rosbash (K) Mel Sartain (K) David Sheppard (K,F)
list of members - 2nd suppl. p.4

(Left continued) Kenneth Sparr (M) Melanie Spriggs (M,P)

John Underhill (M) Donald Warnock (M) Ian Watchorn (M,P)

Jitter: Chris Challen (M,P) Trevor Dibben (M,P) John Hill (M,R)
Thomas Kniffert (MP) John Leopold
Mel Sartain (M) Kenneth Sparr (M) Melanie Spriggs (M,P)

Violin: Kenneth Sparr (M) Colin Vale (M,P) Donald Warnock (M)

Cittern, etc.: Chris Challen (M,R) Robert Hadaway, c.o (M,R,W)

Melanie Spriggs (M,P) Colin Vale (M,P)

Crash: Michael Saunders (M) Welch Folk Museum (R,C)

Rebec: Martyn Banks (M,L) Mary Remnant (C,P) Michael Saunders (M)

Viola: David Cantrell (M) Mary Remnant (C,P)

Violin Family: Caroline Dalton (R) Okechukwu Ndubusi (R)

Mary Remnant (C,P) Richard Walz (M,P)

Viole da Gamba: David Cantrell (M) - Olive Cole (M,P) Paul Egholm (M)

Michael Heale (MCR) Jörg Jörkow (MP) Malcolm Prior (M)
Mel Sartain (M) Melanie Spriggs (MP) Richard Walz (MP)

Hurdy-gurdy: Martyn Banks (M,L) Jöël Garnier (M) John Nicholson (M)

Harp: Caroline Dalton (M) Jöël Garnier (M) Jörg Jörkow (M,R,P)

Michael Saunders (M) Peter Turner (M) Welsh Folk Museum (R,C)

Wind Instruments General: Peter Dollimore (P) Okechukwu Ndubusi (R)

Woodwind General: Robin Barbary (M,C) Brian Galpin (C) David Owen (MCRP)

Transverse Flute: Thomas Baime (M,P) Robin Barbary (MC) Rod Cameron (M)

Jonathan Morgan (MP) Mel Sartain (M)

Recorder: Thomas Baime (M,P) Robin Barbary (M,C) Rod Cameron (M)

Trevor Dibben (M,P) Jonathan Morgan (P,R) Mary Remnant (C,P)

Organ: Noel Mander (M,R) John Nicholson (M) Guy Oldham (CPW)

Mary Remnant (C,P)

Regals: Noel Mander (M,R) John Nicholson (M)

Reed Instros.: Jörg Jörkow (M,R,P) Jonathan Morgan (capped) (P,R)

Pibcor: Welsh Folk Museum (R,C)

Harppipes: Jöël Garnier (M)

Brass: Jörg Jörkow (M,R,P)

Cornett: Jörg Jörkow (M,R,P) Jonathan Morgan (P,R)

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Geographical Index

Australia: Ian Watchorn, NSW; David Rolfe, NSW

Austria: Otmar Seemann, Wien

Belgium: Koen Begu, Biégem; M. van Vaerenbergh, Wemmel

Denmark: Henrik Æggiold, København; Jörg Jörkow, Espergårde;

Carsten Roebæk, Åsens

France: Jöël Garnier, St.Florent; Rémy Gug, Strasbourg

West Germany: Thomas Kniffert, Berlin; Musikinstrumenten Museum, Berlin

Italy: Riccardo Branie, Firenze; Giovanni Giannotti, Torino
Norway: Helge Korvald, Oslo; Kare Lie, Daken

Sweden: John Huber, Hättvik; Kenneth Sparr, Ljusne

Switzerland: transfer Cleland to USA

England:
Brian Galpin, Berks
E.W. Chapman, Bucks
David Owen, Cheshire
Trevor Dibben, Dorst
Paul Egholm, Essex
John Underhill, Glos
Malcolm Prior, Hants
Michael Saunders, Herefd
Chris Challen, Herts
Peter Dollimore, --
Christopher Jones, Kent
John Nicholson, --

London: Melanie Spriggs, El
Noel Mander, E2
Okechukwu Ndubuisi, El4
Jonathan Morgan, NW2
Patrick Corran, NW3
John Pringle, SE15
Mary Remnant, SW10
Olive Cole, SW11
Robin Barbery, SW15
Christopher Sayers, SW19
Guy Oldham, W4

Manchester: Colin Vale, M20

England: Andrew Fairfax, Notts
John Leopold, Salop
Brian Hayden, Somerst
Kenneth Honor, Staffs
Michael Heale, Surrey
Rodger Mirrey, --
Peter Turner, W. Yorks
Martin Finn, Yorks

Scotland: Peter McCrae, Dumfries

Wales: Welsh Folk Museum, Cardiff

U.S.A.: David Cantrell, Ala.
Rob Cameron, Calif.
Mel Sartain, --
John Hill, Ill.
Richard Walz, Minn.

Robert Hadaway, Ceredigion

Donald Warnock, N.H.
David Sheppard, N.C.
W.E. Cleland, Penn.
Thomas Baise, Wisc.

** NB Please check your listing and send in additions or corrections. **

**
Too many UK members don't show their Post Office Codes - the Post Office threatens to delay or surcharge letters without it.

**
A number of members don't show any organological interests; if that's your preference, fair enough, but if it's inadvertent because you hadn't seen what I put in the list, let me have them with your 1978 subscription.
The Gram Press (146 Kingman Avenue North, Nashvil1e, Tennessee 37203, USA) has started producing a Gram Research Series. The first one, dated 1971 (I don't know whether there are any more; I'll try to find out before January), is The Kayed Trumpet and Its Greatest Virtuoso, Anton Weislanger, by Heinz Kühn. It contains a lot of useful information and at least starts to sort out the problem with an instrument allegedly invented in 1801 and used as a solo instrument in a concerto of 1796. It is a 25-page booklet, spin-off from a thesis and my copy cost me £1.50 at Blackwell's.

Joachim Braun has sent me a copy of a research report on the Authentic Performance of Beethoven's 4th Symphony, the result of the Beethoven Seminar at Bar-Ilan University, Ramat-Gan. I don't know whether this is generally available or not, but if you are working on this symphony and concerned with an authentic text (and this seems to be the first attempt to produce one), it would be worth a stamp to Israel to ask Joachin if copies are available. If he tells me that they are, I'll review it properly in the next issue.

I received today a letter from The Ringve Museum, N-7000 Trondheim, Norway, saying that he has sent me a copy of the Check-List of their collection and a Catalogue of an exhibition of bells. These will be reviewed in our next issue, as they've not yet arrived, but anyone who wants them on general principles should write to Peter Andreas Kjeldsberg at the museum. Incidentally, he has taken over from Gary Karpe as the Secretary of CIMCM.

The Musiknistoriska Museet in Stockholm has just published the 5th in their series edited by Ernst Easheimer, Studia Instrumentorum Musicae Popularis. Several articles are concerned with early instruments: one on 15th century, two on 17th and 18th, and two on 19th. In addition to which, this is the most important series of publications on folk instruments (apart from the very slow moving Volksmusikinstrumente Europas) in Europe. The present volume costs 100 Swedish crowns, as do all the others in the series except no.3, which costs 200. It is available from the Museum (S-111 30 Stockholm, Slottbacken 6, Sweden). Tony Bingham might have copies here; apart from him you'd probably have to order it specially.

Jeremy Montagu
Unfortunately most of the material available in English on Early Spanish Music is out of date and inaccurate. There is, however, a great deal of information available in Spanish. This is a partial list of books and editions which can be obtained either in Spain or through dealers in Britain. I have found Grant and Cutler and Brian Jordan the most helpful in obtaining the required books.

Consejo Superior de Investigaciones Científicas (C.S.I.C.) Instituto Español de Musicología. This institution has been publishing scholarly editions for over thirty years. They have one main series that publishes one volume per year. In addition there are various provincial institutes which are affiliated which publish their own material. And, finally, they publish various pamphlets and books of interest to the musician on an irregular basis. Outside of the main series there is often a considerable delay between publication date and availability. These are some of their most recently published titles.

Leon Tello, Francisco Jose; Estudios de Historia de la Teoría Musical. C.S.I.C., 1962. This first half of this book is European music theory. The second half is a detailed discussion of Spanish theory in the 16th century.

Leon Tello, F. J; La Teoría Española de la Música en los Siglos XVII y XVIII. C.S.I.C., 1974. This is a continuation of the above. It includes a discussion of the treatises which deal with performance practice.

Querol Cavaldá, Miguel; Cancionero Musical de Conora. C.S.I.C., 1975. This is the first in a series that will present the music to the songs referred to or included in the works of Spanish writers in the Siglo de Oro.

Angles, Higinio; Historia de la Música Medieval en Navarra. Institución Príncipe de Viana, Diputación Foral de Navarra, 1970. This study includes not only Navarra, but also the musical relationships between that Kingdom, the other Iberian states and France.
Union Musical Española (U.M.E.) have started a series of scholarly editions. The formats and the covers are very similar to the C.S.I.C.,

Kastner, W.S. (ed); Francisco Correa de Araujo: Libro de Tientos... (1526)

Baber Sala, M. A.; Antonio de Cabezón; Glosadas, UME, 1974; These pieces are not included in the C.S.I.C. edition of Cabezón.

Alpuerto is a relatively new publisher. Most of their editions are in the 'Early Music' or the 'Modern Music' fields. They also choose a size of score to fit the intended work.

Preciado, Dionisio; Quiebros y Redobles en F. Correa de Araujo. Alpuerto 1973. In reality this is a study of all of the sources of information on ornamentation in 16th century Spanish instrumental music.

Rey, Juan Jose (ed); Ramillete de Fábriz. Alpuerto 1975. This is an edition with tablature, transcription and historical notes of the one vihuela tablature ms. that has material not found in the seven published books.

Subira, Jose Historia de la Musica Española e Hispanoamericana, Salvat 1953. A very useful general book with many illustrations.


Rubio, Samuel, (ed); Juan Vázquez, Agenda Defunctorum Real Musical 1975

Rubio, Samuel; La Polifonía Clasica Biblioteca 'La Ciudad de Dios' (Real Musical) 1974. This is also available in English and is a study of polypny from the point of view of the theoriticians contemporary with the music.

Lopez Serrano, Matilde; Cantigas de Santa Maria de Alfonso X, el Sabio, Rey de Castilla Editorial Patrimonio Nacional. 1974. This is a brief study of the 'other' Escorial Cantigas ms. (T.I. I)

Criado de Val, Manuel and Naylor, Eric W. (eds.) Arcipreste de Hita; Libro de Buen Amor, Aguilar, 1976. This is a beautiful and rather expensive edition of the work that is often cited as the Spanish equivalent of the Canterbury Tales. The original text is retained, but footnotes provide explanations of unfamiliar words. Included with the text are reproductions of all of the musical instrument miniatures from the Cantigas, Escorial b.I.2.

Bopeña, Federico; La Musica en el Prado Arte Españ. Reproductions and a study of all of the paintings in the Prado that have musical instruments.

Querol Gavaldá, Miguel: Transcripción e interpretación de la Polifonía Española de los siglos XV y XVI. Ministerio de Educación y Ciencias 1975. In addition to the book the MEC has published a set of records on Spanish Music before 1800.
As the Arabian lute is the direct ancestor of the European lute and has survived the latter, through an unbroken playing tradition, to the present day, it is possible that a study of the construction of these instruments may provide some further evidence as to how lutes were built prior to the middle of the 16th Century. In the hope, therefore, that it may act as a catalyst for some fruitful further discussion I give the following brief description of the construction of an old lute purchased in Cairo some years ago.

The instrument was made, (or perhaps rebuilt) by - "Hossein Muhi Al-Deen Holmy, apprentice luthier, third year", according to the label in the body. There is no date or reference to place of manufacture but the Arabic script is North African so it is likely that it was made in Cairo.

There are signs that the belly has been removed several times previously and the workmanship in the body is finer than that of the belly, suggesting that the belly was a later addition, possibly by the above maker, to an older instrument.

String length is 63.6cm, with six double courses, spaced at 3.3cm at the nut and 7.7cm at the bridge with height of strings above belly 7.0mm. While being unfretted, fret positions are indicated by inlay - there being seven frets to the body. Fingerboard is flat and in the same plane as the belly - neck semicircular in section, neck to body joint vertical. The body is made of 19 ribs and finished to a smooth semicircular contour. There is no end block but a thin softwood plate is used as reinforcement in this position. End clasp is a small semicircular disc of wood. Pegbox is 'S' shaped and built up with a closed back.
BELLY

A plan of the underside of the belly is shown in fig 1. Workmanship is of rough appearance with some asymmetry in the arrangement of the bars and with the whole underside being finished with a toothed plane and left rough. The belly is built up from four unmatched sections of spruce (?) thickness varying from 1mm at the neck to 1.5mm at the bridge and is left unvarnished. The edge of the belly is reinforced with segmented surfling 4mm wide.

The end of the bars closely fit and are glued to the sides of the body. End grain in the bars runs at 45°.

Roses are cut from hardwood sheet to a fretwork design and glued to the back of the belly. Each rose is signed with the maker's name.

A plectrum guard of hardwood is glued to the belly.
NOTES ON THE PRESERVATION AND REPAIR OF THE SHAKUHACHI

By Dan E. Mayers

The Japanese shakuhachi, being made of bamboo, a species of grass, is subject to cracking, due to changes in humidity and temperature. The following notes are designed to assist the prevention of such cracks and to suggest how they may best be repaired if they occur.

It was the custom of a more leisurely age to allow bamboo blanks to season for 20 years before use. Today, most shakuhachi are made from bamboo which has only been seasoned 3 years and is, accordingly, still drying out when the instrument is delivered to the customer. Due to the fortunately damp climate enjoyed in England, there is comparatively little danger of splitting in this country and the process of gradual drying out will continue under apparently ideal conditions. Elsewhere, however, it is essential that the shakuhachi be stored in a plastic bag in order to stabilise the shakuhachi environment. If the weather is particularly dry or the instrument is to be stored for a long period, it is essential to wet a Kleenex, squeeze the excess water out of it, and place this at the bottom of the plastic bag near the lower end of the shakuhachi. It is important that this moist Kleenex should not be left near the upper end as it may cause the bamboo to swell and the uta-guche mouthpiece inset to come apart.

The plastic umbrella bags distributed when it rains by the Imperial Hotel in Tokyo to its residents, are particularly suitable.
Some shakuhachi makers bind their instruments in the hope that this may discourage splitting. This procedure, while occasionally esthetically decorative - and frequently the reverse - is seldom effective. The process of drying out involves the shrinkage of the circumference of the bamboo. This causes the cracks to occur and this shrinkage is in no wise impeded by bindings. A little thought will convince one of this.

When a crack develops in a shakuhachi, it will affect the tone of the instrument only if it penetrates the entire thickness of the wall. The effect of such penetration, is, ordinarily, to disturb the lower octave of the instrument. When this occurs, the first step is to determine the seriousness of the crack. this can be done by wrapping the instrument in a moist towel and leaving it for 24 hours. If this procedure heals the crack and the instrument plays normally - until it dries out again - one may expect the following procedure for permanently healing the crack to be successful.

To heal this type of minor crack, all that is needed is to soak the entire instrument in Watco Danish Oil*. It may be necessary to soak the instrument several times before the crack is wholly healed. The excess may be readily removed from the surface with fine steel wool. This preparation is a sealer, rather than a varnish, and does not form a thick surface film. Nevertheless, it may be removed from the bore of the instrument by pulling a cloth through the bore.

*Watco Danish Oil is manufactured by Watco-Dennis Corporation, Michigan Avenue and Twentieth Street, Santa Monica, California 90404, U.S.A. and is available in England under the name of Timberex from Watco (Sales) Ltd., 56 Buckingham Gate, London SW1E 6AE
while the oil is still moist - before it has a chance to dry.

Cracks which are too large to be suitable for the above treatment may simply be filled with any good-quality plastic wood. It is unlikely that this will entirely close the cracks as such plastic wood tends to be slightly porous when dry. If the crack is soaked in the above-mentioned Watco preparation after the crack has been filled with plastic wood, the crack may be expected to become airtight.

It is hoped the above suggestions will help shakuhachi players to keep their instruments in playable condition. Perhaps players of other woodwind instruments subject to cracks may also find these suggestions useful.
FoMRHI Com. 77.  R.K. Lee

Restoration of Cupped Flemish Wrestplanks

Flemish harpsichord wrestplanks were most often constructed of a hardwood (oak or walnut) plank of a single piece, on whose upper surface spruce soundboard stock was veneered with the grain going the longway of the instrument. A frequently encountered shortcoming of the construction method is that the heavy wrestplank dries out and becomes cupped (convex cylindrical upper surface). When this condition is severe, it destroys the mortises in the spine and cheekplace and even causes these to split. If the original veneering operation was carried out at the correct moisture content, there would have been no problem; however, when the moisture content was too wet for subsequent or modern climate conditions, cupping is the inevitable result.

About 20 years ago, W. Charles Fisher then of the Hubbard and Dowd firm, suggested that single layers of 1/8th inch spruce in both the upper and lower surfaces of the wrestplank would yield a balanced laminate without the complexity of modern piano pinblock construction. By calculation, the longitudinal stiffness of the thin spruce plates is adequate to overcome the low transverse stiffness of the oak or maple wrestplank. In the United States, this has been a successful new construction technique for many years. The theoretical prediction proved correct, and the practical result was surprising.

My 1776 J. P. Bull harpsichord had a severely cupped wrestplank with about a two foot radius of curvature when I acquired it in 1958. Both the spine and cheek were split and the nameboard was loose as well. All transverse members in Bull's construction were dovetailed into both the spine and cheek, so that it was not possible to remove the wrestplank without removing the wood above the wrestplank mortises. When this removal was carried out, it was possible to lift the wrestplank and nameboard vertically out of the topside of the instrument. Fins and treenails were removed before performing this operation. Routicves of wet rags were applied to the bottomside of the wrestplank for a period of approximately two weeks, until the top surface of the wrestplank became true again. Quartered spruce plates were then glued to the underside of the wrestplank in order to hold it in the straight condition. After other repairs to the instrument were made, the wrestplank was reinstalled in the instrument, and new pieces of wood were let into the spine and cheek; the bindings were carved to match those in the instrument.

This instrument has been in constant use for more than a decade, and its tuning stability compares favorably with a Steinway piano in the same room with the harpsichord (1000 chairs). Even with humidification and limited central heat, the seasonal variation in Watertown Massachusetts is great, the practical humidity varying between 35% and 90% and the temperature between 15°C and 35°C indoors (–20°C and 35°C outdoors). This repair is suited to our severe climate, and affords great convenience to the player of the instrument because of the frequent tuning required. While this construction does not resemble that of the 17th and 18th centuries, it is completely and easily reversible in that the additional spruce plates can be carved or stemmed to remove them from the instrument at any later time.
The profiling of the front plates of viols, including bass bars, is without doubt critical to the quality of their sound. Much acoustical research has been carried out on the comparable problem with respect to instruments of the violin family (which have the additional complication of having back plates which contribute significantly to their sound); Carleen Hutchins of Montclair, New Jersey, USA, has been the leading light in this field, and her work and that of her co-workers has been reported in detail in Newsletters of the Catgut Acoustical Society. Stated briefly, the essence of the current form of practical plate tuning is to vibrate a freely suspended plate by placing it in the near-field of a sinusoidally-excited loudspeaker, and refining the plate profiles until the Chladni patterns (vibrational modes of the plate made visible by concentrations of powder along the nodal lines of the plate surface) assume the right form.

One of Mrs Hutchins proteges, Laird Carlson of Albany, Vermont, USA, has in recent times been applying the same principles to the tuning of viol plates and I had the good fortune when in the United States recently to receive very generous help from him and from Mrs Hutchins in the profiling and tuning of a front plate taken from an excessively heavy and unresponsive bass viol. The improvement in the bass response of the instrument has been phenomenal.

To discuss the technique in general terms, I believe the starting point should be the selection of profiles which are close to those of good historic instruments. Each sample of wood is different and it is prudent to carve and scrape the plate to thicknesses somewhat in excess of those finally required. I have built up a small data bank of profiles of several historic baroque viols plus several successful modern replicas, and have tentative opinions on what good profiles should be. The rules, if rules exist, are very loose! To get the historic data, I used a set of gauges contrived to fit into the C-holes of the instruments; the technique works well though I note Martin Edmunds' electrical alternative (Fo MRHT Communication Number 4).

Thence follows plate tuning, using the Hutchins approach. Through hard experience I believe that it is not a process easily learnt through reading scientific documentation; it seems to be part science, part craft, and is best taught by personal instruction ... at the feet of the master. The process has been well investigated for violins. For viols there may be many question marks. At the very least it seems to me to offer an aid to the quality control of instrument building. At most, it may be a means to create instruments of outstanding bass performance. I am inclined to the latter view although in all honesty I cannot say that it is necessarily true. Hopefully, in a year or two I will have more definite views.

Perhaps other makers will have opinions? Apart from Laird Carlson who has tuned a number of viol plates using the Hutchins technique, perhaps someone has taken the subject further?

David STRAHLE
Another note concerning Praetorius's pitch standards:

On p8 of Bulletin 8, Jeremy quoted from a letter from Rob Marvin casting doubts on the conclusions of Thomas and Rhodes (Organ Year book, II [1971], 56-76) concerning Praetorius's pitch standards. It is a very well written paper and worth reading and re-reading in conjunction with the papers by Ellis and Mendel that it continually refers to. We discussed some aspects of this paper on p 35 of Comm. 38. [We would like to take this opportunity to correct an error in that communication. The phrase "a fourth higher or a fifth lower" on the 10th line of the first paragraph is nonsense. It should be replaced by "a good tone or a tone and a half higher".]

Bob has the intellectual equipment and knowhow on the acoustics of fipple-blown instruments to rapidly get up to Thomas and Rhodes's level of understanding of organ pipes and then do a proper critique of their methods, hopefully coupled with some experiments and an alternative conclusion. But Bob has not yet said anything to shake my acceptance of their results in any way. This should not detract from the very important point that he makes which is that the surviving recorders in museums having measurements similar to those in Praetorius's plates are a bit more than a semitone sharper than the standard Ellis and later Thomas and Rhodes derived from reconstructing Praetorius's pitch pipes. This difference needs explanation. The two possibilities for solution to this problem that Bob focuses on are that Praetorius was wrong and that his interpreters are wrong. Bob first pits his judgment against that of Praetorius, suspecting that the little foot tuning pipes Praetorius hoped would be used to stabilize pitch standards are not good standards. Not knowing enough about the subject to have an independent view, I will stick with Praetorius until Bob comes up with some good data to support his case. Thomas and Rhodes have data on 26 different pipes they made using Praetorius's specifications, with the missing factors taken from what is presumed to be the best of current knowledge of organ pipe technology of that time. The fact that their results are so consistent is very convincing to me. I think it will be difficult to fault their work, but Bob is a man not to be underestimated.

The point in Thomas and Rhodes's article about Praetorius's set of sealed recorders should be commented on by Bob. They plotted the logarithms of the sounding lengths from foot to plug against the logarithm of frequency, and since the points fell on a straight line, they established that Praetorius's drawings are to scale with each other. This is not news but they then derived the length of an f recorder, from this plot and found that it was 2.7% longer (slightly flatter) than a modern f recorder with a' = 440 Hz (halfway between the pitch standard discussed above and Bob's measured pitches). They were aware that Barnes calculated the pitches of the same set of Praetorius recorders and got a' = 470, more than a semitone sharper (as sharp to Bob's measurements as a' = 440 Hz is flat). We would all be very grateful if Bob would have a go at sorting this one out.

Bob's last point was a complaint that Thomas and Rhodes ignored the possibility that the half feet are correct on the scale of Praetorius's Plate XXXVII showing scaled organ pipes, rather than assume, as they did, that the full length of the scale should have been divided into 20 rather than 19 half-feet. What everyone (including Jeremy) notices when they look at this scale is that Praetorius made some error.
The possibilities of what its nature might be extend beyond those mentioned above. For instance, dividing the full scale into 9 feet could well have been the original intent. The average pitch standard Thomas and Rhodes determined from the organ pipes on the second of the above three assumptions was $a' = 435$ Hz with a semitone range of variation. Using the Savart-Mersenne Law the first assumption would lead to $a' = 458$ Hz (you can see why Bob likes it), and the third would lead to $a' = 412$ Hz. Thomas and Rhodes, in support of their assumption state that it makes the drawing 1/12 full size. This implies one way that Praetorius did his scaling that could be checked against his other drawings. It doesn't work simply on the drawings in my 1945 Barenreiter facsimile but I doubt whether this edition is trustworthy on the scale of reproduction. But it is only from considerations like this one which attempts to determine Praetorius's methods that we can choose between one assumption of the nature of his error and another. The fact that Praetorius made an obvious error here does not in any way affect the value of the other data he offers and the reconstructions of his pitch pipes by Thomas and Rhodes. But now back to the real problem, the difference in pitch standards between surviving wind instruments from Praetorius's period ($a' = 450-460$ Hz according to Bob) and his pitch standard as interpreted by Ellis ($a' = 424$ Hz) and Thomas and Rhodes ($a' = 426$ Hz mean for round pitch pipes, $428$ Hz mean for rectangular pitch pipes and $435$ Hz mean for large organ pipes on Praetorius's plate 37). To add to Bob's values we have Weber's paper (GSJ XXVIII (1975) 7-10) where he claims to have determined the pitch standards of 49 recorders flutes and cornets in the Accademia Filarmonica of Verona. He concludes that 37 are in $a' = 450$ Hz, 6 in 410 Hz and 4 in 465 Hz. (To give readers a feeling for how these numbers relate, note that in the region involved (around $a' = 440$) there are about 25 Hz per equal-tempered semitone). Weber also suggested that the 410 Hz standard was particularly French while the 450 Hz standard Italian. I have no arguments against this and just ask "why can't the North German standard be halfway in between?" Since I see no reason as yet to doubt the measurements of Praetorius or Thomas and Rhodes or Bob Marvin or Rainer Weber, I prefer to seek solutions which allow them all to be essentially correct.

It is pertinent here to consider how much variation from the mean we should expect from adherents to a particular pitch standard at one place and time. I understand that wind instruments intended to be played together were made in sets. Extra care needs to be taken to tune and voice an instrument to its optimum resonance (whatever that meant to them) and still conform accurately to an outside pitch standard. Today we take this for granted but the making instruments that could play with any other in that locality could well have not been expected then. It is also good business to require a merchant or gentleman to buy a whole new set for his growing family rather than make it easy for them to put a set together more cheaply from the second-hand market. In addition the instrument maker probably used a pitch pipe for pitch reference, and though it was good enough for him and Praetorius perhaps Bob is right and it falls quite short of modern expectations. I would guess that a variation of perhaps half a semitone on either side of the mean pitch on fixed pitch instruments from different sets in any locality would not be unusual. I would expect more variation on stringed instruments where performers have more control over pitch. And this is only for instruments performing one musical function. Within the same musical culture different instruments and the same type of instruments performing different musical functions were often at different pitch standards. This is mentioned by Weber and by us (Comm. 38).

Praetorius did not attempt to express relative pitch standards in units more precise than a semitone and it is likely that more precision would have been meaningless.
The main point I'm getting at here is that though a simple picture of pitch standards around 1600 would be most convenient for all of us, I am afraid that we may have to live with a more complex as well as imprecise historical picture than we would like.

SOME REFLECTIONS UPON THE ACOUSTICS OF THE CORNATT

Introduction

The present communication is a summary of an engineer thesis held in 1971. Some further researches have been of course made since that time and the results are also quoted in this paper.

It is unnecessary to introduce the Cornett as a musical instrument, but the traditional difficulty of its playing has been the origin of our work. The success of this instrument in combination with many loud and soft instruments, either in polyphonic music or in the Prebaroque symphonia and sonata, leads to think that, in spite of its difficulty, it has been one of the most favoured woodwinds. One of the numerous reasons of it is its tone colour and its possibility to play loud or soft which is very rare for a Renaissance instrument. (among the wind instruments).

Acoustically, its large bore (in report to the classical brass) and its relatively short length make a completely different instrument to the modern ones and the reaction of the cupped mouthpiece ('bouquin' in French) on a so short instrument has lead to a bad consider of it as an instrument always 'out of tune' and sometimes 'ugly'.

Theoretical and practical background

Where does the problem lay?

The acoustical system includes:
- an excitator composed of the lipped reed and the 'bouquin'
- a pipe which amplifies and changes the aspect of the signal.

The system lips-mouthpiece gives a signal which is peculiarly rich of all 'harmonies' up to at least 1000 Hz. The vibrating way is which...
is called 'relaxation oscillation'. The lip-muscles and the wind pressure have an opposite effect (lips are closing the mouth and wind pressure are opening it alternatively) and produce a 'self-fed' system.

In that way, lips alone can produce musical sounds if trained enough. But the difficulty of this training lead to the invention of the cupped mouthpiece, which helps the system to start with, the dimension of which is rather large for bass instruments and more or less small for the treble ones. We shall see that the dimensions of this 'bouquin' are fundamental in the tone colour and that the pipe only amplifies the produced sound and is actually an impedance adaptor.

On traditional instruments the pipe is always provided with a more or less cylindrico-conical bore. Of course, theoretical datas, based on geometrical shapes, are seldom agreeing with experiments on actual instruments. Anyway, complexity and many parameters of such a system allow nobody to draw a rigorous theory of it. But we can approach it by investigation in spite of the fact that a part of a human being is closely associated to it (the lips-reed is obviously impossible to design artificially, since it alters with a player to another one).

We know theoretically that a cylindro-conus with perfect geometry cannot produce a complete set of harmonics. Some experiments by LARROQUE, ARTH and LEYPP show strange paradoxes such as unusual positions of the nodes and antinodes of pressure and complete eat of harmonics in an actual cylindro-conus.

Which can be partly explained as follows:
- the lip-mouthpiece system is a reed which can be said "strong" the energy of which is much greater than the one of the standing wave existing in the pipe. The system imposes its own vibrating running.
- the 'freedom field' in frequency of such an instrument (range produced with a same fingering or position between upper and lower possible limits on the same partial) is incredibly large (more than one octave on the lower notes), which shows that the player must first think to the exact pitch of a note before intonation and then control exactly the tonus of lips and wind pressure to produce a well pitched sound.

In the case of the cornett, the problem is complicated by finger-holes, for it is actually difficult to know the actual length of pipe with a hole: everybody knows the principle of fork fingerings to flatten some sound, but in that way, the sound colour is often altered.

So the problem is to determine the kind of coupling which exists between the exciting system (lips and 'bouquin') and the associated pipe, and what the reaction of the pipe looks like, when the lips start their vibrations.
EXPERIMENTS AND RESULTS

The measurements of original cornetts from the period of Louis XIII (taken by us in museums and private collections) have allowed us to build 4 instruments with different bores.

The bore of cornetts is rather difficult to design. The measurements are nevertheless agreeing with Seravelli's data (1636). Approximately, the bore is shaped with 2 cones fitting at the first fingerhole (the nearest to the mouthpiece), the first one (from the mouthpiece to the first fingerhole) having a wider conicity than the other one (down to the bell). The mean measures are: \( \phi \) at the mouthpiece: 6mm; \( \phi \) at the thumb hole: 12mm; \( \phi \) at the bell 23mm.

Among our 4 instruments, the \#1 has the mean bore with a protection of soft almond oil, \#2 has the same bore but varnished with a hard protective as for wooden floors, to change the state of the inner walls. \#3 has got a wider bore (about 3mm at the bell with a light expand from the top) and oiled with the same product, and the \#4 is narrower (about 3mm at the bell, same conditions as above) also oiled.

In order to make a good choice, we have made 9 mouthpieces of different design: \#1 to 7 have the same \( \phi \) (internal) at the lips 11,5mm and at the bottom of the cup (2,5mm) ; \#8 is 15mm wide in \( \phi \) at the lips and 3mm at the bottom. \#9 and 2 are of ivory, respectively 7,7 and 9,6mm deep. \#3,4,5 are of ebony, respectively 6,5, 7,7 and 8,7mm deep. \#6 and 7 are of boxwood, respectively 7,6 and 7,0mm deep and \#8 is of ivory 10,1mm deep.

The different combinations which can be made are 4 \( \times \) 32 have the aim to compare the sound colour of the instrument according to:
- the state of the inside walls
- the bore of the pipe
- the material in which the mouthpiece is made
- its depth
- its inner \( \phi \) at the lips.

Of course, the experiments made some years ago are not absolutely rigorous because of the way of it and of the making of the instruments in which we were not as skilful as we can be now. Anyway, the shape of the acoustical phenomena, which is rather reproducible, are easily distinguishable, though we have been using an exciting system by a human being.

The first study is made on the sound colour. The lips alone give a continuous spectrum up to 8000 Hz. There is no special coloured zone in the spectrum of frequencies. At the opposite, the mouthpieces alone give interesting results: all of them from \#1 to 7 (with the same inner \( \phi \) at the lips) give a sound in which one can see a formantic zone (very precise) between 1500 and 2700 Hz (up to 3000 Hz for the ivory ones), and \#8 is quite different, having its formantic zone between 1200 and 2200 Hz.

The mouthpieces made of ivory give a richer sound in the high harmonics than those of ebony or boxwood. The state of the inner surface of them influences the production of harmonics: the harder the surface is, the louder the high harmonics are.
The depth of the mouthpiece is also a characteristic of the sound colour; a flat one gives a richer spectrum in high frequencies than a deep one and the formantic zone is the more precise as the mouthpiece is deeper. The well-known property in the musical world is recognized: the nearer the mouthpiece to the lips is, the richer the sound is.

To study the tone colour of the cornets we have made, we have recorded 5 different items as follows: a slow scale to be listened to, a rapid scale for the sonagraphical study, a repeated note very quickly, virtuosiastic divisions and the emission of the different partials of the sound to compare the 'tuning' of the different pipes.

We have been able to compare:
- the influence of the inner walls of the cornett
- the influence of the width of the bore
- the influence of the 'bouquin' on the cornett itself.

The quality of the walls influences the spectrum which is richer when the walls are harder. But the cornett No. 1 has the right formantic zone (1500-2500 Hz) with an anti formant very well defined.

The cornett No. 2 has got the same formantic zone, but less precise with a more regular spectrum in regard of the use of the same mouthpiece.

If the walls influence the tone quality, the diameter of the fingerholes, which is not the same on the 2 instruments, introduces some more parameters because the fingerhole open part of the pipe can change the sound colour according to the diameter of the last open hole.

The wide bore of the cornett No. 3 is good for high frequencies more than 3500 Hz, but the formantic zone is still present. The narrow bore of the cornett No. 4 makes the formant not so clear and many high frequencies are emitted; harmonics up to 5000 Hz are to be found especially in the 2nd octave.

One can notice that the bore influences the intensity of the harmonics of the sound but without changing the sound colour (always same formantic zone). But the 'mean' bore seems to have been chosen to avoid too high harmonics.

What is especially important is the influence of the 'bouquin'. The results of the study on the sound produced by the mouthpieces alone are to be found in the study of the instruments. With the mouthpiece No. 3 the formantic zone is quite different, not so high as with smaller mouthpieces. But it shows an antiformant at the very place of a great formant of a small mouthpiece. That's a special property of the mouthpiece to produce a sound well coloured in the full sensible area of the ear. And what is especially surprising is that the cornett sound produced with a small mouthpiece is terribly similar to a child's voice... Many acoustical diagrams can prove it at once! Apart of that we know that the main use of the cornett was the reinforcing of children's voices, which is quite suitable if the sound colour is really close to the other one.

So we can see that a physical analysis tells us that the sound colour of the cornett is primarily given by the geometry of the mouthpiece, the richness by the material and the depth of the cup and, secondarily, by the bore of the pipe; but the cupped mouthpiece has a leading part.
The study of the 'freedom field' in frequency shows that the cornett has got a very large one (up to 2 octaves)! The lips-'bouquin' system imposes its frequency especially when the 1st partial is running. The 2nd partial has a smaller one (but still a fourth) because of standing waves of greater energy in the pipe. But the excitation system remains the leader.

The tuning of the partials also shows a great influence of the bore on the partials. The mean bore is the only one to produce good tuned notes, being a, bb', f'', bb'' a.s.o. which is very convenient for the fingering of the b flat and the upper f (f'').

The increase of the wind pressure doesn't follow the classical law: instead of being a function of the square root of the pressure, the logarithm of the frequency is approximately proportional to it.

The 'freedom field' in pressure (range of the wind pressure inside the mouth with which it is possible to play the same note) also gives some information on the reaction of the pipe on the excitation system. When the wind pressure is gradually increased to produce the partials from down upwards, the diagram is different from which we get by playing the partials from up downwards. An 'hysteresis cycle' is clearly visible in the changing from partial \textsuperscript{1} to \textsuperscript{2}, which shows that it is possible to play either the 1st one or the 2nd one with the same wind pressure. But the intensity is different with the same pressure and this thing is bettered by an altering of the lip-tension, which is very important in the changing from the 2nd to the 3rd partials, for which the cycle is not very distinguishable.

One of the conclusions to notice from these experiments is one more proof (it it would be necessary!) of the difficulty of playing our instrument since with a same wind pressure it is possible to get 2 partials. The player must adjust, according to the musical movement of the melody, the lip tension enabling him to produce the right desired sound.

The study of the starting of the sound gives more information upon the coupling of the lips-'bouquin' system and the associated pipe.

The virtuosistic recorded passages have allowed to get a clear image of sonagrams demultiplicated 12 times. (Scale: 12cm for 0.1 second).

The starting can be sum up as follows:
- tonguing: 2ms
- coloured noise around the desired frequency (and its harmonics) during 5ms
- progressive begin of the different harmonics, the 1st one always being in the range 500 to 600 Hz.

Very strangely, the formant starts a little later, but, after 25 ms (a quarter of a tenth of a second!), the normal running is established. In the lower register, the 2nd or 3rd harmonic starts first; in the upper one, the fundamental starts first, but the starting is always happening with the more energizing harmonic.
The coloured noise in the mouthpiece is the vibration of the lips before the pipe starts to react to it. This problem of the starting of the sound on such an instrument is really complicated because the transients are masked by the coloured noise of the lip vibration which is actually difficult to analyse. It is obvious that the player automatically regulates the frequency on the desired one according to the musical part he has to play (if his ear is not too bad, as Wersenne says it!), but the reaction of the pipe is rather slow compared to the surprising quickness of the tonguing.

CONCLUSIONS

This short paper shows that the cornett is an instrument with a rare quick starting of the sound which allows a virtuosity which took place in a given context. Its tone colour is significant: the formant given by the combination of the lips, the mouthpiece and the pipe is exactly centered in the most sensible zone of the human ear, which is also to be found in the organ stop called 'Cornet', composing the 5 first natural harmonics of a note with fipple pipes. Anyway we know from many sources that its name comes direct from the Cornett!

This specific tone colour is due principally to the cupped mouthpiece, and moreover to the inside dimensions (diameters) of it, which leads to suppose that the inside diameter limits a vibrating part of the lips obliging them to produce a rich sound in harmonics located in the formantic zone described above.

Now we can understand that the genuine cornett sound can only be obtained with very small mouthpieces. Having good friends among famous trumpeters, I shall not get angry against them if they play the cornett with their trumpet mouthpiece, but they cannot pretend to play as in former times... And the smallness of the mouthpiece explains simply the reason of playing the instrument at the very corner of the lips. The smaller the mouthpiece is, the thinner the lips must be to respect the proportion of material geometrical things to fit to each other. The statements of many historical treatises are quite in agreement with our different way of taking the problem, and those of Wersenne especially.

And these conclusions can be extended to the whole cornett family: the lysard and the serpent being of a much better tone quality with relatively small mouthpieces than with fairly great ones, as we have experimented it. So the statement of Praetorius on the lysard ('unlieblich und hornhafftig') is true if a wide mouthpiece is used (as it seems also on cornets in German countries according other sources) but is not valid if a small one is set on the instrument. I let the reader think to these problems, the approach of which I have tried to do as a scientist as much as a musician but I know that a scientific study with an apparatus using some part of a human being is always to be discussed....

Being very open to constructive comments I hope to hear from them when they occur.

Paris, September 1977
BULLETIN EXTRA

Brussels Museum of Musical Instruments

Plans
Nr. 3188 Lute J. ehr. Hoffmann, Leipzig 1730
Nr. 1559 " " " 1716

Photograph of X-ray of two Hoffman lutes (Nrs. 3188 and 1559), front views showing positions but not heights of bars.
About 30 Belgian Francs. Write to: Instituut voor het Kunstpatrimonium, Jubelpark 1, 1040 Brussel. ref. ACL L 14, 533 B.
WORKSHOP DRAWINGS and PHOTOGRAPHS.

From John Barnes, 3 East Castle Road, Edinburgh, EH10 5AP, GB.
and Edward R. Turner, North Pender Island, British Columbia VON 2MO, Canada.

Single manual harpsichord by J. L. Dulcken c1750, Boalch no 12, 2 x 8', 1 x 4', length 2480 mm, compass FF - e'''', owned by J. Barnes, Edinburgh, drawn by Richard Ireland and William Bright.

The drawing 2950 x 950 mm shows all the woodwork and metalwork of the instrument and lid including double thickness bentside, internal bracing, soundbars, soundboard thickness in 28 places, drawstop mechanism and action.

A set of photographs consisting of 3 colour slides, 3 b & w prints 205 x 148 mm and 9 b & w prints 152 x 95 mm show the lid painting (the Return of the Ark of the Covenant, 2 Samuel 6) and chinoiserie, internal details and decoration of the stand, the rose, details of keys and keyframe and internal details of the case joints. The case depth is the same as Dulcken used for 2 manual harpsichords.

Italian harpsichord by Gregori, 1726 (the 2 is uncertain), 2 x 8', length 1360 mm, compass C/2 - e''' without e''''', weight 32 kg, owned by J. Barnes, Edinburgh, drawn by Edward R. Turner.

The drawing 3150 x 950 mm shows all the woodwork and metalwork of the instrument, lid, music desk and stand, including the integral case of poplar lined with cypress wood, mouldings, key decoration, hinges, internal bracing, soundbars and soundboard thickness in 12 places, boxslides, keys and keyframe and jacks. The keyboard balance pins and the tongues of all the jacks of the instrument have been replaced but the drawing shows the likely original shape and size. A suggested stringing list is given.

A set of 6 b & w photographs 204 x 153 mm show general views, the inscription, details of keys, keyframe and scrolls, handwriting on jacks, internal details and the ironwork hinges.

Fretted Clavichord by Christian Gottlob Hubert, Ansbach, 1784, Boalch no 1293 x 356 mm x 122 mm, compass C - f''', 39 pairs of strings, weight 12.5 kg, privately owned in Edinburgh (formerly by Sir Donald Tovey) drawn by Richard Loucks. The notes are fretted in pairs except notes C - e and all a's and d's.

The drawing 2300 x 1000 mm shows all woodwork and metalwork of the instrument and lid and the pattern of the coloured paper decoration inside the case. A suggested stringing list is given including covered strings for the lowest 11 notes which have wider tangents.

A set of 10 photographs, b & w 204 x 153 mm show general views, the name label, the decorative paper and details of the undercutting of the keys.

Gurdy Gurdy by Varquain, Paris 1761, no 37832, University of California, Berkeley, drawn by Edward R. Turner.

The drawing 1500 x 570 mm shows all external details of the instrument, together with an interior structure based on other instruments of the period.
Richard Ireland is a school teacher and harpsichord maker in Melbourne, Australia. William Bright is a harpsichord maker in Barraba, Australia. Edward R. Turner is a harpsichord maker and former architectural draughtsman in Vancouver. John Barnes is a harpsichord maker, restorer and collector and Curator of the Russell Collection, University of Edinburgh. Richard Loucks is a Music professor in California.

The main purpose of the drawings and photographs is to enable builders to make accurate copies by the provision of relatively full and reliable information, but they have considerable value in the comparative study of similar instruments, e.g. other instruments by the same makers and also have general educational and decorative value.

**Prices**

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<th>Artist</th>
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**Postage from G.B.**

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</tbody>
</table>

Please remit in either Sterling to John Barnes or Can$ to Edward Turner. Goods will be despatched as soon as possible after receipt of payment.
THE STRING FORMULA
by R.F.J. van Pelt

The impossibility to tune to the required pitch any of my spare harpsichord strings on a modern spinet (all harpsichord strings, thick ones and thin ones broke), and the necessity to calculate some missing strings for a plucked instrument, compelled me to study the string formula. I was greatly helped by Jahnel's chapters on strings in "Die Gitarre und ihr Bau" and I was rewarded by gaining very interesting and useful insights in the secret life of strings.

An electronic pocket calculator with and was an indispensable expedient. The original formula contains the gravity constant \( g = 9.81 \text{ m/sec}^2 \), but I omitted it for simplicity's sake. If you insist on including it, then multiply \( F \) by 0.981 in all formulas.

THE FORMULAS FOR NON-OVERSPUN STRINGS

I used the formula in 6 different forms:

1) \( N = 100 \sqrt{\frac{F}{4L^2Q}} \)
   - \( N \) = frequency in Hertz
   - \( F \) = stretching force of string, in kg
   - \( L \) = length of string, in meters
   - \( Q \) = surface of cross section of string, in mm²

2) \( B = 10000 \times \frac{F}{4L^2N^Q} \)

3) \( Q = 10000 \times \frac{F}{4L^2N^Q} \)

4) \( L = 100 \sqrt{\frac{F}{4N^2Q}} \)

5) \( F = \frac{4L^2Q}{10000} \)

6) \( F = \frac{4L^2Q}{10000} \)

Finally 7) \( Q = \frac{\pi}{4} \times D^2 \) and 8) \( D = \frac{\sqrt{2}}{\pi} \)

Please note: \( F \) concerns the string and is a force.

\( F/Q \) concerns the strings' material and is called stress.

THE VIOLIN

I made the odd supposition that a violin might well be equipped with one material for all strings, and I hoped to get from the formula a plain motivation why the answer is "no". I choose hard steel, as it is the material for at least one of the strings (\( e^2 \)), spec. weight 7.84, and intended a stretching force for each string of about 6.5 kg.

\( L = 0.325 \) meter. One example, the \( e^2 \)-string, \( N = 659 \) Hertz, is worked out in detail, and these and all other results are brought together in table 1.
\( Q = \frac{10000 \times F}{4L^2N^2S} \)

\( D = 2\sqrt{\frac{Q}{\pi}} = 2\sqrt{\frac{0.045185}{\pi}} = 0.239 \text{ mm} + 0.24 \text{ mm} = \text{ diameter } e^2\text{-str.} \)

Table I

<table>
<thead>
<tr>
<th>I</th>
<th>e²-string 659 Hertz</th>
<th></th>
<th>II</th>
<th>a¹-string 440 Hertz</th>
<th></th>
<th>III</th>
<th>d¹-string 294 Hertz</th>
<th></th>
<th>IV</th>
<th>g-string 196 Hertz</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>D</td>
<td>Q</td>
<td>F</td>
<td>F/Q</td>
<td>% of ( \text{br.stress} )</td>
<td>D</td>
<td>Q</td>
<td>F</td>
<td>F/Q</td>
<td>% of ( \text{br.stress} )</td>
<td>D</td>
<td>Q</td>
</tr>
<tr>
<td>mm</td>
<td>mm²</td>
<td>kg</td>
<td>kg/mm²</td>
<td></td>
<td>mm</td>
<td>mm²</td>
<td>kg</td>
<td>kg/mm²</td>
<td></td>
<td>mm</td>
<td>mm²</td>
</tr>
<tr>
<td>0.23</td>
<td>0.042</td>
<td>5.98</td>
<td>144</td>
<td>60</td>
<td>0.23</td>
<td>0.042</td>
<td>5.98</td>
<td>144</td>
<td>60</td>
<td>0.23</td>
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</tr>
<tr>
<td>0.24</td>
<td>0.045</td>
<td>6.51</td>
<td>144</td>
<td>60</td>
<td>0.24</td>
<td>0.045</td>
<td>6.51</td>
<td>144</td>
<td>60</td>
<td>0.24</td>
<td>0.045</td>
</tr>
<tr>
<td>0.25</td>
<td>0.049</td>
<td>7.06</td>
<td>144</td>
<td>60</td>
<td>0.25</td>
<td>0.049</td>
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<td>60</td>
<td>0.25</td>
<td>0.049</td>
</tr>
<tr>
<td>0.34</td>
<td>0.091</td>
<td>5.82</td>
<td>64</td>
<td>26.7</td>
<td>0.34</td>
<td>0.091</td>
<td>5.82</td>
<td>64</td>
<td>26.7</td>
<td>0.34</td>
<td>0.091</td>
</tr>
<tr>
<td>0.36</td>
<td>0.102</td>
<td>6.53</td>
<td>64</td>
<td>26.7</td>
<td>0.36</td>
<td>0.102</td>
<td>6.53</td>
<td>64</td>
<td>26.7</td>
<td>0.36</td>
<td>0.102</td>
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<tr>
<td>0.38</td>
<td>0.113</td>
<td>7.27</td>
<td>64</td>
<td>26.7</td>
<td>0.38</td>
<td>0.113</td>
<td>7.27</td>
<td>64</td>
<td>26.7</td>
<td>0.38</td>
<td>0.113</td>
</tr>
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</table>

I was surprised to see that, given one material, one string length and one pitch, the tensile stress \( F/Q \) is not influenced by the string's diameter; any steel violin \( e^2 \)-string, be it as thin as a spider's thread or as thick as a clothes line, would at 659 Hertz have a tensile stress of 144 kg (but the clothes-line's stretching force \( F \) would amount to 500 kg, so please don't try it).

But what is the importance of tensile stress? Here Jahnel gave the answer: for a tonal result that is rich in harmonics the tensile stress of a steel wire should be between 50 and 70% of the breaking or ultimate stress. Steel has a breaking stress of about 240 kg per \( \text{mm}^2 \). Table I shows that only the \( e^2 \)-string falls within those boundaries, having a tensile stress of 60%. The other strings remain far behind; because of their failing elasticity when under such a low stress, there is no use for them on a violin.

But then there are other materials for strings. We try gut. To avoid doing all those calculations again, we have a look at formula 6, which says that \( F/Q \) is proportional to \( s \) (\( L \) and \( N \) remaining unaltered). As gut has a specific weight of 1.3, \( F/Q \) for such a string will be \( 1.3/7.84 \times 64 = 10.6 \text{ kg/mm}^2 \) in the \( a^1 \)-string. The weakest sort of gut has a brea-
king stress = \(32 \text{ kg/mm}^2\), and the tensile stress should, according to Jahnel, lie between 15 and 70%, thus the 33% of the \(d\)-string is on the verge. \(Q\) (form.3) = 0.613 mm² and \(D\) (form.8) = 0.88 mm.

No material is available for non-overspun \(d\)-and \(g\)-strings, and here we have to cope with new problems.

**Overspun Strings**

In an overspun string it is only the core that undergoes the stretching force. The wound layer adds weight to the string, thereby lowering the frequency. The stretching force has to be increased to produce a pitch that is as high as the non-overspun core would have by a much lower force. Having in mind the paramount role of \(F/Q\) in producing sound of a good quality, we conclude that an added layer of thin wire can raise a too low \(F/Q\) of the core to within the required boundaries.

In the violin-\(d\)-string, which will be our sparring partner in this problem, a non-overspun gut string (breaking stress \(45 \text{ kg/mm}^2\), intended tensile stress \(22 \text{ kg/mm}^2\), stretching force 6.5 kg) would produce 294 Hertz by a tensile stress of only 4.75 kg/mm². Consequently, the added aluminium winding, intended for this string, has to have such a weight that an increase of the core's \(F/Q\) from 4.75 to 22 kg/mm² will raise the sunk pitch to exactly 294 Hertz.

In the formulas \(Q\) becomes \(Q_c\) (core) or \(Q_w\) (winding), \(S\) becomes \(S_c\), \(S_w\) or \(S_{c+w}\), \(D\) becomes \(D_c\), \(D_w\) or \(D_g\) (whole string's diameter).

As the specific weight of a combination of gut and aluminium lies between 1.3 (gut) and 2.7 (Al), we introduce in the formulas an adapted definition of \(S_{c+w}\): it is the weight of a length of overspun string, the core of which measures 1 mm³. The formulas are numbered Ia, 2a etc.

We start the calculations. From \(F = 6.5 \text{ kg}\) and \(F/Q = 22 \text{ kg/mm}^2\) merges \(Q_c = 0.295 \text{ mm}^2\) and \(D_c = 0.613 \text{ mm}\). Formula 2a yields \(S_{c+w} = 6.03\)

Next: \(S_w = 6.03 - 1.3 = 4.73\).

In the case of a winding made of round wire, it should be remembered that between the turns are left small spaces of air, so that only 0.785 of the space is actually aluminium, the rest is air. The "specific weight" of a winding of round aluminium wire is therefore 0.785 x 2.7 = 2.12.
we divide \( S_w = 4.73 \) by \( 2.17 \), which is \( 2.21 \). The ratio of the surfaces of the cross section of core and winding, \( Q_C : Q_w \) is therefore \( 1 : 2.23 \).

But we want diameters, not surfaces. Forgive me for not explaining at length all of this, but the formula is (9a): \( D_w = D_C^2 - 1 \), and

\[
D_s = \sqrt{D_w + 1}
\]

Thus \( D_s = \sqrt{2.23 + 1} = \sqrt{3.23} = 1.8 \), which means that the string's total diameter measures \( 1.8 \times \) the core's diameter: \( D_s = 1.8 \times D_C \), \( D_C = 2.61 \) mm, and \( D_s = 1.10 \) mm.

Thus \( G = \frac{V_0}{1.6} \), which means that the string's diameter is \( 0.245 \) mm.

But then there is the fact that by being wound, the aluminium wire became slightly flattened, and when perfectly round, its diameter would be about \( 11/9 \times 0.245 \) mm = ca. \( 0.27 \) mm.

We calculated a violin-d'-string that is perfect from the formulas' viewpoint, and reasonably good, in any case much better than a plain gut string, from the musician's standpoint. Jahnel has a lot to say about the quality of strings, and I hope there is an English translation of the book.

Finally the violin is still without a g-string. I hope that you will do the calculation yourself. I propose a gut core, overspun with aluminium, \( F = 6.5 \) kg, \( F/Q = 22 \) kg/mm\(^2\), \( N = 196 \) Hertz.

**THE HARPSCICHORD**

The harpsichord and allied instruments have a different string length for each note. We conceive a very simple model: doubling the string length for every octave downward on the scale, and one string diameter \( (0.22 \) mm\) and one material (soft steel, breaking stress \( 124 \) kg/mm\(^2\)). In this harpsichord \( N \times L \) is constant, so is \( F \) \( (3.8 \) kg per string\) and so is \( F/Q \) \( (100 \) kg/mm\(^2\), being \( 80 \% \) of the ultimate stress).

We only consider the B'-strings. If \( c^3 \) measures \( 0.173 \) meter, then \( L \) would measure \( 2.77 \) m, \( BB \) \( 2.90 \) m, and if we tune that string GG (shortened octave), the appropriate length would be \( 3.67 \) m. Imagine a harpsichord of 4 meter !

The traditional way to avoid such extremes is the foreshortened bass: from about \( c^1 \) downwards the strings are, in an increasing way, made too short. Now I can imagine that you propose the use of thicker wire for those strings. But then you forgot that the tensile stress, and consequently the sound quality, is not influenced by the strings' diameter. I was surprised to see that Raymond Russell in The Harpsichord and Clavichord, 2nd ed., pg 19, did make the false assumption: "...the length of..."
the strings in relation to the proper scale falls off, but is compensated by strings of greater diameter, ... to slow down the vibrations by weight.

<table>
<thead>
<tr>
<th>L</th>
<th>N</th>
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<tr>
<td></td>
<td>meters</td>
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<tr>
<td></td>
<td></td>
<td>( \text{kn/mm} )</td>
</tr>
<tr>
<td>c(^3)</td>
<td>0.173</td>
<td>1046</td>
</tr>
<tr>
<td>c (\cdot)</td>
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<td>523</td>
</tr>
<tr>
<td>c(^1)</td>
<td>0.680</td>
<td>267</td>
</tr>
<tr>
<td>c</td>
<td>1.136</td>
<td>131</td>
</tr>
<tr>
<td>B</td>
<td>1.177</td>
<td>123</td>
</tr>
<tr>
<td>E(^\circ)</td>
<td>1.420</td>
<td>87</td>
</tr>
<tr>
<td>D</td>
<td>1.460</td>
<td>73</td>
</tr>
<tr>
<td>C</td>
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</tr>
<tr>
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As in the violin the tensile stress \( F/Q \) should lie within certain percentages of the breaking stress, and the only solution for the foreshortened strings (except overspinning them) is to use materials with a higher specific weight (which makes \( F/Q \) greater) and with a lower breaking stress (which makes the ratio tensile stress to breaking stress greater).

Table II contains the actual data of a kit-built small Flemish Zuckermann Harpsichord, but without any reference to special wire diameters, as these don't influence these values. The thick encircled areas show that in this instrument one switches to a weaker but heavier string material where the tensile stress decreases to about 55% of the breaking stress. It seems that no suitable material exists for the lowest notes: \( \text{GG} \) should have overspun strings.

- 41 -
Finally there is to be dealt with the fact that the lower notes have thicker wire. It seems possible that however no influence of the string’s diameter upon the sound quality of the string is to be expected, there might be an influence upon the sound quality of the instrument as a whole. But in any case 7 factors are obvious. First: a lower frequency is associated with a longer wave-length of strings and wood, so a greater mass is to be set into motion. This viewpoint could possibly be dealt with by an expert reader in a separate article. Secondly: our sound perception has a sensitivity peak in the region of 1000-3000 Hertz. The lower frequencies (and that is all but the harpsichord’s entire compass) must produce more decibels to cause as strong a subjective hearing sensation (measured in “tones”). Table III gives the actual wire diameters and stretching forces in the Zuckermann harpsichord.

<table>
<thead>
<tr>
<th>String Material</th>
<th>Bronze</th>
<th>Brass</th>
<th>Soft Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stretch Force (kg)</td>
<td>4.7</td>
<td>7.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Wire Diameter (mm)</td>
<td>0.56</td>
<td>0.51</td>
<td>0.51</td>
</tr>
</tbody>
</table>

The formula offered the unexpected opportunity to find the breaking stress of a great diversity of strings. With the contraption, drawn here, the pitch (in Hertz), at which the string snapped, could exactly be determined. As f and 5 were known, and N was found, formula 6 produced \[ \frac{P}{\text{br. str.}} = \frac{Q}{f} \]. The string was excited by a slowly rotating disc with a weak plectrum, and the rising pitch was closely followed with the aid of a pitchmeter. The breaking stress varied insignificantly with strings of one material but of different diameters. The thinnest strings were a little stronger than the thicker ones, according to Toon Moonen a result of their way of manufacture. The other drawing shows the string stretched by a known force, and could be used to find its specific weight, but I didn’t use it.
We were going to recommend that this paper be sent back to the author for alteration. Then we heard that he has died. We are very truly sorry, since from his writing he seemed such a lively interesting fellow.

The paper offers little new that is unavailable in English except the methods of Jahnel, which, as seen below, we have some reservations about. Nevertheless it is an approach to the subject which is basically valid and might resonate with the kind of way some readers could readily think about stringing, so we include it with our following comments.

1. The gravity constant is 9.81 m/sec^2 not .981, but the formulas are correct.

2. F/Q is the “stretching force per mm^2 of cross section of string” and it is called “stress”. But this is true for any force you put on the string and so it is not a function of the string material. The maximum stress a string can take before breaking is a function of the string material and is called “tensile strength”.

3. The supposition that all of the violin strings could be made of one material is not odd. This was true with gut up to the time of Leopold Mozart. The assumption that all of the violin strings have the same tension was true for Leopold Mozart but not since 1800.

4. Jahnel’s rules of working ranges of stress on various materials are both highly approximate and conservative. They can be violated with impunity. His upper limit of 70% of breaking stress (equivalent to 3 semitones below breaking pitch) is violated by van Pelt’s harpsichord as shown in Table II and most fingerboard instruments where 80% of breaking stress (2 semitones below breaking pitch) is quite common. The lower limit of 50% (6 semitones below breaking pitch) for steel wire is broken by every non-keyboard historical instrument we know of. Jahnel’s lower limit of 35% (9 semitones below breaking pitch) for gut is ridiculous, and as van Pelt has shown, even excludes the violin a string. Historically, 9% has been the lower limit on ordinary music gut, 4% on high-twist gut and 2 1/2% on Venice Catlines.

5. Gut for violin d strings is available from most string suppliers (i.e. Pirastro, Pyramid, La Bella, Savarez, NRI etc.)

[COMMERCIAL: Our (NRI) high twist ones are the best.]

6. Van Pelt assumes that the lower limit of an overspun string is that of its core. This problem has not been properly studied either experimentally or theoretically. Work by Schelling indicates that this is not a very bad first approximation.

7. A confusing aspect of van Pelt’s calculation on overspun strings is that he defines quantities relating to the components which are not in the same units as quantities of the same name have when used with plain strings. To avoid this confusion we will follow through his calculation using definitions which are unit-consistent. He first decides on the force and stress of the core and from the ratio of these gets the cross section area Qc from which, using Equation 8 he gets the core diameter Dc. He then gets an effective density (or specific weight) \( S_{e+w} \) of the overspun string from Equation 2 by using \( F \) and \( Q \) of the core only but \( N(\text{frequency}) \) of the whole string. In essence he is calculating the density of an imaginary
string having the core's diameter but dense enough to pull the pitch down to
frequency \( N \) he finally wants. The mass per unit length of the real string (which
is the sum of the masses per unit length of the components) must equal the
mass per unit length of the imaginary string. Thus

\[
S_c Q_c = S_w Q_w = S_{cw} Q_c
\]

From this he can calculate the difference between the \( S_{cw} \) he got from Equation 2
and the specific weight of the core \( S_c \) to get the quantity,

\[
S_{cw} = S_c - \frac{S_w Q_w}{Q_c}
\]

(which he calls \( S_w \)). This quantity when divided by 2.12 (which we would call \( S_w \))
gives, as he says, the ratio \( Q_w/Q_c \).

Now using Equation 7, \( Q_w = \frac{\pi}{4} \left( D_w^2 - D_c^2 \right) \) and \( Q_c = \frac{\pi}{4} D_c^2 \). Then
one can calculate the ratio \( Q_w/Q_c = (D_w/D_c)^2 - 1 \), which gives

\[
D_w = D_c \sqrt{(Q_w/Q_c)^2 + 1}
\]

The rest is straightforward.

In our method to do this calculation we use the formula (2) in Appendix 6 of our
Galpin Society Journal XXVII (1974) article. It is

\[
\left( \frac{D_w}{D_c} \right)^2 = 1 + \frac{\pi}{\pi} \frac{\rho_w}{\rho_c} \left[ \frac{D_w}{D_c} + \left( \frac{D_w}{D_c} \right)^2 \right]
\]

The \( D_w \) and \( D_c \) have the same meaning as in van Pelt's article and our \( \rho_w \) and \( \rho_c \) are his \( S_w \) and \( S_c \),
respectively. Our equivalent diameter \( D \) can be derived from his equation 3
using \( N \), the desired frequency, \( F \) the desired tension and \( S = Sc \) the density
of the core. The resultant \( Q \) is converted to \( D^2 \) using his equation 7. We assume
a core diameter \( D_c \) and can then calculate

\[
\left[ \left( \frac{D_w}{D_c} \right)^2 - 1 \right] \frac{\rho_w}{\rho_c} = \frac{D_w}{D_c} + \left( \frac{D_w}{D_c} \right)^2
\]

which we

shall arbitrarily call \( A \). We want \( D_w \) on its own so we solve the quadratic

\[
\frac{D_w}{D_c} = \frac{\sqrt{4A+1} - 1}{2}
\]

Multiplying by \( D_c \) gives \( D_w \).

When we know all of the parameters and compare the \( D_w \) from this calculation
with the \( D_w \) actually used, we find exact correspondence at around \( D_w = 8\frac{1}{2} \) thou
with the calculated \( D_w \) being about 2% too high for every thou less than this and
2% too low for every thou greater than this. We do not as yet have an explanation
for this discrepancy.

- 44 -
8. Though Russell did not seem to be aware of the usefulness of the concept of stress in understanding harpsichord scaling, the quoted statement is not untrue.

9. One of the dangers of Jahnel's approach is a trap that van Pelt seems to have fallen into. Since Jahnel expresses allowed stresses as % of breaking stress, it seems logical that we may lower the lower stress limit by lowering the higher one by using a weaker material. The upper and lower limits are not related at all. The upper limit involves the tensile strength of the material. The lower limit involves the elasticity, the diameter/length ratio, and density (all of these for the winding also if there is one), the bridge impedance, plus a large helping of arbitrary aesthetic judgement. None of these factors depends in any way on the tensile strength.

10. We are not experts on harpsichords but it seems reasonable to us to consider that an important factor in increasing the diameter (and tension) of the strings towards the bass is to counteract the flabby resistance to the plectrum which grows with increasing string length.

11. In a subsequent letter, van Pelt requested deletion of the last sentence and the last diagram (with the 5kg weight) in his paper to keep its essentially theoretical nature. Yet the description in the letter of his experimental troubles with the method and his cure of these troubles can well be of interest to our readers so we will include a summary of them. He found that friction at the bridge and at the axle of the pulley caused an overall uncertainty range of a ½ tone. The cure was to position the apparatus almost vertically so that the force against the bridge and pulley are minimal, thus minimizing the friction. This is a solution we have also found and use it routinely in our string-testing apparatus.

For what it's worth:

WROUGHT IRON MUSIC WIRE

Cary Karp

At the Musikhistoriska Museet in Stockholm, a research project is currently in progress which involves examining the physical, chemical, and musical properties of late-18th century wrought iron music wire, as well as practical experiments in the fabrication of such material "in replica". The results of this project will be formally published.
The tensile strength of cold-drawn wrought iron wire increases in direct proportion to the degree of diameter reduction subsequent to the last annealing. Tensile strength is thus not a material characteristic of cold-drawn wire.

2. Wrought iron wire with a 0.1% carbon content (a typical value) had a post-annealing tensile strength of circa 600 MPa (1 megapascal = 1 N/mm² = 145 psi = 10 kp/mm²). A 99% diameter reduction, which is the maximum possible before annealing becomes necessary, can increase the tensile strength to circa 1250 MPa. Skilled workers can probably attain tensile strengths approaching 1500 MPa. Cold working is thus adequate, in and of itself, for providing wrought iron wire with the tensile strengths required by the instruments on which it was used.

3. The gain in tensile strength is independent of the number of steps in which it is effected. The limiting factor in determining the maximum diameter reduction per drawing is that the force required to pull the wire through the drawing die must not stress the wire past its elastic limit.

4. None of the wire examined was case hardened, nor on the basis of point 7 can the necessity for the use of this technique in the preparation of music wire be established. There is reason to believe that case hardened wire, if it was used at all, would have been too brittle to withstand the same strain as cold-drawn wire.

5. The wire examined retained what presumably were its original physical characteristics unless it had suffered severe visible corrosive deterioration.

6. Cold-drawn wrought iron music wire differs audibly from modern steel music wire when used under identical conditions. There is reason to believe that this is caused both by differing internal material characteristics and by differences in the effective elastic modulus of the two materials when stressed to levels near the breaking stress of cold-worked wrought iron. The stress-strain curves of various stringing materials should be compared in any thorough discussion of their relative characteristics.
ACCURACY OF MEASUREMENT OF WOODWINDS AND THE "EXACT COPY"

Cary Karo

The above heading has become a subject of regular discussion in the FoMRHI Bulletin and much can be said about the matter. I have written an article entitled, "Woodwind Instrument Bore Measurement", which has been accepted for publication in G53 1978 and will hopefully be of use to the readers of FoMRHI. Several points elaborated upon in the article are immediately relevant to the current FoMRHI discussion and it may be helpful to mention them here.

1. Establishing musically relevant tolerances for reproduction work is an extremely complex problem. Virtually every measurement will require its own tolerance and it is quite futile to speak in generalized terms. The failure of an octave key on an oboe to close by 0.01 mm will render the instrument largely unplayable but 1.0 mm on the length of the bell will be of no consequence. Similarly, bore tolerances will vary according to absolute diameter, location of pressure nodes, etc.

If a carefully-made "copy" sounds, feels, and appears exactly as its maker intended the existence of prescribed tolerances is irrelevant, nor is an attempt to adhere to such tolerances a guarantee for success. Ideally the maker will be working to the limit of his or her ability and as long as the term "exact copy" is used attention to detail cannot be excessive. The effort necessary for establishing a series of tolerances for the reproduction of a given instrument is thus not necessarily justified.

2. The "original" must be measured accurately enough to permit the desired quality of reconstruction. The tolerances required here are as difficult to define as in the previous case, but the tolerances which can be attained can be determined by examining the measuring procedure, itself. With commonly used devices such as telescoping gauges, steel measuring scales, and micrometers some care must be exercised to attain constant ±0.1 mm tolerances. Working as carefully as possible with such tools is therefore not likely to result in
exact expressions of tolerance may be irrelevant. (It must not be forgotten in instrument making or measuring that the use, for example, of a micrometer which can accurately be read at 0.001 mm in no way implies either that 0.01 mm tolerances are being maintained or that they are possible at all.)

4. If measurements are to be used for the extensive comparison of large numbers of instruments the tolerances of the measurements must be indicated. These tolerances are totally unrelated to standards of accuracy in reproduction, but are absolutely necessary as an indication of the quality (reliability) of the measurements themselves and determine their relative statistical value.

5. The irregular shape of most woodwind bores was not produced by a single complex reamer. Several tools, each with a simple shape, were individually to create the composite profile which is observed. These individual tools were often used as part of the tuning and voicing procedure and their absolute measurements were probably of little concern to the maker.

6. The term "exact copy" is often defined in three different ways:

   A. as a literal duplication of a specific instrument in its present physical condition.
   B. as a reconstruction of what the "original" was when its maker regarded it as completed.
   C. as an instrument which could as easily have been built by a specified earlier instrument maker as by the "copyist".

The relative merits of these approaches can be argued, but it is obvious that they require successively greater degrees of insight into earlier instrument making practices. (Present woodwind copying practice hovers between the first two approaches in large part due to the widespread use of single complex reamers rather than series of simple ones.)

7. Attaining the insight needed for all three aspects of reconstruction will ultimately require in-depth analysis of entire surviving populations of older woodwinds, and the development of the techniques necessary for this should be well worth the effort. The priority between developing techniques for the literal duplication of musical instruments and gaining true understanding of historical instrument making practice must put the emphasis on the latter. In this regard "obsession" with accuracy of measurement is not purely folly.
I can remember that when I started producing drawings of keyboard instruments for the Victoria & Albert Museum I was faced with the problem of finding out what information the buyers of the drawings would be seeking and for what purpose the drawings would be used. Like Mr. Barnes (Comm. 46 FoMRHI Bulletin No.6) I concluded that the vast majority of buyers would be using the drawings to make copies of the instruments concerned. I therefore set out to produce drawings that would be suitable as working drawings for instrument builders.

I soon found that in attempting to do this I had to correct distortions of the instrument which in turn introduced inconsistencies which demanded further corrections for their resolution. Before long many of the important dimensions of the instrument were actually in error. I realised that this would make the drawings of little value for those who did not want working drawings and could also make them unacceptable to the more discerning instrument builders too. I contemplated producing two drawings of each instrument, one accurately representing the instrument in its present state and the other giving my interpretation of the instrument's original state. This course of action was ruled out on the grounds of cost and it also seemed pointless as any competent builder would be able to prepare his own working drawings from the first type of drawing.

Thus I adopted a philosophy which was essentially the same as B.K. Lee's (Comm. 66 FoMRHI Bulletin No.8) showing all the factual information about the instrument that I could, with little or no subjective interpretation of the data. Now, with the experience of many instrument drawings (some of them working drawings) behind me, I am even more sure that the course I adopted was the correct one. It applies especially in cases where the drawings are to be published in order to prevent excessive handling of the instruments. The danger is that if interpretations or adjustments are made to the data, the drawing can easily become one person's particular version of the actual instrument so that some purists and scholars will still find a need to examine the instrument, thus nullifying the raison d'être of the drawing.

In Comm. 46 Mr. Barnes gives some recommendations for the production of drawings of keyboard instruments. They are, on the whole, excellent but I think anyone new to the field should treat his suggestions for the elimination of distortions with some caution, especially if the drawings are intended to be definitive ones for publication. It is especially risky to produce corrected drawings direct from measurements as it is only possible to check for accuracy by the use of redundant measurements if an uncorrected version of the drawing is first produced.

My own method of measuring an instrument is to secure to the instrument at string band level some eight to twelve trig points at carefully chosen positions. The positions of these trig points are then transferred directly to a sheet of polyester drafting film using a process of trilateration using a beam compass. It is then possible to survey the entire instrument at this level from these trig points, to produce a plan which shows the
positions of bridge, nut and hitchpins, case sides, etc., to a high degree of accuracy. This method has the advantage that no measurements with a tape are necessary and an overall accuracy of less than one millimetre can be achieved without difficulty. It also has the advantage that the trilateration process allows very quick cross-checks on accuracy to be made during the course of measurement.

Having done this, I then take a series of plan view X-ray photographs of the instrument, each plate overlapping with its adjacent ones so that a composite X-ray picture of the entire instrument can be generated. The X-ray machine and the plate holder are held in a fixed relationship to each other by means of a steel frame while the instrument is moved for each shot. This ensures that the spatial relationships of the X-ray source, plate holder and the instrument are sufficiently well defined to enable the X-ray plates to be corrected subsequently for the effects of parallax.

The generation of a patchwork of corrected plates is facilitated by securing wires to the underside of the instrument before the X-rays are taken so that the shadows thus cast can be used to align the plates relative to each other. Cumulative errors in the generation of the patchwork are eliminated by reference to the previously prepared string band plan, while the degree of fit between adjacent plates gives a useful check on the accuracy of the correction for parallax and the alignment of the X-ray machine to the instrument. The final step is to produce a master plan by tracing all the necessary information from the X-ray patchwork on to the string band plan. The whole process, including the detailed caliper and rule measurement of the instrument, takes between forty and eighty hours depending on the complexity of the instrument.

I am puzzled by Mr. Barnes' assertion that the use of X-ray photographs as a basis for producing drawings complicates the identification and elimination of distortion. My experience is the opposite. There is no other technique which, to my knowledge, directly relates dimensions on different planes of the instrument and thus exposes distortions to direct measurement. It has been through the examination of X-ray photographs that I have come to the conclusion that the nature of the distortion of most instruments is too complicated to be eliminated without loss of information. X-rays are also indispensable in locating the position of soundbare relative to the bridge(s) and careful examination of the plates often reveals 'out of trueness' which must have been present when the instrument was built and is not the result of distortion.

Mr. Lee, in Comm. 68, recommends that the drawings should be presented in the manner of an illustration rather than as an engineering drawing. I agree with him that, if well done, this adds considerably to the visual appeal of the drawing and can also make its interpretation simpler in some cases. However, modern technical drawing methods have been developed specifically to portray complicated three-dimensional shapes in an economical and unambiguous manner, so they are really very suited to our particular purpose. I find that by bending the conventions slightly it is possible to produce drawings that very few people find difficult to interpret. I am, of course, biased by my engineering background and would no doubt follow...
Mr. Lee's methods if I had his particular skills. I think the main point here is that the draughtsman should adopt a style natural to himself so that he can concentrate on the real priorities, namely to produce a drawing that is

a) clearly legible

b) a close representation of the actual instrument containing all the available information

c) within the required range of accuracy, or as accurate as the methods of measurement will allow

d) free of any ambiguities or inconsistencies in its interpretation.

It is quite an achievement for the draughtsman to have satisfied himself on all the above counts without the extra burden of having to adopt an unfamiliar style of drawing and it is likely that the drawing so produced will serve its function perfectly.
Following are a few thoughts stimulated by discussions on measurement in the Bulletin No. 8.

First of all there is the question of how precisely we can (or need to) know the length of the Brunswick foot. Is any standard measure in existence, or was there one in existence at any time for comparison with a standard meter? Whenever and however a comparison was made of the Rute or Fuss to the meter, it is absurd to think that the comparison was made to an accuracy of ± 0.0005 cm in 456 cm; yet this is the implication that one must draw from giving one Rute = 456.550 cm. The two editions of Meyers Lexikon that I have been able to consult do not define the Brunswick foot but in defining other obsolete feet give a precision of only four significant figures. This practice is evidently in agreement with Schlapp nach!, which defines the Rute as 456.6 cm. This seems to me as much accuracy as can be justified. Dividing by 16 to get the equivalent of 1 foot, it is again not justified to get 5 significant figures when only 4 were given. To 4 significant figures, then, all sources agree on 1 Brunswick foot = 28.54 cm; and it is a delusion to claim or ask for any greater accuracy.

These calculations are presumably important to someone wanting to make a reproduction of an instrument whose measurements are known in Brunswick feet, yet I think it is safe to say that there is no instrument whose dimensions are known to an accuracy of a 0.01 Brunswick foot. Bessaraboff suggests an error of about 1% in scaling from the Praetorius drawings. Therefore it is pointless to worry about defining the Brunswick foot any more precisely than 28.54 cm; and 28.5 cm is probably good enough.

Taking measurements from an existing instrument is a different matter. It is easy enough to apply a micrometer that can be read to 0.0001 in. or 0.001 mm, but I agree with Philip McCrone that it is mindless to think that this is worth doing. A fact that needs to be taken into account is the expansion and contraction of wood with changes in humidity. I am informed by a wood technologist that over the range of humidity normally encountered a factor of 3% can be expected for change of dimension tangentially. (The figure is slightly less radially and much less longitudinally.) The Wood Handbook of the U.S. Department of Agriculture supports 3% as an average figure but also points out that as a rule the factor is larger the harder the wood. Consider, for instance, the range between 6% and 20% moisture content. The tangential change for red cedar is 2.2%, but for sugar maple it is 4.4%. Radially the corresponding figures are 1.5% and 2.8%. Consider what 3% variation means for the bore of a woodwind. Assume that it is 20 mm in diameter with 5 mm wall thickness under dry conditions. Uniform swelling by 3% would increase the wall thickness to 5.15 mm and decrease the bore to 19.85 mm. The standard of the wood products industry where preciseness is required is to measure at 20°C and 50% relative humidity. How many people have been careful to measure instruments under these defined conditions? I contend that in the light of these facts the only sensible approach is to be satisfied with measuring and reproducing as a first approximation with a precision of 0.1 mm. Because (as Arthur Benade is quoted) 0.01 mm can make an acoustical difference, though, some touching up afterwards can make a better instrument. However, this touching up is a trial and error matter and cannot be avoided by trying to make the first approximation accurate to 0.01 mm.

Museums for good reason do not normally allow their antique woodwinds to be played, so one must measure an instrument in a condition different
from its "warmed up" condition; and different samples of wood will differ in the uniformity with which they swell; so that even though a reproduction and a museum specimen started out "cold" identical to within 0.01mm, it would be highly unlikely that they would end up identical after playing for an hour or so. Every player is aware that some instruments improve after playing for awhile and others degrade. Knowing that expansion of the wood by 0.1mm or so can occur and can be acoustically significant moves this phenomenon from mystique toward science, but a science that retains a good measure of unpredictability.

Finally, just a few words in response to the query about seasoning boxwood. Many people have heard the old story about burying boxwood in the ground for ten or twenty years. I have tried the burying technique with both Persian and South American boxwood — but satisfying myself with three years underground. The S. A. boxwood showed severe decay after this time. The Persian was still sound, and the grain pattern had been brought out very prettily, but on drying it again severe checking developed. That's my experience for what it's worth. If anyone else wants to try it, a very slow drying method should be devised or perhaps impregnation with polyethylene glycol 1000 as soon as the wood is taken from the ground.

Trevor Robinson

Comments

Paul Hailperin

PORTATIVE ORGAN. How can one distinguish a drone pipe on a visual representation of an organ?

REBEC. Again, how can one tell if a 2-string rebec in a painting is a drone instrument?

SHEAWA. It is impossible to tell anything about the width or shape of a shawm bore (this applies also to Bagpipes) from the outside. Except, taking the point ad absurdum, that the bore is at least slightly narrower than the outside. The earliest extant shawms are indeed rather wide when viewed as enentist does, but from the top end to at least the lowest fingerhole the bore is narrow and the wall is the thickest I've ever observed on any woodwind. If it is impossible to count the fingerholes, why speculate? The little-finger is also available and these instruments might just as well have had 7 fingerholes, as do renaissance shawms. Three-quarters of the length of a kneeling trecento person sounds like it would be very close to 75 cm, the length of an Altponsner, which has as lowest note g, not G.
A REASONED AND PRACTICAL APPROACH TO MEAN-TONE FRETTING
E Segerman and D Abbott

When two frets parallel to both nut and bridge lie under several strings they provide the same size of interval between the frets on each string. Intonation systems which provide many such equal sizes of intervals are thus particularly useful on fretted instruments. We shall here explore fretting systems based on only two sizes of intervals, a diatonic semitone (when the names of the two notes have different letters, such as f# to g) and a chromatic semitone (when the same letter is involved such as f to f#). When a chromatic semitone is larger than a diatonic one we have a Pythagorean temperament and if the chromatic semitone is smaller we have a mean-tone temperament. When they are equal we have equal temperament.

The octave contains 7 diatonic and 5 chromatic semitones, and since they have to add up properly, once the size of one is specified, the size of the other can be deduced. Thus, since the octave contains 1200 cents, $7d + 5c = 1200$ where $d$ is the size in cents of the diatonic semitone and $c$ is the size in cents of the chromatic semitone. (A cent is 1/100 of an equal-tempered semitone interval.)

Let us now consider the most usual choice of chromatic notes in the 16th and 17th centuries, choosing c# instead of db, eb instead of d#, f# instead of gb, g# instead of ab, and bb instead of cf. (If another choice is desired, the following analysis can easily be altered accordingly.) Thus the sequence of diatonic and chromatic semitones is as follows:

notes: c c# d eb e f f# g g# a bb b c
intervals: c d d c d c d c d c d

Now let us consider how these fall on the fingerboard of an instrument with open strings tuned to natural notes only (the note bb sometimes had this status as well as bb so we include it as well).
From this table it is clear that no compromises are needed for the 2nd, 5th, 7th, 9th and 13th frets since they have the same total interval from the open-string note (distance from the nut) for each open string. That is, the second fret is always \( \text{d} + \text{g} \) above the open string, the 5th fret is always \( \frac{3}{2} \text{d} + 2 \text{g} \) above the open string, etc. Considering the frets that would involve conflict, the 1st, 3rd, 4th, 6th, 8th, 10th and 11th frets, one can either place the fret properly according to one of the intervals and avoid playing the particular frets on the particular strings which don't fit, or one can place the fret at a compromise position. Both of these approaches seem to have been used on early instruments.

We should not assume that early players necessarily wanted every chord to be as in-tune as possible. The degree of being in-tune was a variable that they exploited for musical expression, with some chords (and keys) conveying more intonation tension than others. Thus the choice of where to put the conflict frets depends on the chords used plus the musical uses of these chords. Another factor in making this choice is that the original temperament decided upon (by picking the relative sizes of \( \text{d} \) and \( \text{g} \)) was a compromise in itself, and it is possible to position a fret for a purer interval in a particular chord at the sacrifice of worse intonation on other chords using the same fret.

The medieval theorists usually prescribed a Pythagorean tuning. In this tuning the interval of a 5th is pure (string length ratio 3:2) but the 3rd is very sharp (string length ratio 81:64 which is 21.5 cents (or the syntonic comma) sharp of the just or pure interval with ratio 5:4). Nowadays we use equal temperament with the 5th 20 cents flat and the third still quite sharp (13.7 cents). 'Quarter comma' mean-tone sometimes used during the baroque has the 5th 5.4 cents (\( \frac{1}{4} \) syntonic comma) flat but the 3rd pure. In these scales the values of \( \text{d} \) and \( \text{g} \) as expressed in cents is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Pythagorean</th>
<th>Equal</th>
<th>( \frac{1}{4} ) Comma Mean-tone</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{d} )</td>
<td>90.2</td>
<td>100.0</td>
<td>117.1</td>
</tr>
<tr>
<td>( \text{g} )</td>
<td>113.7</td>
<td>100.0</td>
<td>76.0</td>
</tr>
</tbody>
</table>

Most mean-tone temperaments used in early music fall between equal and \( \frac{1}{4} \) comma mean-tone.

Since the naming of various mean tone temperaments is traditionally based on the amount of deviation from pure of the 5th, we shall do the same and call this deviation \( m \) in cents. It then follows from solving the relevant simultaneous equations that:

\[
\text{d} = 90.225 + 5m \\
\text{and} \quad \text{g} = 113.685 - 7m
\]
We shall now add these up for the various fret intervals above the open string with the two choices for each ambiguous fret distinguished by (d) or (c) depending on whether it is chosen as a diatonic or chromatic semitone above the previous one (except for the 4th fret where we give the appropriate alternative specification).

**TABLE II**

Intervals above open string for each fret

<table>
<thead>
<tr>
<th>Fret</th>
<th>Interval</th>
<th>Fret</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(d)</td>
<td>90.2 + 5m</td>
<td>6(c)</td>
<td>611.7 - 6m</td>
</tr>
<tr>
<td>1(c)</td>
<td>113.7 - 7m</td>
<td>7</td>
<td>702.0 - 6m</td>
</tr>
<tr>
<td>2</td>
<td>203.9 - 2m</td>
<td>8(d)</td>
<td>792.2 + 4m</td>
</tr>
<tr>
<td>3(d)</td>
<td>294.1 + 3m</td>
<td>8(c)</td>
<td>815.6 - 8m</td>
</tr>
<tr>
<td>3(c)</td>
<td>317.6 - 9m</td>
<td>9</td>
<td>905.9 - 3m</td>
</tr>
<tr>
<td>4(b string)</td>
<td>384.4 + 8m</td>
<td>10(d)</td>
<td>996.1 + 2m</td>
</tr>
<tr>
<td>4(except b string)</td>
<td>407.8 - 4m</td>
<td>10(c)</td>
<td>1019.6 - 10m</td>
</tr>
<tr>
<td>5</td>
<td>498.0 + m</td>
<td>11(d)</td>
<td>1086.3 + 7m</td>
</tr>
<tr>
<td>6(d)</td>
<td>588.3 + 6m</td>
<td>11(g)</td>
<td>1109.8 - 5m</td>
</tr>
</tbody>
</table>

Since most instrument specialists have access to tables or charts giving them fret positions according to equal temperament, a simple way of using the previous table would be to start with equal tempered positions and calculate the deviations. This is done by first choosing an m (as discussed below), calculate each interval according to Table II and then subtract 100 times the number of the fret. If the resultant number is negative, the fret is shifted towards the nut by that number divided by 100 multiplied by the distance to the previous fret. If the number is positive then the fret is shifted towards the bridge an amount arrived at by multiplying the distance to the next fret by that number divided by 100. (This method is not theoretically accurate but is accurate enough for practical purposes.) If a compromise fret position is decided on, the weighted average is made from the intervals calculated from the Table before the shift is worked out.

In a later Communication we shall illustrate the use of Tables I and II to analyse the fretting patterns of various citterns to determine the probable tunings and types of temperament. In our experience so far, temperaments ranging from m = 3 to 5 cents seem to have been used. If m is at a very typical value of about 4, the 3rd is about just as sharp as the 5th is flat. For at least a first attempt at mean-tone fretting, we recommend using this value. Following this recommendation, let us, as an example, calculate the fretting of a 6-course cittern having all frets under all courses, and for simplicity averaging over the first 4 courses which carry the brunt of the playing.
With \( m = 4 \) the intervals are:

**TABLE III**

<table>
<thead>
<tr>
<th>fret</th>
<th>cents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1( (d) )</td>
<td>110</td>
</tr>
<tr>
<td>1( (c) )</td>
<td>86</td>
</tr>
<tr>
<td>2</td>
<td>196</td>
</tr>
<tr>
<td>3( (d) )</td>
<td>306</td>
</tr>
<tr>
<td>3( (c) )</td>
<td>282</td>
</tr>
<tr>
<td>4( \text{not b} )</td>
<td>392</td>
</tr>
<tr>
<td>4( (b) )</td>
<td>5</td>
</tr>
<tr>
<td>6( (c) )</td>
<td>7</td>
</tr>
<tr>
<td>8( (d) )</td>
<td>8</td>
</tr>
<tr>
<td>8( (c) )</td>
<td>8</td>
</tr>
</tbody>
</table>

It is assumed that the 4 relevant courses are tuned to \( e' \ d' \ g \) and \( b \). Then for the first fret, we see in Table 1 that 3 of the strings require 1\( (d) \) and one 1\( (c) \), so the average will be \( 3 \times 110 + 86 = 104 \). For the third fret only 3\( (d) \) is necessary.

The fourth fret is \( \frac{3 \times 392 + 416}{4} = 398 \). The 6th and 11th frets require 1:1 averages between the \( (d) \) and \( (c) \) values. The other frets use unaltered values. If we subtract 100 \( \times \) the number of the fret from the resultant values we get:

**TABLE IV**

<table>
<thead>
<tr>
<th>fret</th>
<th>cents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+4</td>
</tr>
<tr>
<td>2</td>
<td>-4</td>
</tr>
<tr>
<td>3</td>
<td>+6</td>
</tr>
<tr>
<td>4</td>
<td>-2</td>
</tr>
</tbody>
</table>

The \( g' \) on the 1st fret of the 3rd course is mainly useful in a first inversion E major chord, and in the above scheme it is sharper than an equal tempered third and is almost as sharp as a Pythagorean third. If, as the surviving Italian music suggests, this particular chord position is avoided, the temperament in Table 4 can be improved by not averaging the 3rd course in so the first fret would have a deviation of +10. Similarly the \( e^b' \) on the 4th fret of the 4th course is usually avoided so the temperament can be improved by not averaging the 4th course in, resulting in fret 4 having a deviation of -8. This modification has the added advantage of offering a true unison for tuning the open 4th course to the 4th fret on the 3rd course.
As another example let us consider a lute in a with courses tuned to a" e" b g d A. (We must remember that these are nominal pitches, and i.e. what we decide to call the strings, may have little relation to the actual notes tuned to.) Looking at Table 1 we notice that if we avoid the g# on the first fret of the g course and the c# on the 4th fret of the a course (or use it as a d# in an E major chord), the only problem fret of the 3 is the 6th.

One solution to the 6th fret problem is to not use the g# on the 5th course or the c# on the 4th course. Then assuming $m = 4$ (so Table 3 is relevant) the deviations from equal temperament becomes:

| Deviation from equal temperament |
|---|---|
| **fret** | **cents** | **fret** | **cents** |
| 1 | +10 | 5 | +2 |
| 2 | -4 | 6 | +12 |
| 3 | +6 | 7 | -2 |
| 4 | -8 | 8 | +8 |

A simple way of practically effecting the fret shifts from the equal temperament positions would be to first draw up the equal temperament positions as parallel frets. Then find a ruler with fine gradations such as one marked out in 50ths of an inch. On such a ruler a length of 2 inches has 100 gradations. Hold this ruler at such an angle to the marked out frets so that zero is at the fret of interest and the 2-inch point is at the next fret position in the direction of the shift. Then the number of cents shift is counted off on the gradations (one for each cent) and the new fret position marked.

If the procedure outlined here is understood, various fretting modifications for differing musical circumstances can easily be made. On instruments with movable frets this is best left to the musician. If the instrument has fixed frets then the maker needs to make the decisions himself. He must then be thoroughly conversant with the repertoire (keys, modulations, etc) for which the instrument is going to be used so that his fretting will properly please the ears of the customer and his public.
GENERAL CONSIDERATIONS OF MEAN-TUNE FRETTING ON INSTRUMENTS WITH LUTE TUNING.

Let us consider the relative tuning of the six course lute vihuela or viol with a major third between the 3rd and 4th course and intervals of a fourth between all other adjacent courses. The set of accidentals for our scale is again assumed to be c♯ e♭ f♯ g♯ and b♭. For the moment we are not concerned with what pitches the open strings are tuned to. We assume that the frets are tuned to some mean-tone temperament with the appropriate diatonic and chromatic semitones in our scale for the first course. Upon writing out all of the notes on all the frets (Table VI) we find that only 4 out of the 11 different frets in the octave involve problems that need considering. The fret with e♭ on the first course has a d♭ and a♭ on the 4th and 5th courses respectively. The fret with g♯ on the first course has a d♯ and a♯ on the 2nd and 3rd courses respectively. The fret with a b♭ on the first course has an a♭ on the 4th course. The fret with a c♯ on the first course has a d♯ on the 3rd course.

The options the musician has are that he can avoid these fret positions, use them as is, shift these frets to compromise positions or shift these frets to the alternative position where the notes in our scale are produced on these strings but the notes on the other strings are out of our scale.

There is no particular reason why any lute vihuela or viol cannot be nominally tuned with its open string on any of these fret positions. If we restrict ourselves to open string nominal pitches which unambiguously provide all of the unisons for tuning adjacent strings to one another (i.e. insisting that all of the open strings plus the 4th fret on the 4th course and the 5th fret on other courses are in our scale), then first strings tuned to c d e f g and a remain as 'good' tunings for meantone fretting.

Statements by lutanists such as Galilei (the 1/18th fretting rule) and artists' depictions indicate that equal-tempered fretting was quite common in the 16th and 17th centuries, but statements by players such as Luis Milan (who instructed his readers to move the 4th fret for certain pieces) and John Dowland (who published his modification of Gerle's fretting) were striving for better intonation for the thirds in their chords than equal tempering offers. When we analyse the tablature of the period to see how various frets are used harmonically, it would not be surprising to find that the alternative of mean-tone fretting by sharp-eared prosperous (the quality of the strings needed to make this worthwhile is high) performers was well catered for by the composers. The nominal tunings of lutes and vihuelas when either played alone or in ensembles of different sizes could well have been more influenced by the mean tone fretting pattern used than the actual pitch standards used by other instruments in the same musical culture.
APPENDIX 2

MEANTONE FRETTING ON THE FRENCH CITTERN

Let us now similarly consider the 4-course French cittern tuned to intervals of down a tone, down a fifth and then up a tone. Assuming the same scale and writing out all of the notes on all of the strings, we find only 3 out of the 11 different frets in the octave that are troublesome. The fret with eb on the first course would have all of the notes on the other courses out of our scale, so we would expect to eliminate this fret position on the other strings, affect some compromise position or fix the fret position for df on the first string to get the other string notes into our scale. The fret with f on the first course has an ap on the third course. Finally, the fret with bb on the first course has an ab and dp on the second and third courses respectively. A conclusion we are immediately led to by having only 3 problem frets in the octave is that all of the missing bits of frets on this instrument cannot be explained (as Dart suggested) by avoiding notes which would be out of tune. The cittern diagram in Le Roy's "Breve et Facile Instruction..." (1565) shows the 4th fret completely missing, the 6th and 11th only under the first course, and the 8th only under the first two courses. In the second octave, if we start counting afresh the first fret (13th) is only under the first course, the third fret (15th) is only under the first two courses, the 4th fret (16th) is all there and the 6th fret (18th) is missing. From the open first string on Le Roy's illustration, identifying diatonic frets as larger than chromatic semitones we read the sequence as:

first octave: d, g, d, c, c, d, c, d
second octave: d, c, d, c, d, c, d

Assuming that the second octave is consistent with the first, combining them and comparing with Table 1 we find that this string is most probably nominally tuned to e (octave and real pitch unspecilied). The problem frets from an intonation point of view are then the 1st, 6th and 11th. These are truly solved by eliminating these frets from under the strings other than the first (this is the case with the first fret in the second octave, but in the first octave the ab on the g string is just avoided). But what about the other missing frets and bits of frets? The only explanation that we have come up with so far is to ease fingering in two kinds of major chord shapes.

On a fully fretted fingerboard these (both as c major chords) would be noted in tablature as:

If the fourth fret is missing in the first of these, one can place our fingers on the positions and get the same chord with less effort. Let us call this chord lingering utilizing the missing fret as type I. If the 8th fret is missing under the 3rd course, the other chord can be fingered as with greater ease. Call this Type II chord lingering. (This last chord was notated as in the music because the tablature ignores the missing 4th fret.)

Type II chord lingering: (This last chord was notated as in the music because the tablature ignores the missing 4th fret.) The missing parts of the sixth fret similarly facilitate a D chord of type I and a Bb chord of type II. Similarly, the 11th fret offers a G chord of type I and Eb chord of type II. The 13th and 15th frets offer F and G chords respectively of type II. The missing 18th fret offers a D chord of type I.

In summary, our analysis of the fretting on the cittern illustration of Le Roy's indicate that the nominal tuning was probably with first course nominally at e.
(octave and pitch standard indeterminate). Four (8, 11, 13 and 18) of the seven frets either totally or partially missing can be associated with losing notes that do not fit into the set of accidentals of the normal scale. Only one such note remains, the $\text{ab}$ on the 1st fret of the $\text{g}$ string which is avoided in the music. All of the curtailed frets allow easier-to-grab fingerings of various major chords. We would expect that this partial-fretting system has other fingering advantages but we have not had enough experience with playing the repertoire on instruments fretted in this manner to explore them.

### TABLE VI

**LUTE OR VIOL FRETTING**

<table>
<thead>
<tr>
<th>interval</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$c$</td>
<td>$d$</td>
<td>$d$</td>
<td>$c$</td>
<td>$d$</td>
<td>$d$</td>
</tr>
<tr>
<td></td>
<td>$c$</td>
<td>$c$</td>
<td>$d$</td>
<td>$d$</td>
<td>$c$</td>
<td>$d$</td>
</tr>
<tr>
<td></td>
<td>$d$</td>
<td>$c$</td>
<td>$d$</td>
<td>$d$</td>
<td>$c$</td>
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<td>$d$</td>
<td>$c$</td>
<td>$d$</td>
<td>$c$</td>
<td>$d$</td>
</tr>
</tbody>
</table>

Any vertical line of notes could represent the tuning of the open strings, with the octave proceeding from there.

### TABLE VII

**LE ROY CITTERN FRETTING**

<table>
<thead>
<tr>
<th>interval</th>
<th></th>
<th></th>
<th></th>
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<tbody>
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<td>$d$</td>
<td>$c$</td>
<td>$d$</td>
<td>$d$</td>
<td>$c$</td>
<td>$d$</td>
</tr>
<tr>
<td></td>
<td>$e$</td>
<td>$f$</td>
<td>$g$</td>
<td>$a$</td>
<td>$b$</td>
<td>$b$</td>
</tr>
<tr>
<td></td>
<td>$d$</td>
<td>$e$</td>
<td>$f$</td>
<td>$g$</td>
<td>$a$</td>
<td>$b$</td>
</tr>
<tr>
<td></td>
<td>$g$</td>
<td>$a$</td>
<td>$b$</td>
<td>$c$</td>
<td>$d$</td>
<td>$e$</td>
</tr>
</tbody>
</table>

fret: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
ON MEDIEVAL AND EARLY RENAISSANCE TUNINGS AND FRETTING PATTERNS

Pre-Medieval and Perhaps Early Medieval Modes

In Greek and Roman times, the intervals of an octave and of a fifth were consistently pure. A fifth below combined with an octave upwards provided the fourth which was also pure. All of the other intervals varied from mode to mode.

The modes or scales generally had seven different notes per octave as our modern diatonic scale has. The 1st, 4th and 5th of these notes is invariant. Between the 1st and 4th there are two other notes, the intervals of which are different in each mode. These first four form the tetradchoird of that mode. Between the fifth above and the octave above there is a second tetradchoird, and the intervals there are identical to those of the first tetradchoird. These ancient modes have very little relation to the Medieval European modes which have Greek names (i.e. Ionian, Dorian, Phrygian, Lydian, Mixolydian and Aolian which can be produced on the white keys of a keyboard instrument starting on C, D, E, F, G and A respectively; only the first three of these form an octave with the two tetradchoirds having the same pattern of intervals in the ancient way).

Later survivals

The intervals in very few of the ancient modes resemble our usual tones and semitones. One of these which does is the Pythagorean mode. It was perhaps the oldest and it came to dominate scholarly writings in medieval and Renaissance times, with many writers even in the Baroque (e.g. Christopher Simpson) at least theoretically subscribing to it. In this mode the intervals in each tetradchoird can be expressed in terms of string-length ratios as 8/9, 8/9, 243/256 or in cents as 204, 204, 90. The interval between 4th and 5th of any early mode is 8/9 or 204 cents.

Another of the early modes, Ptolemy’s Diatonic Syntyphon needs special mention. The intervals of the tetradchoird are 15/16, 8/9 and 9/10 or 112, 204, and 182 cents respectively. It represents ‘just’ intonation (where the thirds are all perfectly in tune) but starting on the third note of the scale. Getting the thirds well in tune was certainly most important in the Renaissance and later (being the motivation behind mean-tone temperaments) but the extent to which this was important in Medieval times is uncertain.

Relative Tunings on Stringed Instruments using early modes

Let us now consider the possible relative tunings of the courses of a stringed instrument fretted for any one of the early modes assuming one fret per note in the scale.

If the tunes were only played on one course and the other strings used only as drones, any set of relative tunings would be possible. Nevertheless this allows a very limited melodic range and it would be worthwhile to consider tunings that allow a melody to
move from one course to another. Two courses tuned an octave apart help but a
gap is left if one prefers to remain in lower positions. Each interval in the
first tetrahord is usually different from the others but is identical to that in the
second tetrahord a fifth higher, so a tuning in fifths is obviously convenient.
Combining this with octaves gives a total melodic range with gut strings of 2 octaves
fingered in the first position. Only 3 diat. frets are needed for this. More frets
are usually useful on only one of the two open string pitches. On four courses this
can be effectively achieved with intervals of 3rd, 4th 5th or by octave, back 4th,
and octave. The latter tuning will allow the courses to be played independently or
in two octave pairs for added resonance.

**Medieval fretting patterns**

Most illustrations of medieval instruments show spaces between frets which are
considerably larger than one-fret-per-semitone as we have today. This could have
been the result of a tradition of carelessness in this respect by artists, but we need
to seriously consider the possibility that the fretting was usually diatonic (i.e. one
fret per note in the scale) rather than chromatic (where two fret spaces are required
for most intervals between adjacent notes in the scale).

If the fretting was diatonic Pythagorean with tuning in fifths and octaves, we would
expect that the distance between the third and 4th frets should be less than half
that of adjacent fret spacings. If the fretting were 'just', the small fret spacing
would be between the pegs end of the fingerboard and the first fret. What we usually
see in the illustrations is no small fret spacing, but rather nearly equal spacing.

The fret at an interval of a 4th above the open string is at 1/4 the open vibrating
string length, and that at an interval of a 5th, 1/3 the string length. The distance
between them is 1/12 the string length. Two frets divide the first 1/4 of the open
string length into three parts, and if these are equally spaced, the spacing of each
is also 1/12 the string length. The ancient mode which corresponds with this equal
spacing and closely represents what many illustrations show was called 'Ptolemy's
Diatonic Hemiolon'. If more than 4 frets are used in this mode, those in the second
tetrahord are 2/3 as wide as those in the first tetrahord. Again, this correspondance
could be illusory and that the artists did not care to depict fretting accurately.
Yet since we cannot be certain of this it is worth our while to experiment with this
mode in medieval music. We are not justified in purely assuming that the music
should be performed in either Pythagorean or just intonation or in just blindly playing
it in equal temperament.

**15th Century Cetra**

The block wooden frets on the 15th century Italian cetra seem to be equally spaced in
the Ptolemy Diatonic Hemiolon mode discussed above. The gaps between the blocks
follow this pattern generally but not accurately. By this we mean that the differences
between the pattern from one example and another and between these and the theoretical
are pattern rather greater than one would expect from the care and precision with which
the intarsias and sculptures were executed.
The surfaces of the block frets appear to be planar and assuming that the stopping action results from a step-like displacement of the plane of one block with respect to its neighbours, we attempted to carefully examine the illustrations to determine whether in the direction from pegs to bridge, the path is upstairs or downstairs. We found no clear indication of either. The effect could have been either too subtle to detect or that the spaces between blocks have no direct relationship with establishing the stationary end of the stopped vibrating string.

The latter possibility is reinforced by the observation that the instrument was fingered on top of the spaces between the blocks (see e.g. the marble relief in Florence Cathedral by Luca della Robbia, shown as plate 75 in Buchner 2nd ed.).

Also, the tuning for this instrument as given by Tinctoris (a tone, a fourth and back a tone, without specifying whether the general pitch direction was up or down) just doesn’t work to get even a partially consistent scale with Ptolemy Diatonic Hemiolon fretting.

Our guess at the solution is that the first block (nearest the pegs) acts as a nut with a line near the bridge-side edge of it being the end of the open vibrating string. The subsequent blocks are gently curved so that the end of the stopped vibrating string is on the crest somewhere in the middle of the block. (We assume that the hump is filed flat at its ends to match the observation that the edges of the top surface of each block are in one plane.)

The humped shape of each block surface provides much wood surface to distribute the pressure of the string along, and coupled with the wood grain going perpendicular to the string, the rate of wear on the block frets by the thin hard metal strings is thus kept low. The cithara is the first fretted instrument for which there is direct evidence for the use of metal strings and a mechanism such as this could well have been devised to handle this problem. We would nevertheless not expect the wooden frets to last for more than several months of serious playing, so we suspect that they were slotted in to the neck, held in by friction. The varying degrees by which the different frets extend on the ‘bass’ side of the neck might be to offer a grip to pull them out when changing was necessary.

With the fret arrangement outlined above the first fret space is about half a block width while subsequent fret spaces are much greater. This is reminiscent of Ptolemy’s Diatonic Syntonon mode or ‘just’ diatonic fretting. The tuning was not in fifths and octaves, but the humps on the blocks could be sculptured differently for each course to get a note in tune that would not be so with straight frets.

We shall now consider the tuning of the cithara. We assume that the open strings which carry the main melody in any interpretation of Tinctoris tuning are e and b to provide a ‘just’ scale based on e. If the b is above the e then the open string notes are b a e f# or a b f# e depending on whether Tinctoris was thinking of pitches going down or up respectively. Similarly if the b is below the e then the open string notes are e d' a' b or d' e' b a. The effective fret positions for each course expressed in cents for any of these tunings is given in the Appendix.
A choice between these tunings is offered by observing the fingerings of the two cetra players in the della Robbia sculpture mentioned before. The small cetra is \( \frac{2}{3} \) the size of the large one, so we assume that they are tuned a fifth apart. We also assume that the first four courses are tuned in some Tinctoris fashion and the fifth course is an accompanying bourdon that we need not consider here. The fingered positions on the large cetra (shown in French tablature here for convenience only) are \( \begin{array}{c} \text{large cetra:} \\ \text{small cetra:} \\ \end{array} \) and that for the small one are \( \begin{array}{c} \text{large cetra:} \\ \text{small cetra:} \\ \end{array} \). The only tunings which work are e" d" a" b" for the large cetra and b'V e' f' for the small one. These pitches are also appropriate for iron strings at a pitch standard close to modern when we consider the apparent string lengths.

Appendix: Fretting in 'just' intonation

Let us consider an extended 'just' scale to include all of the usual chromatic notes. All major thirds are pure and all of the fifths are pure except those between g" and d", b" and l", d and a", and f" and c# which are a comma (21 cents) flat. In this scale there are two kinds of tones, a major tone with frequency or string-length ratio 9/8 with interval 204 cents, and a minor tone with ratio 10/9 and interval 182 cents.

A major tone is made up of either a major chromatic plus a minor diatonic semitone or minor chromatic plus a major diatonic semitone. A minor tone is made up of a minor chromatic plus minor diatonic semitone. The major chromatic semitones are dDT to d", f to f" and a to a". The major diatonic semitones are cDT to d", f to f" and a to b". All other diatonic and chromatic semitones are minor. The sizes of these four types of semitones are:

<table>
<thead>
<tr>
<th>Chromatic Major</th>
<th>Diatonic Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{135}{128} ) or 92 cents</td>
<td>( \frac{27}{25} ) or 133 cents</td>
</tr>
<tr>
<td>( \frac{25}{24} ) or 71 cents</td>
<td>( \frac{16}{15} ) or 112 cents</td>
</tr>
</tbody>
</table>

A major third is a major tone plus a minor tone \( \frac{5}{4} \) or 386 cents. A minor third is a major tone plus a minor diatonic semitone, \( \frac{6}{5} \) or 316 cents. A fourth is a minor third plus a minor tone, \( \frac{4}{3} \) or 495 cents. A fifth is a major third plus a minor third, \( \frac{3}{2} \) or 702 cents. A sixth is a fifth plus a minor tone, \( \frac{5}{3} \) or 814 cents. A minor seventh is a fifth plus a minor third, \( \frac{9}{5} \) or 1018 cents, etc.

With this scale all major thirds are true, minor thirds above d", gDT, aDT and b" are one comma flat, minor thirds above d" and a" are two commas flat, and fifths above d", f" and b" are one comma flat. It is because of these flat minor thirds and fifths especially over d and b" that makes 'just' intonation impractical for general use, providing the impetus for compromise temperaments such as meantone. If one can accept the limitation of avoiding the dissonant intervals listed above in the music, or if one is willing and able to sharpen the false-flat intervals when they come up in the music by stretching the string with the stopping finger, then the resultant harmony should be most exquisite. To fully appreciate this a tone full of in-tune higher harmonics is desirable. Very thin gut strings potentially have this property but they are notorious for being untrue. Metal strings are the only realistic possibility where the improvement in intonation is so marked that it may be worthwhile to attempt to cope with the limitations of 'just' fretting.
With the four different sizes of semitones a practical chromatic fretting system would be too complex to devise. A diatonic fretting system is much more possible. The following chart gives the fret positions in cents for two possible nut positions relative to the notes played. Possible open string tunings are given in a sequence of fifths, with the ones in the middle of the chart using a minimum of accidentals, with more flats coming in with open-string notes beneath and more sharp coming in with open-string notes situated above the middle. If the chart were extended further either beneath or above that given, more than two possible positions for each fret would be needed. There is no a priori reason why this is a reason to stop the chart, but it is a convenient limit which includes all of the open-string pitches likely to be needed.

<table>
<thead>
<tr>
<th>interval</th>
<th>semitone</th>
<th>tone</th>
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<td>cents</td>
<td>386</td>
<td>498</td>
<td>520</td>
<td>680</td>
<td>702</td>
<td>884</td>
</tr>
</tbody>
</table>

Diatonic 'Just' Fretting Chart

The tuning information on the cetra given by Tinctoris indicates that the four courses are all adjacent in the above chart. This encourages our guess that a diatonic fretting system such as given here is relevant.
Jeremy Montagu

These are the first two volumes of the new catalogue of the Berlin Musical Instrument Museum, the first since Curt Sachs published his in 1922, and a much handier format, normal book size rather than large quarto, though bound in plastic-covered paper rather than cloth.

It is interesting to compare these two volumes, published a year apart. The second, the Brass instruments, has very much better indices in which one can look up, for example, instruments from the Number 8 or the Snoeck or the Wit collections, as well as those from any particular city or by any maker. The String catalogue, on the other hand, indexes only makers and repairers, which seems to me a pity. A major collection such as this is inevitably a collection of collections and, as a Brass volume shows, it can be easy enough to facilitate a researcher's task by including such an index. Both volumes include a numerical index of catalogue numbers.

The catalogue entries themselves are clear and informative, describing each instrument adequately and including all materials of which the instruments are made and brief measurements, with rather more detail than in many catalogues. Bibliographic and iconographic references are given for every instrument which has been published elsewhere (including the Curt Sachs Catalogue), and the iconographic references are particularly important due to the lack of illustrations in these two volumes. The String volume has clear line drawings, excellently done, of each type of instrument, with all the parts named, but with no indication as to whether they are drawings of types or of a particular instrument in the collection. Where there is only one instrument of a type, such as the Bærar, no. 4790 on p. 52, one may presume that it is that particular instrument; where a drawing of a Sārinda precedes the entry for a Sārindā a couple of pages later; where drawings of a pochette and of a kit, side by side, precede entries for fifteen pochettes one wonders which, if any, are actually portrayed. As the introduction makes clear, it was a policy decision not to illustrate every instrument - they had wished to do so but it would have cost too much and taken too long; readers are invited, instead, to come and see the instruments in the museum.

To my mind this decision was a mistake. A catalogue is a mine of information and of resources. Without pictures one has no clear idea of what the resources are and whether they are worth investigating further. I owe the Berlin Museum my warmest thanks for their help in providing photographs for my "World of Mediaeval and Renaissance Musical Instruments", especially for the pictures that they produced at very short notice after Vienna declined to provide photographs that had been half-promised, but I was able to ask for the photos I wanted because I had made notes on their pre-1600 instruments, with a few exceptions, and this catalogue is going to be very little help on my future books unless I have the time, and the money, to go back to Berlin and take more notes. I would be the first to admit that this is a selfish and unusual need, but notwithstanding there are many instruments here that many of us would like to study if we knew that they are worth studying, and only by seeing a picture can we judge whether, for example, an "1675 flageolet vin wikkel, orange (o)", is worth a trip to Berlin.
Berlin cats. p.2

or not - in this particular case we can go to the British Museum and look up the Sachs Catalogue, where there is a picture, but surely such a process should not be necessary. One would have thought that a compromise would have been possible, that each type of viol, for instance, could have been illustrated with at least the outlines of the various body shapes represented in the collection. Alternatively it might have been possible to do something like the Bessaraboff Boston Catalogue, where there are drawings of all the important types and bulk plates at the end with small but visible photographs of practically every instrument.

The Brass Catalogue is much better illustrated. By no means every instrument is shown and a number are frustratingly illustrated with only a detail picture of the maker's mark rather than of the whole instrument - to my mind the type of bell-profile is much more important than the type of engraving a maker's name on early trumpets and trombones. But at least there are 51 photographs of the 217 instruments in this volume, as well as a number of details of makers' marks, valves, etc. In addition, references are given to Baines's European and American Musical Instruments and to Nishioka's Wind Instruments, in which many of these instruments appear, as well as to the Sachs Catalogue and other sources.

Both volumes are, of course, well worth having and will be essential to most of us. The texts are excellent, as one would expect from these authors. The great collections can be counted on the fingers of one's two hands, and when one of them produces an up-to-date catalogue, it is a red-letter day. We look forward eagerly to further volumes.

Which reminds me; I have given the title of the String volume as it appears on the cover and on the title page. There is no indication that this is or may be a first volume, but save for the first three instruments, which are African musical bows, all the instruments therein are sounded by bowing. Presumably a further volume will describe the plucked string instruments, and another the keyboards, but there is no indication of this nor warning that they are not included here.

FoMRHI Comm. 91 Review of:

A. Bemer, J. H. van der Meer and G. Thibault (with Norman Brommelle), Preservation and Restoration of Musical Instruments, ICOM, 1967. 77 pp., illus. £2.75 (members of ICOM £1.75) or French Francs 13,75 (8,75).

Jeremy Montagu

Many of you may remember that on the original membership form we listed some projected Communications and that one of them was to be detailed comments on this ICOM handbook. For the first year of our existence I kept trying to do something about this; the pages of my copy got blacker and blacker with marginalia and corrections (the first of which is to the Errata slip!) and comments, and in the end I gave up simply...
because such a commentary would be longer than the book itself. Now, ICOM have sent me a copy for review in our Bulletin & Communications, and I feel in duty bound to review it. However, I do not feel that we can afford the space to do a proper job on it unless you, the members, write to me while you are renewing your subscriptions and ask me to do so - if enough of you do ask me to, then I will take it apart in the same detail that I have done with other books, perhaps in a series of Communications. For the moment, I will keep it short and general.

The initial list of Materials used in the making of Instruments has numerous errors and omissions - ignore it save where it corresponds with your own knowledge. This is a pity since the book is addressed to the non-specialist who has a few (or many) instruments in his care and it is intended to advise and help him; if it begins with information which he can see to be inaccurate from his collection, he is unlikely to have much faith in the book. A pity, as I say, because some of the information is true and important, especially the advice on conditions of humidity, etc., under which instruments should be kept and the urgency of the task of achieving those conditions before the instruments rot, fall apart, are attacked by vermin, parasites and fungi, and so on. The storage conditions in many private collections, including my own, are appalling, due either to lack of time, money or space; the tragedy is that the same is true of many public collections also. This book does go into brief but useful detail about the dangers and, very briefly, into some of the means of combating them.

It then goes into rather more detail on the subject of restoration, and all that I can say in the space that I wish to take up in this issue is: if you need the advice of this book before restoring an instrument, don’t do it. Leave it as it is either until you know more or until somebody produces a reliable book. In some places the authors’ advice is good, but in many others, far too many, it is inaccurate, questionable, dangerous or calamitous.

This section is followed by a note by Norman Brommelle on Materials used in Conservation, some of which is out-dated (see the Nürnberg restorers conference papers forthcoming in MICAT), some of which is unwise, and at least one part of which, that on the use of glues, extremely dangerous. One must never, never glue a joint in such a way, or with such a material, that it cannot be reopened. And whatever Michael Zadro may have said during our correspondence in Early Music, epoxy resins must be regarded as immovable, if only because unless a future restorer knows that they have been used fifty, a hundred or two hundred years in the future, and so can use a suitable solvent, if one exists, the instrument will break before the bond does.

The second half of the book consists of a set of uninformative and inaccurately captioned and described plates. Few are accurate in scale or proportion; only one has any of its original legend (they are all taken from other books). As a result, they are of little use save to those who know them already, and therefore do not need them. Detailed references, critically evaluated (eg a discussion of the comparative accuracy of Mersenne’s artists), to sources of illustrations would have taken half the space and would have been ten times the value.

In conclusion, read the advice on storage and display conditions, and try to do something about it, and forget most of the rest of it. Whatever you do, don’t follow any of the advice about conservation or restoration, or about the materials used in conservation, unless you already know more than there is in this book.
This Directory is an essential vade mecum for all peripatetic organologists - if you are interested in musical instruments and ever go out of your front door, you need a copy. Unfortunately, its value is reduced by its age. Published this month (October, 1977), the information in it was solicited in 1971. As a result, a number of the collections listed no longer exist. It is therefore essential before trying, or even planning to visit any of the private collections to enquire whether they are still accessible - all private collections can only be visited by appointment anyway, and to check on opening times, and occasionally on addresses, of the public collections.

The information in the list is minimal, often slightly less than in the Survey of Musical Instrument Collections in the United States and Canada by William Lichtenwanger and others (Music Library Association, Ann Arbor, 1971) but adequate as an indication of range of coverage. There are a fair number of misprints in the text; whether there are as many in the addresses and telephone numbers, I have no way of checking and can only hope that they may have been proof-read more carefully or anyway set in type with more care. A good many collections that I know of are omitted, either because they were not known to CIMCIM and thus did not receive a questionnaire or because they did not return the questionnaire. There are some sheets in the back of the book which readers are requested to tear out and return with corrections and additions, and I hope that all readers will do this. To save us all some labour, I will suggest here that the editor, or publisher, look at pp. 202-210 of Langwill's Index of Musical Wind Instrument Makers, 4th edn (and the equivalent pages of the forthcoming 5th edition) and send questionnaires to all the many collections listed there and absent from this Directory - that at least will expand the Directory in one area.

The Directory includes a few American and Canadian collections which were not in the 1974 Survey referred to above (a few references that I have found suggest a cut-off date of 1975, though as I said above the bulk of the information is earlier), and covers 91 other countries and all five continents. It is thus, as I said at the beginning and despite any faults and a high price, essential to any of us who travel and who look at collections of instruments. A few countries have only one or two entries and you may know them already, but I defy any reader to look at this book and say "I know them all" - you don't and the only way that you will is by getting this Directory.

Perhaps I should add that ICOM is the International Council of Museums and a section of UNESCO, and that CIMCIM is the Comité International des Musées et Collections d'Instruments de Musique. Also that Frits Knuf's address is P.O.B. 2707 Baren (Gld.) Netherlands, though the Directory should be in the likely bookshops by the time this review appears.
Chapter 3: The Hundred Years' War

42. 65. 2 The Arnault lute pattern was very atypical of its day. The belly shape turns into a tighter curvature as it approaches the neck, while most lutes of its day had the same curvature of the shoulder all the way to the neck; the neck length long enough to carry 11 frets is also most rare.

43. 65. 2 We do not know whether Laux Maler's lute designs were radically different from previous ones since only a selected sample that was appropriate for baroque conversion have survived. The one on plate XIII has no remaining feature on it which distinguishes an early 16th century instrument from a 17th century one. The long thin shape (called 'pear') as well as the short fat shape (called 'pearl') were both known well before Maler's time.

44. 65. 2 There is no reason why simple polyphony cannot be played with a plectrum. Holbourne's music for cittern shows how it is done. Too many writers engage in facile categorization (I am a sinner here as well), while insulting the imagination of the early musicians whom we can be sure would have tried everything out on their instruments that is possible. Whether they incorporated it into their mainstream music style is another matter and the subject for our research. My point here is that just because an alternative possible interpretation seems difficult we should not assume that early musicians took the easy simple way out. Professional performers in any medium, probably then as well as now, to earn their fee, need to display skills that the members of their audience have no hope of emulating. This argues for the more complex rather than the obvious. Whether this complexity was solely in the division and other ornamentation of the melody line or whether it also had polyphonic components is ambiguous in the contemporary descriptions of the playing of Petrokono, the most celebrated 15th century guitarist and lutanist.

45. 65. 2 and 69.1 J. M.'s distinction between the psaltery and dulcimer in terms of stringing and bridge structure is certainly true of most modern folk descendants, but was not true in the Hundred Years' War period. I haven't found a dulcimer illustration from before the middle of the 15th century, more than one string per course before the 16th century, evidence for ups and downs on string levels before 1536 or a picture of this before Praetorius, or individual chess-men bridges before the 18th century. The vast majority of the psalteries I've seen illustrated from the 14th century to Mersenne are multiple strung and I'm suspicious about the others (the grouping in courses of the 7 string 4 course lute or gitern is often not shown by the artists; also many of these apparently single-string psalteries if tuned diatonically would have too big a range for any string material known then for the string-length range depicted.

46. 69. 2 Art-historians state that medieval artists did not normally use living models but generally worked from standard pattern books. They presumably filled in or modified the models in the books according to memory or imagination to create an image that represented the idea that they intended to convey. It is possible that the artist here was indicating that the angels were so marvellous that they could play beautiful music with slack bows - a feat obviously impossible for ordinary mortals.
We shall have to take JM's word for the teeth on the rebec bows in plate 47 as they don't show on the reproduction. Since the mode of string vibration is so different in bowing and plucking, I wonder as to the wisdom of calling a multiple plucking device such as a toothed stick a bow. What would the organologists call the electrically rotated toothed wheel that my colleagues at I MIST developed for the pop group "10 cc" to use on their guitars?

I am not convinced by JM's identification of a prototype trumpet marine in plate 45. I agree that the instrument being played looks rather like a rebec, but the long boxy thing with strings above the player's head seems unconnected to the rebec to me and could just be another instrument in the background.

The question of whether each medieval instrumentalist usually played several instruments is a subject of current controversy amongst specialists studying the poetry of the period where statements about this are made.

I know of no data indicating that composers before the Renaissance wrote for amateur musicians.

The making of highly decorated instruments for wealthy amateurs is much more a 17th and 18th century phenomenon than it was earlier. Before then the highly decorated instruments were usually made as gifts for the collections of noblemen. A collector's item then could well have been treated as one would be today, i.e. admired for its uniqueness and visual beauty, with musical function very secondary. Through the nobleman, his family and friends would occasionally dabble, whatever serious playing any of these instruments could get would be in the hands of musicians in the nobleman's employ.

J.M. final point about tracing the playing of sets of the same type of instruments in varying sizes to this period earlier than the Renaissance is most significant. Unfortunately I am not as convinced of this conclusion as he is from the pictures he shows. The players to me look like the same pair (or two manifestations of the same person) reappearing in the different lights demonstrating the myriad of different ways that the Lord can be praised by the playing of instruments.

Chapter 4 (the final one) will be discussed next issue.