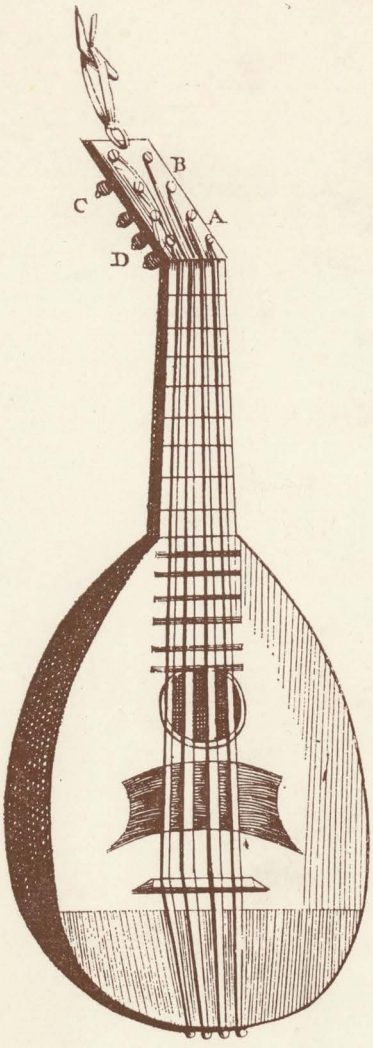

Preservation and Restoration of Musical Instruments

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with the collaboration of Norman Brommelle

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PRESERVATION & RESTORATION OF MUSICAL INSTRUMENTS

Provisional Recommendations

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ERRATA

Page ii, line 4, *for* in 1960 *read* in 1962

Page iii, under List of Plates, *for* I. Tromba marina—Pochette *read* Tromba marina—Pochette—Rebec

Page vi, lines 4 and 7, *for* DEUTSCHLAND *read* FEDERAL REPUBLIC OF GERMANY

Page vi, line 12, *for* Dr Frau Otto *read* Dr Irmgard Otto

Page 11, line 8, *for* cornets, *read* cornetts,

Page 23, line 23, for *Anleitung* read *Anweisung*

Page 24, top of page, insert *I. General works on preservation*

Page 27, line 20, for *Wind musical instruments* read *Musical wind instruments*

Page 27, line 14, *for* Cambridge, 1965. *read* Cambridge, Mass., 1965.

Page 36, line 11, for *piccoli alla francise* read *piccoli alla francese*

Page 36, line 11, for *viola de brazzo* read *viola da brazzo*

Pages 61, 73 and 75, for *Harmonicorum Libre* read *Harmonicorum Libri*

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To the Reader

THESE provisional recommendations are the fruit of the joint efforts of three curators of specialized museums who for years have had to cope daily with the major and minor problems that arise in connection with the preservation and restoration of musical instruments. In order to solve the former, they have conformed to the essential fundamental principles that apply to the preservation of all cultural property, at the same time adapting them to particular cases. As regards restoration, the difficulty is acute, since these objects were built to sound; solutions have had to be found which differ for each type of instrument, and these are numerous. It is the result of their experience that the authors offer here, without giving undue importance to the value and permanence of their work. The task is urgent. If the degradation of instruments is to be checked, the alterations in materials caused by insects, sun, mould, etc., remedied, the people in charge of collections must be informed of the tried methods of preservation with particular reference to the manner in which they have been applied; in the years to come unscientific restorations are to be avoided, and to this end the experience of international specialists and the benefits of most recent research must be made available in order to establish a method both rational and careful for restoring instruments.

These recommendations are obviously not addressed to the curators of instrument museums, but rather to the isolated collector and to those in charge of institutions possessing, amongst other objects, a few instruments of music, and who wish to be informed of the problems that may arise and of their solutions. It is hoped that this little guide will answer the questions most frequently asked by visitors to our museums, and it is for them, too, that it is intended.

The authors are fully aware of the provisional nature of these recommendations, and, since the problems peculiar to tropical and sub-tropical regions are not dealt with, they realize their limited nature. It is their wish that it will be possible in the future to widen their scope, make additions and keep them up to date, thanks to the knowledge acquired as science progresses.

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We wish to express our sincere gratitude to those who helped us bring this work to completion: Dr Frau Otto, Madame Jean Jacquot, Mademoiselle Josiane Ricci, and Mr Guy Oldham; all have been of invaluable assistance to us.

Materials used in the making of Instruments

BEFORE starting to study the problems of preservation and restoration we must first examine the materials used in the making of instruments. Their variety is greater than one generally imagines and we shall begin with a list of those most frequently employed.

ORGANIC MATERIALS

Skins: used for membranophones, such as drums, or as sound boards for a number of stringed instruments in the Arab world and the Far East.

Leather: bagpipe bags, organ bellows, the covering of cornets, etc.

Parchment: bands in the bodies of certain plucked and bowed stringed instruments, etc.

Horse hair: for bows.

Hog bristles: for harpsichord jacks.

Gut: for strings.

Quills: for harpsichord jacks.

Bone: flutes, whistles, skull drums from Tibet, etc.

Ivory: flutes, recorders, lutes, mandoras, African harps, horns, etc.

Horn: different types of horns, whistles, flageolets, etc.

Tortoise shell: used for the belly of various stringed instruments (European guitars, African lutes, etc.), for Indian rattles, etc.

Whalebone: used as piano springs.

Wood (exotic such as mahogany, rosewood, bamboo, and also different European species).

Fibres including rattan, coconut, etc.

Cork: in transverse flutes.

Textiles: bands of linen in organs, in the bodies of numerous plucked stringed instruments, etc. Silk bagpipe bags, silk strings in certain instruments of the Far East. Felt for clavichords, piano hammers and dampers.

METAL

Copper: hunting and signal horns.

Bronze: Lamaic Tibetan trumpets, bronze drums, Indonesian metallophones, lurer, etc.

Brass: trumpets, trombones, clarions, horns, etc., also wire for strings (clavichords, harpsichords, citterns, etc.).

Tin, lead and alloys: such as those used in organ pipes.

Nickel alloys: such as "German silver".

Steel or iron: for fastenings, tuning pins, etc.

White metal: Jew's harps, modern whistles, children's trumpets, etc.

Gold and silver: both used to decorate instruments: silver flutes, trumpets, etc.

SILICEOUS AND RELATED MATERIALS

Stone: lithophones, prehistoric pan-pipes, bull-roarers, marble recorders, etc.

Terracotta or glazed earthenware: Precolumbian instruments, dara-bukas, friction drums, etc.

China: eighteenth-century flutes, ocarinas, etc.

Glass: glass harmonicas, glass flutes, bells and horns.

The materials used for decoration must also be included, such as paint, lacquer, inlaid work, mother of pearl, paper designs used to decorate the soundboards or the internal parts of harpsichord cases, "papier mâché", etc.

The Preservation of Instruments

GENERALLY speaking, the problem of the preservation of musical instruments is the same as for other objects made of the same materials. Nevertheless, it must be stressed that the problem is particularly acute in this field. The essential parts of an instrument, those upon which its sonority depends, are generally made of thinner material than would be found in ordinary objects, and this renders them more fragile and delicate. The soundboards of harpsichords, spinets, and clavichords are examples. The soundboards of plucked stringed instruments such as guitars, harps, etc., and those belonging to the families of viols and violins (to mention only European) that are played with a bow, are very thin and are very often made of soft wood such as pine or cypress. In some cases the body itself is also fragile.

Gut strings, the hair for bows, the skins of membranophones (drums and kettledrums) and of African harps and rebabs, or the skins of a number of stringed instruments of eastern Europe and of the Near and Far East, are all extremely vulnerable to deterioration. We shall examine these points in greater detail.

The causes of the deterioration of musical instruments as of other objects are given in detail in a UNESCO publication on climatology and conservation in Museums.[1] The following is a brief summary:

1. *Unsuitable atmospheric conditions.*
   (*a*) High or low relative humidity and rapid changes in humidity.
   (*b*) Extremes of heat and cold. Temperature changes also affect the relative humidity.
   (*c*) Atmospheric impurities, both solid and gaseous.
2. *Light.*
3. *Rodent and insect pests.*
4. *Mechanical damage,* either by improper handling or in some cases by continued regular use.

1. (*a*) *and* (*b*) *Temperature and humidity* for instruments, in exhibition galleries, store-rooms, laboratories and workshops.

[1] H. J. Plenderleith and P. Philippot, *Climatology and Conservation in Museums*, Rome Centre Publication, no. 3, 1960.

It is important to keep the relative humidity constant in the region of 50–60 per cent. A suitable specification could be 55 (± 3) per cent. Instruments constructed, and intended for use in climates of high average RH might be regarded as exceptions to this rule, but if they have been exhibited in a temperate climate they will necessarily have become acclimatized to the lower RH. Provided that extremes of temperatures do not occur, the temperature as such is not important and may be chosen for the comfort of visitors and students provided that it is kept reasonably constant, since, in the absence of air-conditioning, a variation in temperature will affect the relative humidity. In temperate climates 16–20°C. is tolerable, whereas in hot climates 20–25°C. is more suitable.

The importance of control of relative humidity lies in the fact that if the RH is low, hygroscopic materials such as wood and skins, for instance, shrink and, if constrained by the form of construction, risk distortion and cracks. Excessive dryness also produces embrittlement in a number of materials. These dangers become progressively greater as the RH is lowered from 50 per cent. With higher humidities (above 65 per cent) there is danger from mould growth, rust and also the possibility of glues softening. The range 50–60 per cent is therefore important. Increase in temperature will lower the relative humidity, and this is particularly evident in the winter, especially on dry frosty days, when the outside temperature is below 0°C., whereas the indoor temperature may be 20°. In these circumstances, the relative humidity indoors will fall to below 30 per cent, with disastrous consequences to delicate wooden and ivory instruments. In the absence of air-conditioning various precautions can be taken. The temperature indoors should be as low as possible consistent with comfort; instruments should be kept away from local sources of heat such as radiators, and from the radiation of strong light sources, such as, for example, those often used for television; large temperature gradients in a room should in any case be avoided. Portable humidifiers may be used in small rooms. Some of these are described in the Rome Centre Publication referred to above. They are usually of two kinds—those which produce water vapour by an evaporation system and those which produce a fine spray of small drops of water—the former seeming to us preferable. Some humidifiers are provided with a hygrostat to maintain the RH at a constant level. Less efficient methods of humidification may be used in some places, such as having shallow trays of water over radiators.

Apart from increasing the relative humidity in dry centrally-heated

rooms, there is also the question of guarding instruments against sudden alterations in RH due to rapid weather changes or a failure in the heating system. Curtains, hangings and carpets of natural fibre material (not synthetics), untreated wooden floors and panelling, etc., help to even out variations, by acting as a reservoir to take in and give out moisture. Enclosure in cases can also even out changes. Though it is not advisable and usually not practicable to seal a case completely, cases with only small apertures can maintain comparatively stable conditions, especially if they have untreated wood and thick cellulosic fabric linings inside. They are, of course, not proof against long spells of low RH. Experimental work is being done in the Victoria and Albert Museum, London,[1] on the use of trays of chemical salts in show-cases containing musical instruments.

Protection against comparatively long periods of high relative humidity is important, especially in hot seasons, owing to the danger of mould growth, of rust and of the softening of glues. Store-rooms must be regularly inspected. In well-ventilated surroundings the dangers are less. In show-cases and cupboards and if plastic bags are used for storage, mould inhibitors should be used (see below). Whether or not bags should be completely sealed depends on circumstances. If a bag or case is opened for inspection on a warm humid day, exposure to draughts on a subsequent cold day may lead to a high RH in the enclosure, and possible condensation. An advantage of complete sealing in storage is that, with woollen materials, moth poisons such as paradichlorobenzene are more effective. Generally, however, such sealing is definitely not advisable.

In persistently damp conditions, in which no effective improvement can be made, a desiccant such as silica gel may be used in the proportion of 1 kg. to every 2 cubic metres of drawer or enclosure space. It may be regenerated by heat when the colour changes from blue to pink. In general, however, where climatic factors do not make it impossible, local sources of damp should be eradicated. Sometimes an external wall may be much colder than the remainder of a room even though not necessarily damp. In such circumstances, precautions should be taken to insulate the backs of wall cases containing instruments. In museums sometimes installed in historical buildings, in store-rooms often located in basements, damp conditions are most of the time persistent; it is

[1] The results have been published in *Studies in Conservation*, February 1966, p. 8; see Tim Patfield, *The Control of Relative Humidity and Air Pollution in Show-cases and Picture Frames*.

then necessary to use a dehumidifier. Different types of these are described in the article referred to above, p. 3, note 1.

Excessive cold may also prove damaging to instruments, particularly to organ pipes and lead harpsichord roses (see p. 19).

(*c*) *Atmospheric impurities*

It is important that instruments should be kept as free as possible from dust which, in addition to inert mineral particles, may contain tarry matter and corrosive impurities such as chlorides. Chlorides are particularly likely to be present in marine and industrial atmospheres and set up corrosion in metals. The advantages of exhibiting instruments in cases have already been mentioned in connection with relative humidity. There is also an obvious advantage in the reduction of the amount of dust deposition. For the same reason, instruments in storage should be kept in cupboards or in non-airtight plastic bags. Larger pieces should be covered with unsealed dust sheets.

Of the various gaseous impurities, sulphur dioxide, which occurs in town and industrial atmospheres, is the most serious hazard, since textiles and other organic materials such as leather are deteriorated by it. Here again enclosure in cases is helpful, though air-conditioning is the only complete solution.

The more or less uniform layer of stable corrosion product, usually described as patina, which forms on metal parts may or may not be tolerated. It is an aesthetic matter and one has to consider the general appearance of the instrument. If it be decided to remove the patina, the metal should be protected with a transparent lacquer, of which cellulose nitrate, the methacrylates and polyvinyl acetate are examples. If the instrument is to be played and it is thought that the tone might be affected, the lacquer can be removed with the appropriate solvent.

2. *Light.*

The damaging effect of light on organic materials and on varnishes is well known, and strong sunlight and skylight should be avoided. Whilst the ultra-violet component is the most damaging, the visible radiation is also dangerous. Thus the light should be cut down as much as possible consistent with exhibition requirements. When not on exhibition, instruments should be covered up. A convenient method of reducing the amount of light is by Venetian blinds.

With artificial light one must distinguish between ordinary electric bulbs and fluorescent tubes. With the former the instrument must be protected from the heat produced, but the amount of ultra-violet radiation is negligible. With the latter the heat output is much less, but some ultra-violet rays are emitted. For both daylight and fluorescent tubes, filters in different forms which eliminate the ultra-violet component are available. These are described by Feller.[1]

3. *Parasites.*

Woodworm and clothes moth are two of the most important hazards for instruments.

Woodworm can be killed when an attack has occurred by placing the instrument in a gas chamber. The best fumigants are hydrogen cyanide, methyl bromide and ethylene oxide: each has its advantages and disadvantages. Liquids containing chlorinated hydrocarbons may also be used, and though not as penetrating as gaseous methods leave behind a poison which protects the instrument for a considerable period.

For moths, treatment with paradichlorobenzene crystals is effective when sealed in a container with the textile as in the case of the bags of bagpipes; it is ineffective in the case of the felt of keyboards where enclosure is impossible. In such a case a liquid containing a chlorinated hydrocarbon such as pentachlorophenol can be used.

Conclusion.

Needless to say, great care should be taken in the cleaning of all types of instruments. Dust removing often entails damage if rough dusters or hard brushes are used. One must not forget that varnishes, soundboard paintings and glass have to be handled with caution, that bowed instruments are particularly vulnerable near the sound-holes, etc. Metal instruments, or metal parts of instruments can be polished only if this is done without too much pressure and with a soft cloth.

The chlorinated hydrocarbons are all poisons, and, for instance, paradichlorobenzene is a powerful liver poison. Research workers in museums where these materials have necessarily to be used should have regular periods in the open air.

Dusting should be regarded as a skilled technical operation. Dust removed from one surface, with comparative ease may be transferred by the duster to another object which may absorb the dust. The dusters used must be numerous and meticulously clean.

Such recommendations may seem unnecessary: but we have so frequently come across accidents due to bad treatment that we think it preferable to draw the reader's attention to this matter.

[1] R. L. Feller, *Museum*, vol. XVII, no. 2, 1964, pp. 57–98.

Restoration of Instruments

WHERE possible the restoration of a deteriorated instrument is commendable; common sense plays a large part in deciding what instruments are to be restored. In ethnological collections the sounds produced by certain instruments are often less important than other factors such as shape, ornamentation and their social function. Some instruments in a collection may have an historical importance, because of their association with a famous person, for example. In technical museums, instruments are sometimes shown as illustrations of technical development. Some Renaissance instruments were made solely or partly for visual pleasure. The restoration of such instruments is of a different order from that of instruments to be played, and it is with these latter that we are mainly concerned. But even with this end in view, certain instruments defy restoration and it is preferable to have copies made if one wishes to form an idea of the sound produced. These should be *exact*: not only in their outer appearance but also in their inner construction, essential for tone and execution. In the case of archaeological instruments, such as Egyptian harps, Roman cornua and Scandinavian lurer, restoration is too risky.

In European countries, it is wiser to begin by restoring European instruments, and of those, the instruments for which players are most readily to be found. It is often less expensive for a museum to purchase a modern specimen of an Oriental instrument, or set of instruments, than to have a museum piece radically restored, especially as the form and ornamentation of these instruments have undergone little change in the course of the last centuries.

Which restorations are permissible? Here we must distinguish between two sorts of restorations: those that concern the ornamental aspects of the instrument and those that concern the musical aspects. We shall deal only with the second category.

Certain fundamental principles must be laid down. Later, we shall elaborate these for different categories of instruments. These are:

1. (*a*) In no case may concessions be made in view of modern concert performances when restoring an instrument. It must be restored in such a way that a very close approximation to the original construction is

achieved; it must sound as nearly as possible as it did during the period when it was regularly played or, to be more precise, as we believe it did, according to results obtained by historical research. A Ruckers harpsichord in its original condition must be restored so that its construction and its tone are very nearly that of the original. A Ruckers harpsichord with added keys and stops or even an added manual and with eighteenth-century soundboard and bridges must, however, be made to sound as it did when it was last modified. No old harpsichord should be restored for a performance, in a modern concert hall, of a contemporary harpsichord concerto such as Manuel de Falla's or Francis Poulenc's *Concert champêtre*.

An old instrument need not necessarily be tuned, after restoration, to the modern pitch. If the instrument cannot support the string tension, it is quite possible to tune it a half or a whole tone lower, as pitch varied greatly in past centuries. It may be difficult to form ensembles of wind instruments on account of the different pitches, but we must all be very strict as regards selecting instruments of the same pitch.

Therefore, those parts of an instrument that are essential to the production and transmission of sound and to its resonance should be left whenever it is possible, or else—in case of absolute necessity—restored to the state when the instrument was in constant use. Thus, there must be no thick, heavy soundboard linings in the wrong places, for instance, which might seem necessary to counteract the high tension of too-thick strings; no quilling, for instance, with leather for a Flemish seventeenth-century harpsichord. Crow quills are sometimes difficult to obtain, but those of eagle, vulture and condor may be obtained from many zoological gardens, and these constitute acceptable substitutes.

(*b*) Compromises are sometimes inevitable as regards the sound-producing and transmitting parts when the original material is unobtainable or too expensive. Steel and brass wire may be used to string harpsichords instead of the original low-carbon steel, approaching pure iron. And if quills of the right elasticity are not available, it is better to try to approximate the original tone with artificial materials, such as nylon or Delrin.[1]

(*c*) One group of instruments can form an exception to these rules: those of the "braccio" group, such as violins, violas, violoncellos, and double basses. These have undergone very little change in the course of the past centuries and hardly at all since the end of the eighteenth

[1] Delrin is obtainable from Dupont de Nemours (U.S.A.).

century, at least as far as the body is concerned. Thus the restoration of an early eighteenth-century violin does not necessarily imply giving it a baroque neck, fingerboard, bassbar and bridge. With such instruments, which may be qualified as "ancient" though used up to this day, it is permissible to retain the parts added later in such a way that the sound remains that belonging to a later period than the one in which the instruments were built. Sometimes, for a performance, a violin may be strung in the modern way with aluminium and wire-spun strings, giving the instrument the tone-quality of a later period, but this stringing is not advisable for exhibition in a museum.

2. The tone an instrument will have after restoration can never be predicted with certainty. Where possible several instruments should be restored and the best ones selected for performance and demonstration.

3. It frequently happens that an instrument has been modified in the course of its existence. Sometimes the changes do not affect the type of the instrument, as, for example, when the compass of a harpsichord has been extended, when a seventh string has been added to a six-stringed viol, when neck, fingerboard, bassbar and bridge of a violin have been changed at the end of the eighteenth century, when a five double-course guitar has been turned into a six-stringed guitar, or when one or more keys have been added to a wind instrument. Whether such instruments should be restored to the original state or not depends upon various circumstances.

(*a*) If an old instrument, after its original playing-life, has suffered alterations that show a lack of historical knowledge, it should be restored to its original state or at least to one of its successive conditions in a period when it was actually played. Thus the bad reconstructions and so-called restorations of harpsichords and viols done in the nineteenth century should be corrected.

(*b*) If the modification was made while the instrument was still being used, a restoration to its original state may sometimes be attempted; but this, again, depends on the particular circumstances. If the compass of an early harpsichord was enlarged in the eighteenth century, should the compass be reduced or not? If such an early harpsichord with its original compass exists in the collection, then the modified instrument can be left as it is; it will thus provide an example of the baroque practice of "ravalement", i.e. extension of the original compass, with change of the original wrestplank. If such is not the case, the decision should be taken by a specialist, bearing in mind the historical elements

that are to be found in the instrument. The author of the change should also be considered: when a famous maker like Taskin has transformed a Ruckers harpsichord, there should, of course, be no question of restoring the instrument to its former state; the same is true of repairs made in plucked or bowed instruments by masters such as Schelle, Hummel, Vuillaume, etc.

4. In some cases, changes have been made that affect the type of the instrument. A harpsichord may have been transformed into a pianoforte, a viol into a violoncello, a viola d'amore into a viola, a lute into a guitar.

(*a*) Again, if the transformation was not made in view of playing the instrument, it is better to restore it to its original state. For example, an eighteenth-century pianoforte turned into a harpsichord in the nineteenth century, for historical or pseudo-historical purposes, though it may be an object of curiosity, has no organological value. Its restoration as a harpsichord is therefore useless.

(*b*) If the transformation was made in view of playing the instrument, the situation changes. It may be desirable, when a collection does not include a viol, to restore to its original state a viol that has been transformed into a violoncello. Such an instrument may, however, be retained in a collection that does include one or more viols, as an interesting example of an eighteenth-century practice. If, on the other hand, this alteration was the work of a famous violin-maker, then the violoncello should be retained. But in the case of a transformed Stainer viol, it might be preferable to restore it to its original state, if this does not entail too many additions. The same type of problem arises for "Tangentenflügel" transformed around 1800 into pianofortes. To restore them to their original state is not advisable, as a new action would have to be made.

5. It should always be seen to that a detailed report of the restoration be made, with photographs if possible of the various stages of the restoration and with drawings to scale of the construction.

An opened instrument should also be photographed; inside views, taken if possible from different angles, are indispensable as documentary evidence; signatures may be found even in unexpected parts of the instrument, such as on the top-block of a violin or on the box-slide of a harpsichord.

6. In the process of restoration, it may be necessary to renew a part of an instrument. This is a delicate problem and the solution proposed is based on personal experience.

(*a*) Parts essential to the resonance should never be renewed. Small damages may be repaired. This applies, for example, to the bodies of plucked and bowed stringed instruments; to the soundboards of stringed keyboard instruments, and to the tubes, or parts of tubes, of wind instruments. The pipes of organs, like the tubes of wind instruments, being important if not essential to the resonance, should never be entirely renewed. This would be the equivalent of trying to restore a harpsichord lacking a soundboard. But if a few pipes are missing from an organ register, it is permissible to replace these pipes with exact copies based on the remaining ones, so that the main tone-colour and resonance of such stops are not seriously affected.

(*b*) Parts essential to the generation of the sound of the instrument, such as strings, harpsichord jacks, pianoforte hammers, organ bellows, or wind-instrument reeds, and those essential to the transmission of the sound, such as bridges and sound-posts, should, whenever possible, be retained. They should only be renewed if it is impossible to repair them, or if they are entirely missing (which is often the case with strings); but the renovation must be as close as possible to the original.

(*c*) Parts remarkable for their marquetry, wood-carving, paintings, etc., should never be renewed. This also applies to parts bearing technical markings or signatures. If, as in the case of a lute with a damaged inlaid neck, it is impossible, without affecting the marquetry, to restore the instrument so that it can be played, it should be restored only for the appearance. If a violin scroll or a viol head is slightly damaged, an attempt may be made to restore the wood-carving, since the tone of the instrument will not be affected.

(*d*) Accessory parts that do not greatly affect the appearance of the instrument, such as wrestplanks, wrestpins, fingerboards in bowed instruments, tail-pieces, pin boxes, harp actions, have to be replaced when in a very bad condition, but the new parts must conform to the original.

Warning must be given against retaining original wooden parts by inserting metal bars or bolts, since corrosion of the metal, and staining and deterioration of the wood may occur.[1] As far as possible, two different materials must not be juxtaposed or introduced one into the other, on account of the difference in the expansion and contraction of these materials with changes in temperature and relative humidity.

7. Restoration should always be done by a craftsman with enough historical interest and feeling for the instruments concerned. Not every

[1] Experiments are being made in some museums with stainless steel.

violin- or guitar-maker is capable of restoring stringed instruments of the bowed or plucked type, not every harp-maker of restoring old harps, not every wind-instrument factory of restoring woods and brasses, not every piano-tuner of repairing damages in old stringed keyboards, not every organ-builder of restoring old organs with the respect due to the instruments. Where necessary, advice must be sought from specialists.

The ideal would be, for museums, to have a workshop with different specialists: one section for keyboard instruments: harpsichords, spinets, clavichords and organs, one for viols and violins, one for lutes, guitars, citterns and all plucked stringed instruments, one for wood winds and brass, and also one for mechanical instruments. All restorations should be done under the supervision of the curator. The initial cost, of course, would be high, but this would be compensated by the fact that the risk of deterioration, particularly after restoration, would be eliminated; further trouble could be spared by thereafter keeping them in suitable climatic conditions.

I. BOWED AND PLUCKED STRINGED INSTRUMENTS OF THE LUTE TYPE

Of this group, which also includes bowed instruments of the braccio and gamba type as well as the "pardessus de viole", quinton, viola d'amore, lyra-viol, baryton and double bass, the following can be said:

Resonator: Of the body itself nothing should be renewed. Minor damages may be repaired, if these repairs aim at a faithful reconstruction of the original. Linings by cross-bars must never be used in instruments of the braccio family that normally have no such linings. In instruments with linings—gamba family—these should be applied in the original place. The bassbar should usually be left or restored to its last form. Varnish should be touched as little as possible. After applying a narrow wedge to fill up a crack, the part repaired should be varnished to resemble as nearly as possible the original. All these elements are so essential to the tone-colour that no alteration, or very little, should be effected.

Parts of visual importance: Scrolls and pegbox heads in bowed instruments should not, even when damaged, be renewed, as these are very typical pieces of wood-carving. Nor should parts with marquetry carving or paintings be renewed. Consequently the renovation of parts (e.g. necks) of many old plucked instruments is never to be recommended. Often, we find new heads, new necks put on old instruments;

these should be an exact copy of an original by the same maker or belonging to the same school: if this is not the case, they should be replaced by some made according to the principles we have mentioned. The same applies when such parts are lacking.

Sound transmitters: If the original bridge is present (often in fixed lute and guitar bridges, rarely in loose bowed-instrument bridges), these should, if possible, be kept in their original condition. If the bridge is damaged or—in the case of a fixed bridge—is so weak that it could not support the tension of the strings, it may be replaced by a faithful copy of the original. The same is valid in the case of a damaged sound-post. In both cases the original damaged parts must be kept. If a sound-post has fallen, it should be put into place by a really trustworthy violin-maker who takes care to replace it in exactly the right position.

Accessory parts that do not greatly affect the appearance: A damaged neck may usually be replaced by a new one, if it is not inlaid, carved or painted. A pegbox and pegs may be renewed, but the originals must be kept as documentary material. These renovations may only be carried out where the parts concerned are seriously damaged. It sometimes happens that the peg-holes have become too big and the right tension cannot be maintained. In this case it is sufficient to line the peg-holes so that they become small enough to hold the peg firmly. Parts such as fingerboard, nut, stringholder and button may be renewed, if necessary.

In instruments of the braccio family the problem of baroque measurements arises. Instruments which have retained these should be left in their original condition, no part should be renewed, as these instruments are rare. If a violin has a baroque neck, but a bridge (or bassbar) of a later date, the bridge (or bassbar) should be restored to its original baroque condition. If the collection contains several baroque instruments, of the braccio type, none of which has baroque measurements, it may be advisable to give one instrument (or two, if possible) a neck, a bassbar and a bridge that will make it conform to its original measurements. This must be left to the discretion of the owner or person responsible for the collection.

Some plucked instruments, such as lutes, have roses. If a rose is missing, this can seriously affect the tone-colour. If a collection includes several lutes, it is wiser not to begin by restoring an instrument without a rose. If the only lute of a collection lacks a rose, it is advisable to insert a rose of approximately the same weight, modelled after that of a similar instrument from another collection.

Sound generators: The original strings of an instrument have almost always disappeared. Whenever possible, restringing should be done with strings that conform to the original. Gut strings are easily obtained, and it is not necessary to use nylon strings on lutes and guitars, as some players do. Resonance strings should always be of metal. Instruments of the braccio family are an exception. If these are used for baroque music only, the old thin gut strings should be used. Wire-spun strings did occasionally occur from the end of the seventeenth century, but the use of these should remain exceptional. Instruments with baroque measurements should certainly be strung in the baroque manner (for exceptions, see pp. 9–10).

Viols, lutes and guitars and such instruments were fretted. If there are no inlaid frets (lutes of the classical period never had), gut frets should be applied.[1] The first fret should be placed at one-eighteenth of the vibrating string length (from nut to bridge); the second fret at one-eighteenth of the length from first fret to bridge and so on. Smaller corrections as to the positions of the frets can be made by the player.

Finally, some instruments of this category have undergone certain alterations. We have already mentioned these (4(*b*), p. 11) and suggested the type of restoration to be carried out. In the case of a violoncello *a cinque corde*—sometimes called a *violoncello piccolo*—tuned to a violoncello by removing the fifth peg and closing up the fifth peg-hole, it is advisable to restore it to the original condition, as five-stringed cellos are rare. In that case it may be necessary to have a new bridge and tail-piece built.

II. HARP

The problems that arise in the restoration of this type of instrument are less numerous. The soundboard and body of the instrument, which are of extreme importance to the tone-quality, should not be renewed.

Smaller damages may be repaired in the spirit of the original. Linings must be kept or restored in the original places. The neck and pillar must be retained, not so much on account of their importance for the tone-colour, but because they are often finely decorated. Hooks, "fourchettes" and the mechanical action put into motion by the pedals must be restored, hence the renovation of those parts that do not greatly affect the appearance is permissible. It should be kept in mind that old

[1] As to the method to be followed, see Marin Mersenne, *Harmonie universelle*, vol. IV, p. 81, and Thomas Mace, *Musick's Monument*, p. 63; also, Gerald Hayes, *Musical Instruments and their Music*, vol. II, p. 24 and Josef Bacher, *Die Viola da Gamba*, Kassel, n.d., p. 28.

harps are smaller than modern instruments, and need thinner strings than those used for our modern concert harp. Thick strings entail too great a tension and this would cause the soundboard to bulge, if not to crack.

III. STRINGED KEYBOARD INSTRUMENTS

Resonator: The essential part of a stringed keyboard (clavichord, harpsichord, pianoforte) is the soundboard. This must never be renewed, though minor damages have often to be repaired. The inner construction, especially the barring, must remain, or if this has been changed, restored if possible to its original condition. There must be no heavy bars in the wrong places to prevent the soundboard from vibrating, nor heavy additions to the framing which are also detrimental to the sound.

Sound transmitters: Bridges are important for the transmission of the vibrations from the strings to the soundboard. If possible, they should be left in their original condition. Sometimes bridges are so badly hollowed out by woodworm that they hardly fulfil their function. In that case, the damaged parts can be renewed, only if the renovation is done in the spirit of the original.

Sound generators: Sometimes the mechanism is partly or totally missing. If only a few clavichord tangents, some harpsichord jacks or a few pianoforte hammers or dampers are missing, these can be supplemented in accordance with the remaining parts. Sometimes, in old harpsichords all jacks are missing. In that case, especially if the instrument promises to have a fine sound after restoration, it is necessary to make new jacks closely copied from others found in harpsichords of the same type and provenance.

Old jack quills of harpsichords are seldom preserved, and if so, are not in a state to be used: they should be kept as documents and new quills put in for use. These must approximate as nearly as possible to the original ones. In many Italian harpsichords and in all other harpsichords, crow quills are the best. Quills must not be too soft (goose quills, for example) or they produce the wrong tone-colour. But rather than leave the instrument unrestored it is preferable, if the quills of large birds of prey are unobtainable, to use quills of an artificial material. Nylon or Delrin quills can give practically the same effect as those of the large birds of prey and even of crows. As historical authenticity is desired, leather quilling should never be used for harpsichords that did not possess it originally, as this produces an absolutely different

sonority. Delrin is always preferable to leather. In those Italian harpsichords that did originally possess leather or brass quills, it is obviously preferable to restore them with leather or brass quills. For quill springs, hog-bristle of about 0.5 mm. ($\frac{1}{50}$ in.) thickness is desirable; if this is not available, mono-filament nylon may be used. Thin steel wire endangers the smoothness of the action.

Correct restoration of pianofortes implies the use of hammer-covering of the original material and thickness. Steel or, in some instruments in the bass, brass wire must be used for stringing. Preservation of the original strings is rare, and in very few cases do we know the exact string gauges. We do know, however, that the string gauges, up to the beginning of the nineteenth century, were smaller than those we use today. Therefore, comparatively thin wire may be employed in instruments up to about 1800, some latitude being given to the restorer in choosing experimentally, under the curator's supervision, the best sonority.

In some late clavichords, and in pianofortes dating from the last half of the eighteenth century and the first quarter of the nineteenth century, open-covered brass wire strings were used. These are difficult to find commercially, but can be produced by a simple hand string-spinning machine, which should be at the disposal of the restorer. In all cases the stringing should resemble the original as closely as possible, keeping in mind that the pitch, around 1800, was still lower than nowadays. Amplification of the sonority for modern concert-hall use is unthinkable in a collection aiming at historical authenticity.

Accessory parts of no visual importance: If possible, the original wrest-plank should be retained. If the original is so worm-eaten that it cannot support the tension of the strings, it may be renewed in exceptional cases. The tuning pins, too, should be kept in their original condition, if possible. If they are missing or have been replaced by modern thick pianoforte pins, new pins that conform to the old model must be put in. If these replace thicker pins, the pin-holes must be lined. In no case, in instruments made before 1830, should a hole be bored in the pin and the string looped through it. Keys often have lead filling for balance. If the leading was changed after the period of regular use, it should be restored to the original condition. Added lead in that case should be removed so that the balance, and consequently the touch of the instrument, conforms to the original. If some of the keys, the stop, the knee-levers or the pedal actions—loud and soft—are missing, these may be supplemented, but always with the original in mind. This also applies

to many fanciful pedal actions with which the early nineteenth century experimented. In some rare cases where a complete keyboard is missing, while the rest of the instrument is in fairly good condition, a new manual may be put in, the keys being modelled and covered in a fashion similar to that of another instrument of the same period and provenance. It is quite unnecessary and obviously undesirable to use modern keys with celluloid covering.

Some instruments have had their compasses enlarged or have had stops or even complete manuals added. If such alterations were applied for practical use, they may or may not be retained. We have discussed this in some detail in the general principles formulated above.

IV. WIND INSTRUMENTS

Resonators: No parts of tubes should be renewed. Small leakages, cracks and other damages should be repaired where this is possible, in metal instruments, and also in those of wood, ivory and other materials. The same applies to recorder blocks. Even if blocks are loose, it is better to try to preserve them, for they have often been fashioned with great skill by the maker. (See page opposite pl. XI.) When part of the tube of a wind instrument is lost, or in such bad condition that it cannot be restored, some museums have had an exact copy of this part made, but this solution is only advisable when a very clever craftsman, with sound historical knowledge, is available; as a rule, such a restoration cannot be recommended.

Generators: Great care should be taken that the original mouthpieces of brass instruments do not get lost. This can easily happen, for instance, when the instrument is played with a different mouthpiece during a performance. If there are old reeds or parts of them, these should be carefully kept and moistened regularly. If the instrument is required for performance, new reeds should be made according to the measurements of the old ones. If the mouthpiece of a brass instrument is missing, a new mouthpiece can be made for the performance, preferably—if the player is capable of playing with it—one that conforms to the original. New reeds and mouthpieces can be copied from old specimens in similar instruments—if necessary belonging to other collections—or from models given in old treatises.

Parts important to the appearance: Finely cast bells and joints of metal instruments, specially cast or engraved keys and turnery must not be renewed. If restoration is possible only by such renovations, no attempt must be made to put the instrument into playing order. The colour

inside the bells of brass instruments, being of historical importance, should on no account be removed.

Accessory parts that do not greatly affect the appearance: Flute corks, key coverings and pads, keys without engravings, etc., key mechanisms, stays in trombones and in some horns, may be renewed. In natural trumpets, often a metal stay has been inserted between the parallel parts of the tubing where there was originally a wooden block and the bell has been soldered to the lower bend of the tube. In this case the stays have to be replaced by a wooden block and the whole covered with cord or strips of linen; the soldering has to be removed and the bell attached to the tube by a wire passed through a hole in the bell. (See pl. XX (4).) Plain keys, when missing, may be replaced by copies of the original ones. The same applies to S-tubes in bass recorders and the inner slides of trombones, but only if the shape and the material of the original are respected. The elimination of leakages by applying waxed or greased thread (lapping) to the joints of seventeenth- and eighteenth-century instruments is always advisable. (See p. 58: how to apply the thread.) All original thread must be carefully kept.

V. ORGANS

Resonators: The pipework directly affects the tone of an organ; the pipes must therefore never be renewed, or essentially altered. Only minor damages may be repaired. No attempt should be made to restore an organ in which the pipes are completely lacking. This also applies to instruments in which the tin of the pipes has been very strongly attacked by "allotropy", i.e. when it has crumbled to powder, owing to exposure to low temperatures. Bad restorations of a later period must generally be removed.

Additions of complete registers (for example of pedal stops, while the pedal was originally merely coupled to the manual stops) which do not conform to the original may be removed without difficulty. The added parts must be retained as documents. If original registers have been completely or partially replaced by others in a different spirit from the original, "restoration" of the original stops would amount to a replacement, and is therefore inadvisable. Minor alterations, such as the suppression of the short octave, may be corrected by lengthening the pipes and the instrument thus restored to its original state.

Dents in metal pipes may be smoothed out. Clips at the top of metal pipes can be restored by soldering them. Where a few pipes in a register are missing or badly damaged, these may be added, but they must

conform to the material and proportions of the remaining pipes. This is not a complete renovation. The same applies to a reed register when the resonator is missing from a few pipes. Reeds may also be added if only a few in the register are missing. Here, too, there can be no question of renovation. It sometimes happens that new pipe tops have been added at an earlier period to metal pipes. If this restoration was carried out with material greatly differing from the original, new pipe tops should be made of a material that conforms to the original. When restoring metal pipe tops, the length of the pipes should be such that the original pitch is retained, and this can be determined on the basis of the wooden pipes. In many cases measures have been taken at a later date that seriously influence the tone-colour; for instance, the applying of nicking, the narrowing of metal pipe feet, the fixing of wedges in wooden pipe feet, and tuning slides. These must be removed and the original condition re-established. As to nicks, these should not be "restored" by applying a new block. The only possible restoration consists in rubbing out the cuts from the inside. Pipes must never be cut open in order to reach the block. In general, when a few missing pipes are added to a register, when pipes are lengthened and restored to their original condition, all the essential features of the register should be respected (material, shape, diameter, bore, presence or absence of pipe stops, height and width of the mouth, etc.). The voicing of organ pipes is a very delicate question. It should only be done if absolutely necessary and then solely by someone thoroughly acquainted with the type of organ to which the instrument to be restored belongs. It is of paramount importance that the instrument be entrusted to absolutely reliable organ-makers or restorers.

Generators: These consist in what is generally called the wind work. There is a tendency to build in an electric motor for supplying wind to old organs in order to eliminate the mechanical method of activation by hand strips or pedals. This is not advisable for museum pieces that are not, like church organs, regularly played. The original mechanical wind supply should remain the only one. The wind pressure *must* be correct. If the original bellows weight exists, there are no difficulties. The weight should never be increased to achieve a brighter tone. If the original weight has been renewed at a later period, or is altogether missing, it should be made to conform to other organs of the same type and period. Bellows (in old organs only feeder and main bellows) are often leaky, but leakages can usually be repaired by renewing the leather, and this is always permissible. The same applies to wind chests; if the

woodwork is badly worm-eaten, the replacement of these parts is allowed, if filling with artificial material is not possible. Leakages in the wind trunk and groove boards may likewise be repaired without replacement. In the case of worm-eaten woodwork, this may be renewed. This also applies to the upper boards. The pipe-holes in these have sometimes become a little large. Lining of the holes is to be recommended in that case. Metal air ducts may be renewed if it is not possible to retain the original ones.

The same can be said of manual and pedal keyboards as of those of stringed keyboard instruments.

Accessory parts that do not greatly affect the appearance: If the original parts of the action of keys and stops (trackers, stickers, roller action, stop rods, couplers, puffers, pull-downs, pallets, etc.) are missing, or cannot reasonably be kept and in consequence require renewal, this may be done wholly or partially, on condition that the potentialities of the original instrument be strictly respected.

Parts that affect the appearance: Practically speaking, this is only the organ case; it should be treated according to the general rules for the restoration of furniture and other woodwork.

CONCLUSIONS

The above are the most important problems likely to be encountered. We have confined ourselves to those of a general nature; not *all* problems have been dealt with, even though some of those omitted may have a certain importance. For instance, what is to be done with an octave virginal formerly used on top of a larger instrument? The larger instrument has been lost; the octave virginal has never been played on separately, but, being the only part preserved, may be restored as a document. There are no general rules for solving this and similar problems.

We have deliberately refrained from mentioning automatic instruments. The organ parts of barrel and other automatic organs can be restored by an organ-maker. The mechanism for these, as for musical boxes, is best restored by a watch- or clock-maker. This subject properly belongs to the domain of watch-making rather than to that of the restoration of musical instruments.

Some instruments can never be restored without being completely renewed. A cracked bell or gong, for instance, would have to be entirely recast. The metal, especially the outer part, and the centre in gongs would have to be renewed. A "restoration" of this nature is against the general principles we have set down.

Finally, there are certain instruments the restoration of which does not lead to any historical falsifications. Considerable latitude is allowed in restoring them, and we have not dealt with them here. They comprise, in particular, instruments from the nineteenth century such as harmoniums and harmonicas which, because of their comparatively short history, pose no problems of restoration. Most piano technicians are capable of restoring harmoniums.

We have endeavoured here to draw up a summary of the principles to be followed in preserving and restoring musical instruments. If we have not insisted on the problems involved in regard to instruments that come from Asia, Africa, Oceania or certain regions of America, it is because, in a temperate climate, they are practically the same as those that arise for European instruments; the solutions adopted in our Museums is, on the whole, valid for almost all types of instruments except in some particular cases: a material such as bamboo, for instance, necessitates a higher degree of RH than most other woods.

The question of the preservation and restoration of extra-European instruments in their countries of origin seems to us so important that it deserves to be studied at length. It will form the subject of another booklet such as this one with illustrations and precise indications on stringing, mounting, etc. Any suggestions tending to complete or correct these, as well as constructive criticism, will be gratefully welcomed.

Bibliography

THE list of technical and historical books appended to these *Provisional Recommendations* is, as the title indicates, selective. But we feel that we should explain the principles that have determined our choice. For the first part, there exist very few studies devoted to the preservation of musical instruments; therefore we have consulted several articles on the preservation of cultural property in general and those that can apply to our problems have been listed here.

The person responsible for restoring musical instruments must be thoroughly acquainted with the construction of each type, and know something of their evolution and of their historical and artistic background. Therefore we have given titles of both old and modern works that we consult most frequently in our museums, those also that we advise our visitors to read. However, we have avoided mentioning articles or monographs on special instruments, types or makers. We have also omitted methods that mainly treat of technique, ornamentation, etc., such as those of Ganassi, Diego Ortiz, Bermudo, Diruta or François Couperin. We have devoted a large space to stringed instruments, as the problem of stringing and tuning is one of those with which all curators have to cope. Old treatises on wind instruments have only been listed when they contain data on practical problems such as reed-making: thus we have refrained from mentioning Hotteterre's *Principes de la flûte traversière* . . . and *de la flûte à bec* . . ., Quantz's *Versuch einer Anleitung die Flöte traversiere zu spielen*, Fantini's trumpet method or Altenburg's book on the art of playing trumpets and drums.

From the vast literature on organs, we have restricted our choice to books on small instruments, portative and positive, such as those preserved in museums, and also to a few general studies on organ-building.

Finally, few works of the nineteenth century are marked on our list: it might have proved interesting to refer to Koch's *Musikalisches Lexikon* or to Berlioz's *Traité de l'instrumentation*, but we consider that the organological problems of these periods are easier to solve, the information given by "Brevets d'invention" or "Patentschriften", etc., and by contemporary periodicals, being more readily available.

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II. *Selective list of books on musical instruments*

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Materials used in Conservation

NORMAN BROMMELLE

THE materials used in the conservation of musical instruments are those currently used in the conservation of works of art in general. It is not expedient to give details of the manufacturers of these materials in this handbook. Sometimes a material such as the polyethylene terephthalate fibre will be manufactured in different countries under different names—in England as Terylene, in France as Tergal, in the U.S.A. as Dacron and in Italy as Terital—and, apart from methods of weaving, would have identical physical properties whatever the source. Occasionally one only of the major manufacturing countries produces a particular product and this is exported elsewhere under its own name. An example is the Eastman 910 fast-setting cyanoacrylate adhesive. Such materials could be listed satisfactorily. In many and probably most cases, however, materials of similar composition may have small differences in manufacture in different countries, so that a simple substitution might be misleading or even dangerous as far as the conservator is concerned. Thus a polyvinyl acetate emulsion made in France might differ considerably from one made in the U.K., owing to differences in the composition of plasticizers and emulsifiers. A comparison between the products of different countries would be a lengthy task, and would rapidly become out of date.

We shall therefore give a general summary of the *types* of material available, and conservators should consult the large chemical firms or research institutes in their own countries or write to IIC[1] or the Rome Centre for Conservation,[2] for further details.

The use of modern synthetic substances in conservation requires some justification. It was formerly considered that nothing should be used in conservation which had not been used by the original craftsmen, but with the advent of carefully tested modern materials, with new properties and good stability this view must be judiciously modified.

[1]IIC: The International Institute for Conservation of Historic and Artistic Works, c/o The National Gallery, Trafalgar Square, London, WC2, England.

[2] International Centre for the Study of the Preservation and the Restoration of Cultural Property, Via Cavour 256, Rome, Italy.

The following types of material are in current use for general conservation and are described here in general terms as being suitable for various applications in the conservation of musical instruments.

Epoxy resins

This versatile class of resin includes cold-setting cements, usually with a slightly yellow colour. An important property is that they harden without appreciable change in volume. Certain grades can be used for glass repairs and would be applicable, for example, to crystal flutes. Although some types of the resins may be regarded as general adhesives, careful selection of the most appropriate grade for a particular purpose must always be made. For this, the local manufacturer must be consulted and it is quite impossible to make comparisons on an international basis. Among the uses of these resins are wood to wood, wood to metal and metal to metal joins and also the consolidation of worm-eaten wood.

Varnishes and surface coatings in general

The surface coatings of musical instruments must never be interfered with. Occasionally however, paintings on harpsichords, etc., require restoration. This is specialized work for the picture-restorer. He may use the traditional varnishes, mastic or dammar or one of the newer materials which have now been carefully tested. These are the polycyclohexanone resins such as AW2, the polymethacrylate esters and polyvinyl acetate. There are at present no other than these three groups of materials that can be recommended.

Cleaning materials for textiles

Musical instruments may have textile materials as part of the object. Methods of cleaning will be governed by their condition and whether they can be detached for treatment. The methods of cleaning textiles will be considered in an IIC Handbook which is now in preparation.

Careful cleaning with a hand vacuum cleaner, with muslin stretched over the nozzle, may be sufficient. Washing when feasible is the most effective solvent treatment, and a mild soap or a non-ionic detergent may be added to the water. The latter should be obtained from the manufacturer rather than from a retailer, and an assurance obtained that it does not contain a fluorescent "whitening" agent. When wet cleaning is inadvisable a "dry-cleaning" solvent may be used. Two types are ordinarily used, either a chlorinated hydrocarbon such as perchlorethylene or an ordinary petroleum solvent of the kind used for

thinning oil paints. Volatile hydrocarbons mixed with inert absorbent powder are currently available, sometimes in aerosol containers, for treating local areas for grease spots and grime.

Treatment of leather

Mixtures of lanoline, wax and oil are available in most countries for improving the flexibility of leather. Some of these include fungicides. These are mainly traditional recipes and can be safely recommended.

Adhesives for attaching felt, paper, etc.

The class of materials known as the modified celluloses are now fully accepted for this purpose. Among these are methylethyl cellulose and sodium carboxy methyl cellulose. They have the advantage of being comparatively inert and stable and are probably better than the farinaceous paste adhesives previously used for this purpose.

Replicas and impressions

Various materials which make this work much easier include siliconized rubber which can be applied to almost any material without damage to the object. The liquid is coated on the object and solidifies to a flexible rubber in a very short time. The very sharp negative impression obtained can be used as a mould for the usual casting techniques. In this connection both epoxy resins and polyesters should be mentioned. The term "polyester" is generic and covers a wide range of materials. In the field of conservation it refers to a range of resinous substances usually in the form of viscous liquids which, with the addition of a second material, usually described as a "hardener", solidify to a glassy solid. These can be pigmented and made to imitate in appearance almost every kind of solid.

Fungicides and insecticides

Moth and mildew can usually be avoided by careful curatorship and attention to the factors of relative humidity, etc., discussed earlier. However, the ideal conditions cannot always be attained. As a precaution against damage from moths, felts in instruments and other textile materials can be sprayed with lauryl pentachlorophenol. Other chlorinated hydrocarbons are effective and each country will have its established formulae. Owing to the slight health hazard, operators should use face masks.

The materials of the furniture-restorer

These are mainly traditional, and animal glues, now available in a semi-liquid form, are still widely used. Polyvinyl-acetate emulsions are used to some extent, especially for attaching fabrics to wood. Epoxy resins, and the rapid-setting cyanoacrylate resin Eastman 910 have some applications. Ureaformaldehyde resins are also used to some extent not only for those applications in which animal glues are traditionally employed but also, compounded with inerts, as gap-filling cements. Cellulosic and rubber adhesives are available, under trade names, in all countries and find occasional applications for minor repair work, but should not be used for major work.

The Plates

WHEREVER possible, the best contemporary drawings of instruments have been used when compiling the following plates. These have been chosen, not primarily for their decorative value despite their very real artistic qualities, but because of their clarity and accuracy as practical documents.

We are aware of the difficulties that arise when an instrument has to be restored to its original condition for exhibition purposes or for playing. How, for example, are we to know the number of strings and the tuning of a bass-viol with five, six or seven pegs? How is a cittern to be strung? How should a flute be restored when the different parts do not hold together and the keys have deteriorated? What reeds are suitable for an eighteenth-century oboe or bassoon? What did the mouthpiece of a cornett look like? Far from considering them as negligible, it is such questions of detail that we have attempted to answer, dispensing with technical terms or scientific descriptions for the sake of simplicity, since this guide is not a treatise on organology.

We have deliberately excluded keyboard instruments: organs, harpsicords, spinets, clavicords. Their restoration must be entrusted to experts, and such indications as we might have given would have been too summary.

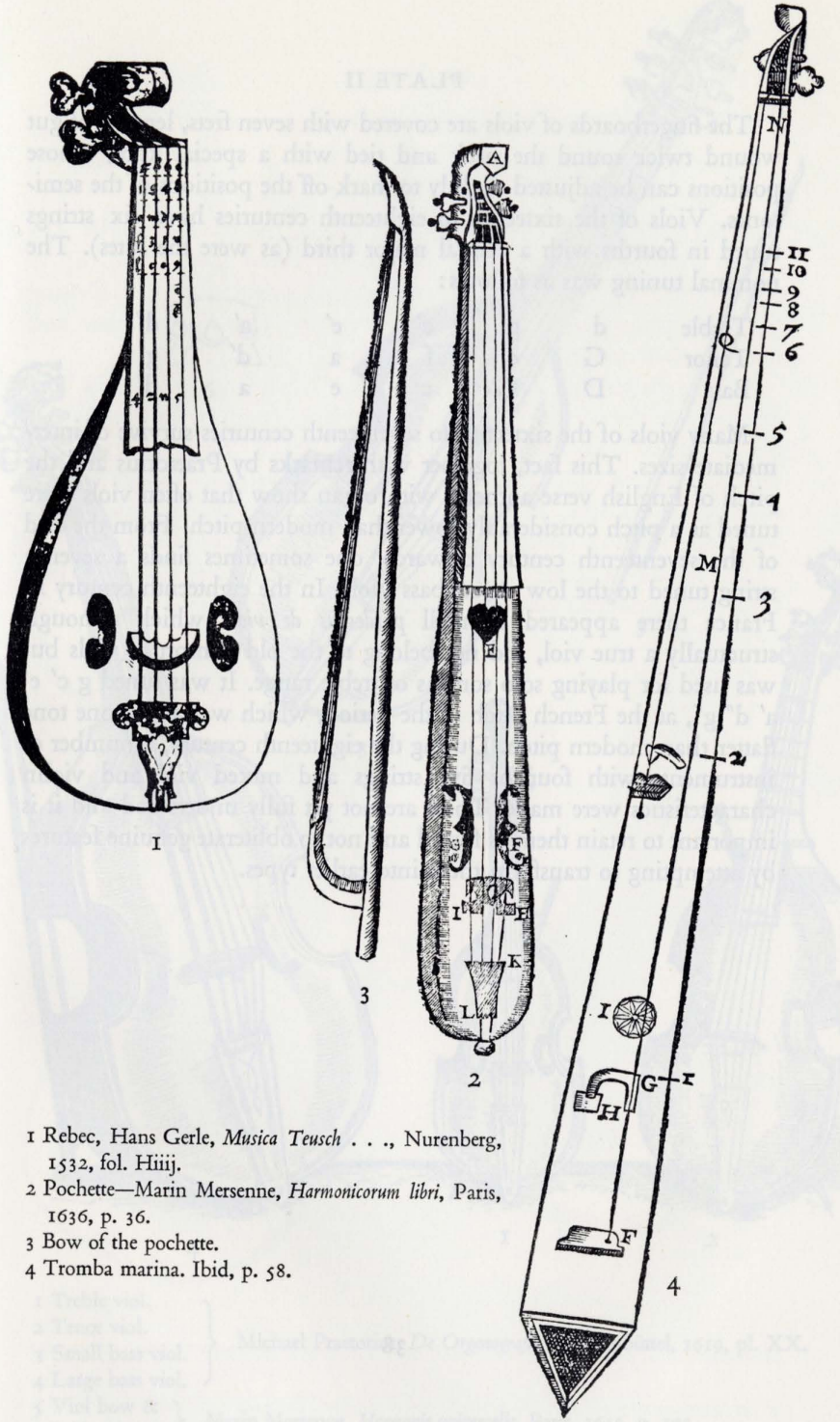
Neither have we included the family of violins, since it seemed to us unnecessary for an instrument in almost universal use, although there are many differences in construction between an eighteenth-century instrument in its original condition and a contemporary violin (see p. 10). On the other hand, it should be pointed out that in the seventeenth and eighteenth centuries there existed a tenor violin, intermediate between the viola and the 'cello, that might be mistaken by the uninitiated for a child's instrument. The same applies to a five-stringed 'cello of Bach's time. Lastly, we have not given illustrations of percussion instruments, the advice contained in the text seeming to us sufficient.

1. Instrument called *Geigleyn* (small fiddle) by Gerle (1532). The rebec was strung with gut and tuned in fifths and was one of the immediate ancestors of the violin but continued in use and developed into the pochette.

2. Pochette; so-called because it could be carried in the long pockets of outdoor coats, especially by dancing-masters who travelled from house to house. The later form with a neck and fingerboard like a full-size violin but a body like a miniature viol or violin was called a kit. The tuning of the pochettes used by Monteverdi in his *Orfeo* (1608) was an octave above that of the violin (see David D. Boyden: Monteverdi's *violini piccoli alla francise* and *viola de brazzo*). The tuning of the dancing-masters' kits was like that of the violin, the actual pitch depending on the string length.

3. The bow illustrated by Mersenne is longer than the usual pochette bow.

4. Mersenne has shown a tromba marina with the old Medieval body of triangular cross-section. The majority of instruments of the seventeenth and eighteenth centuries have hexagonal or semicircular cross-sections. The vibrating bridge is shown at G with one foot under the string resting on the belly and the other lightly resting on a plate H of ivory or glass.



1 Rebec, Hans Gerle, *Musica Teusch* . . ., Nurenberg, 1532, fol. Hiiij.
2 Pochette—Marin Mersenne, *Harmonicorum libri*, Paris, 1636, p. 36.
3 Bow of the pochette.
4 Tromba marina. Ibid, p. 58.

PLATE II

The fingerboards of viols are covered with seven frets, lengths of gut wound twice round the neck and tied with a special knot, whose positions can be adjusted slightly to mark off the positions of the semitones. Viols of the sixteenth to eighteenth centuries have six strings tuned in fourths with a central major third (as were the lutes). The nominal tuning was as follows:

Treble	d	g	c′	e′	a′	d″
Tenor	G	c	f	a	d′	g′
Bass	D	G	c	e	a	d′

Many viols of the sixteenth to seventeenth centuries survive of intermediate sizes. This fact, together with remarks by Praetorius and the pitch of English verse anthems with organ show that often viols were tuned at a pitch considerably lower than modern pitch. From the end of the seventeenth century onwards, one sometimes finds a seventh string tuned to the low A on bass viols. In the eighteenth century in France there appeared a small *pardessus de viole* which although structually a true viol, did not belong to the old consort of viols but was used for playing solo sonatas of treble range. It was tuned g c′ e′ a′ d″ g″, at the French pitch of the period, which was about one tone flatter than modern pitch. During the eighteenth century, a number of instruments with four or five strings and mixed viol and violin characteristics were made. These are not yet fully understood and it is important to retain them as found and not to obliterate genuine features by attempting to transform them into earlier types.

1 Treble viol.
2 Tenor viol.
3 Small bass viol.
4 Large bass viol.

} Michael Praetorius, *De Organografia*, Wolffenbüttel, 1619, pl. XX.

5 Viol bow &
6 Bridge

} Marin Mersenne, *Harmonie universelle*, Paris, 1636, p. 192.

PLATE III

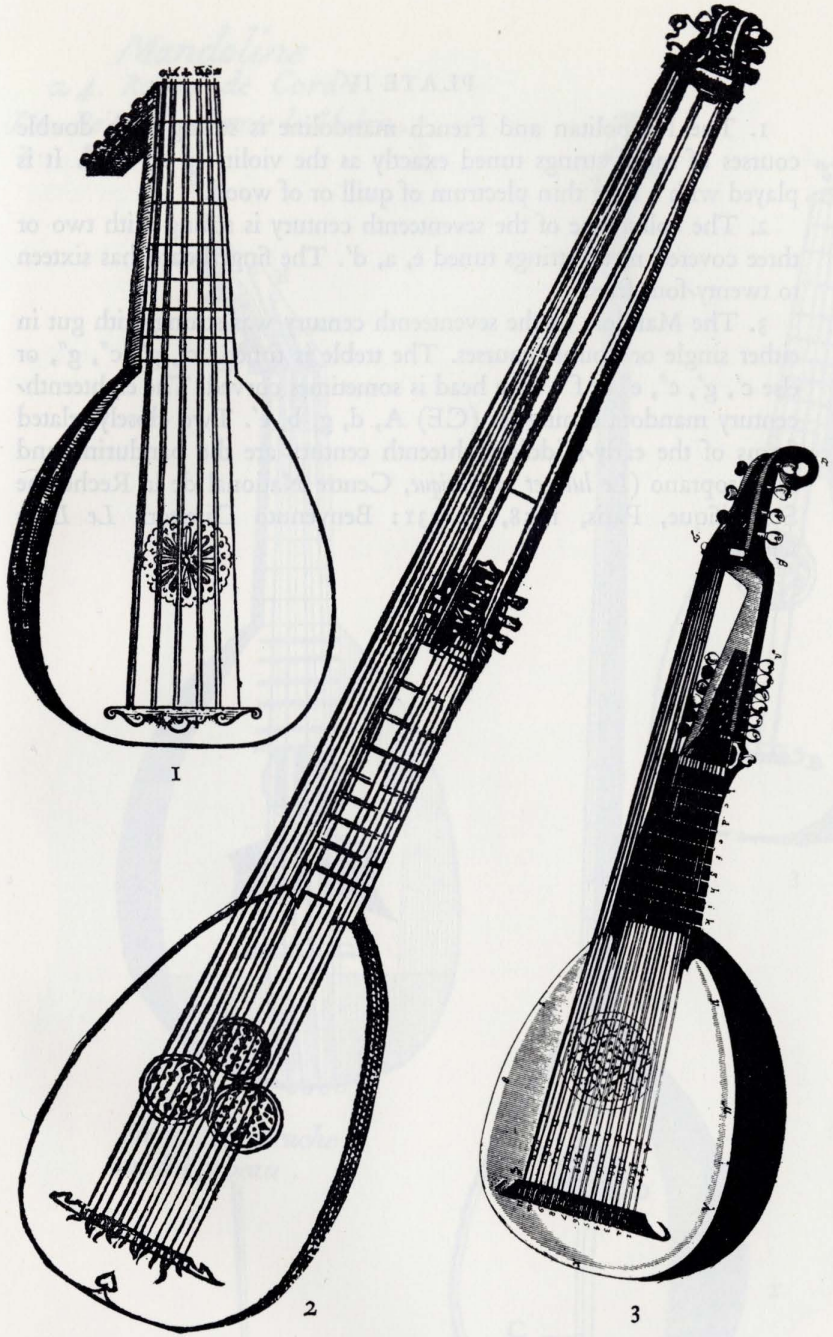
1. The lute of the sixteenth century is strung with gut as follows:

Small ("tenor") lute	G	c	f	a	d′	g′
Large ("bass") lute	D	G	c	e	a	d′

The highest course ("chanterelle") is single, the others double. The lowest three courses are strung in octaves. From about 1600, up to seven extra lower courses were added making a total of thirteen. During the same period the octave courses gave way to unison courses and many variable tunings were introduced.

2. The chitarrone (literally "large guitar") is a large lute with a long extension of the neck to give ample sounding length to the bass strings or "diapasons" which are of course only plucked "open", not stopped with the fingers. The fingered strings are generally in double courses tuned like the lute, the lower diapasons being tuned diatonically. Praetorius shows a chitarrone with single strings, usually of metal.

3. The tuning of the theorbo follows the same plan as that of the lute with unison courses and diatonic diapasons like the chitarrone.



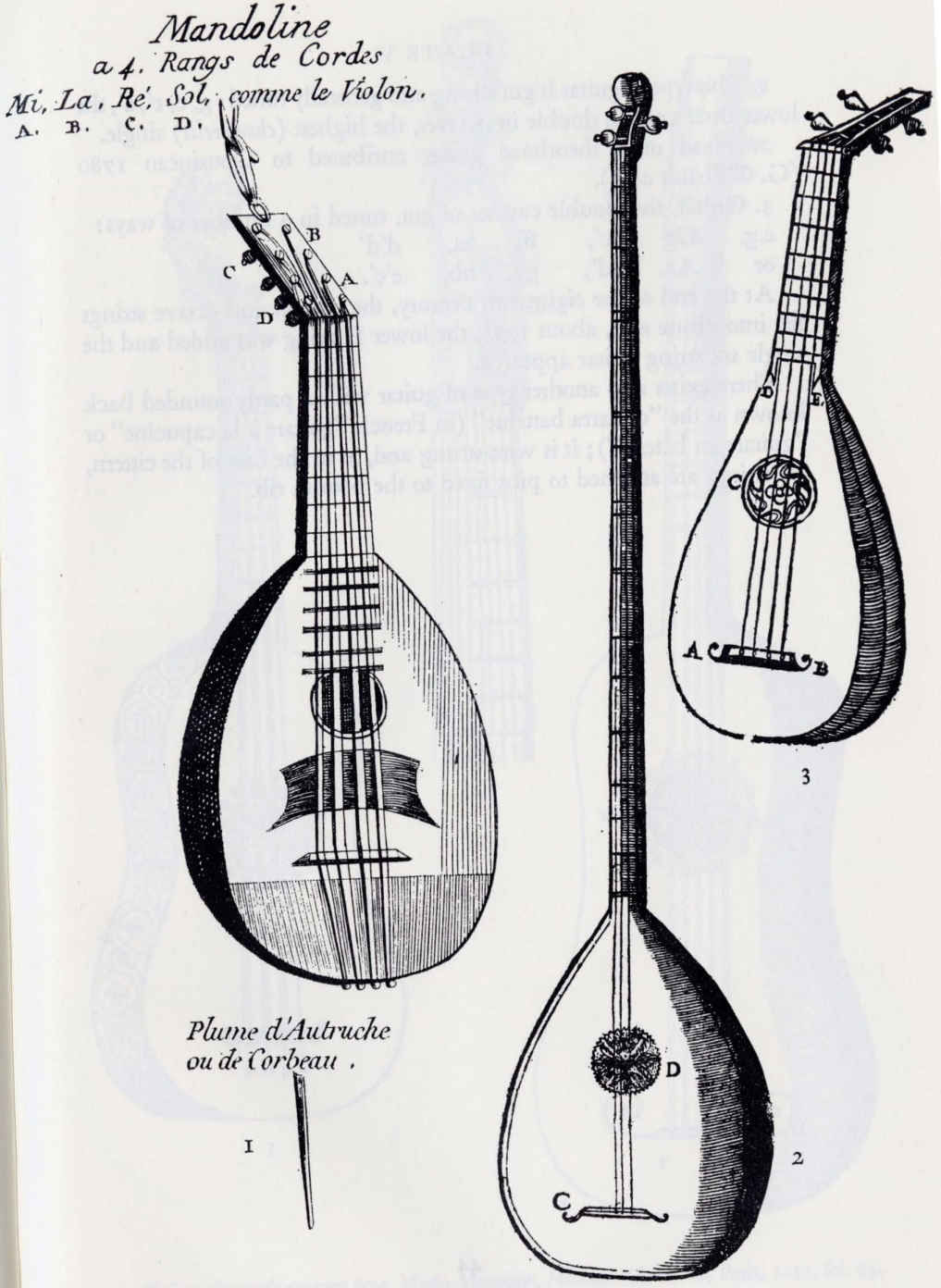
1 Six-course lute, sixteenth-century type. Marin Mersenne, *Harmonicorum libri,* Paris, 1636, p. 15.
2 Archlute or chitarrone. Michael Praetorius, *De Organografia*, Wolffenbüttel, 1619, pl. V.
3 Theorbo. Marin Mersenne, *Harmonie universelle,* Paris, 1636, p. 50.

PLATE IV

1. The Neapolitan and French mandoline is strung with double courses of metal strings tuned exactly as the violin: g d′ a′ e″. It is played with a long thin plectrum of quill or of wood.

2. The colascione of the seventeenth century is strung with two or three covered metal strings tuned e, a, d′. The fingerboard has sixteen to twenty-four frets.

3. The Mandora in the seventeenth century was strung with gut in either single or double courses. The treble is tuned: c′, g′, c″, g″, or else c′, g′, c″, e″ or f″. The head is sometimes curved. The eighteenth-century mandora tuning is: (CE) A, d, g, b, e′. Two closely related forms of the early-middle eighteenth century are the pandurina and liuto soprano (*Le luth et sa musique*, Centre National de la Recherche Scientifique, Paris, 1958, p. 231: Benvenuto Disertori, *Le Liuto soprano*.)



1 Mandoline, eighteenth century. Michel Corrette, *Nouvelle Méthode* . . . , Paris, p. 2.
2 Colachon. Marin Mersenne, *Harmonie universelle*, Paris, 1636, p. 99.
3 Mandora. Id., *Harmonicorum libri*, Paris, 1636, p. 26.

PLATE V

1. This type of guitar is gut strung and generally tuned: g, c, e′, a′, the lower three courses double in octaves, the highest (*chanterelle*) single.

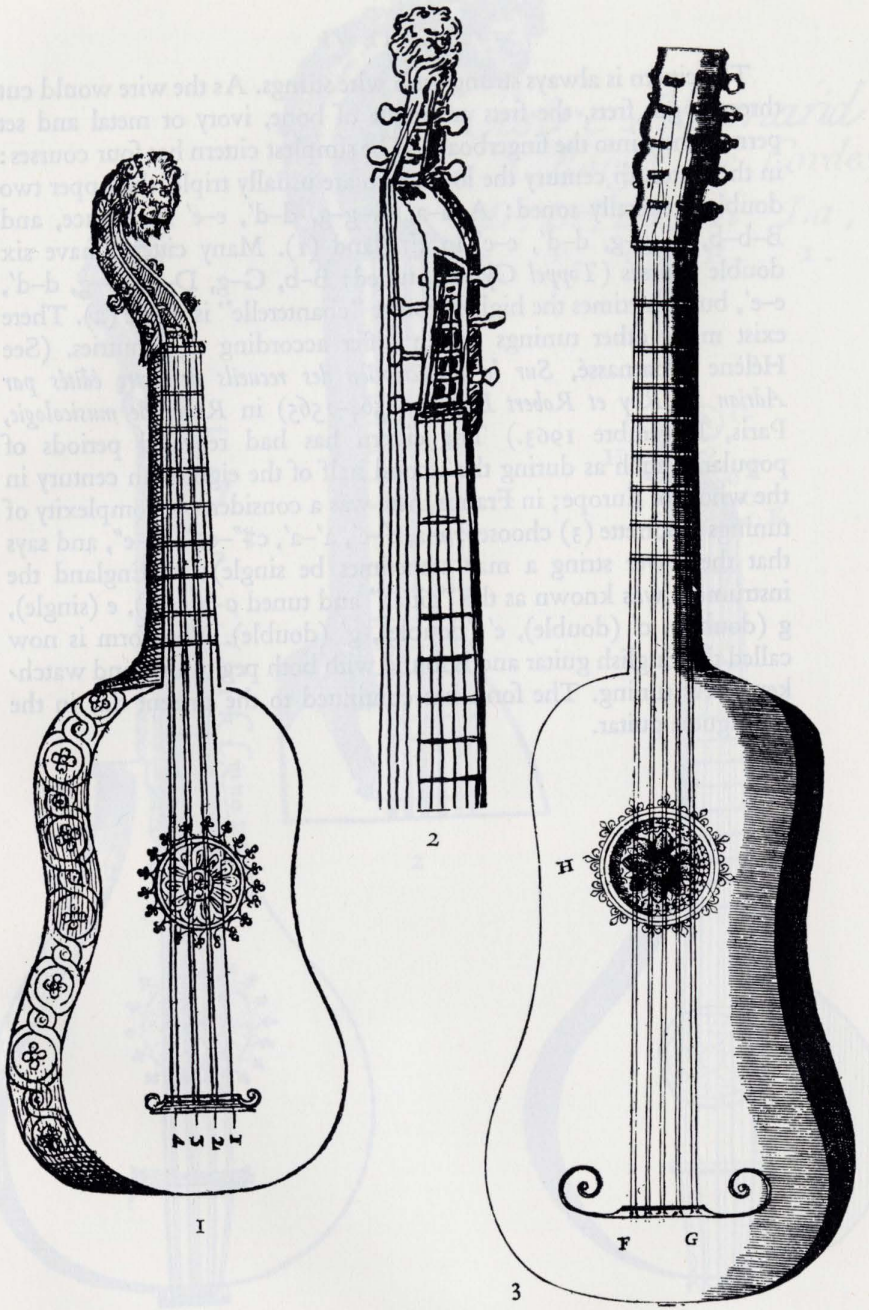
2. Head of a theorboed guitar attributed to Cousineau 1780 (G. Thibault coll.).

3. Guitar, five double courses of gut, tuned in a number of ways:

e.g. Gg cc′, ff, aa, d′d′
or Aa, dd′, gg, bb, e′e′.

At the end of the eighteenth century, the unison and octave strings fell into disuse and, about 1795, the lower E string was added and the single six string guitar appeared.

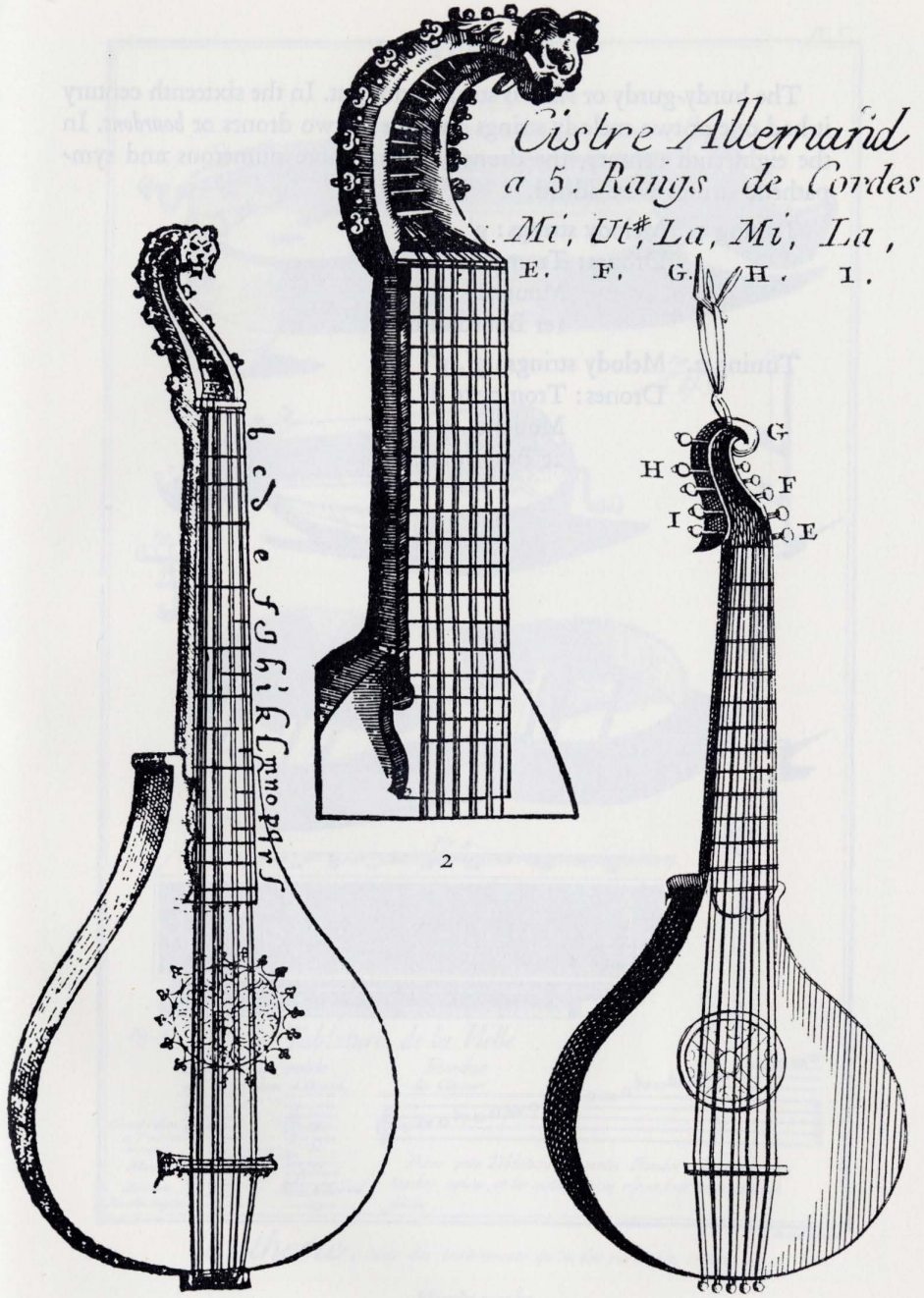
There exists also another type of guitar with a partly rounded back known as the "chitarra battente" (in French "guitare à la capucine" or "guitare en bâteau"); it is wire-strung and, as in the case of the cittern, the strings are attached to pins fixed to the bottom rib.



1 Guitar, sixteenth-century type. Marin Mersenne, *Harmonie Universelle,* Paris, 1636, fol. 95.
2 Head of a theorboed guitar, late eighteenth-century.
3 Guitar, seventeenth-century type. Marin Mersenne, Ibid, fol. 95vo.

PLATE VI

The cittern is always strung with wire strings. As the wire would cut through gut frets, the frets are made of bone, ivory or metal and set permanently into the fingerboard. The simplest cittern has four courses: in the sixteenth century the lower two are usually triple, the upper two double, generally toned: A–a–a, G–g–g, d–d′, e–e′ in France, and B–b–b, G–g–g, d–d′, e–e′ in England (1). Many citterns have six double courses (*Toppel Cythar*), tuned: B–b, G–g, D–d, G–g, d–d′, e–e′, but sometimes the highest course "chanterelle" is single (2). There exist many other tunings which differ according to countries. (See Hélène Charnassé, *Sur la transcription des recueils de cistre édités par Adrian Le Roy et Robert Ballard (1564–1565)* in *Revue de musicologie,* Paris, Décembre 1963.) The cittern has had repeated periods of popularity such as during the second half of the eighteenth century in the whole of Europe; in France there was a considerable complexity of tunings (Corrette (3) chooses: a–a, e′–e′, a′–a′, c♯″–c♯″, e″–e″, and says that the lower string a may sometimes be single); in England the instrument was known as the "gittar" and tuned c (single), e (single), g (double), c′ (double), e′ (double), g′ (double). This form is now called the English guitar and is found with both peg tuning and watch-key screw tuning. The form has continued to the present day in the Portuguese guitar.



1 2 3

Cittern

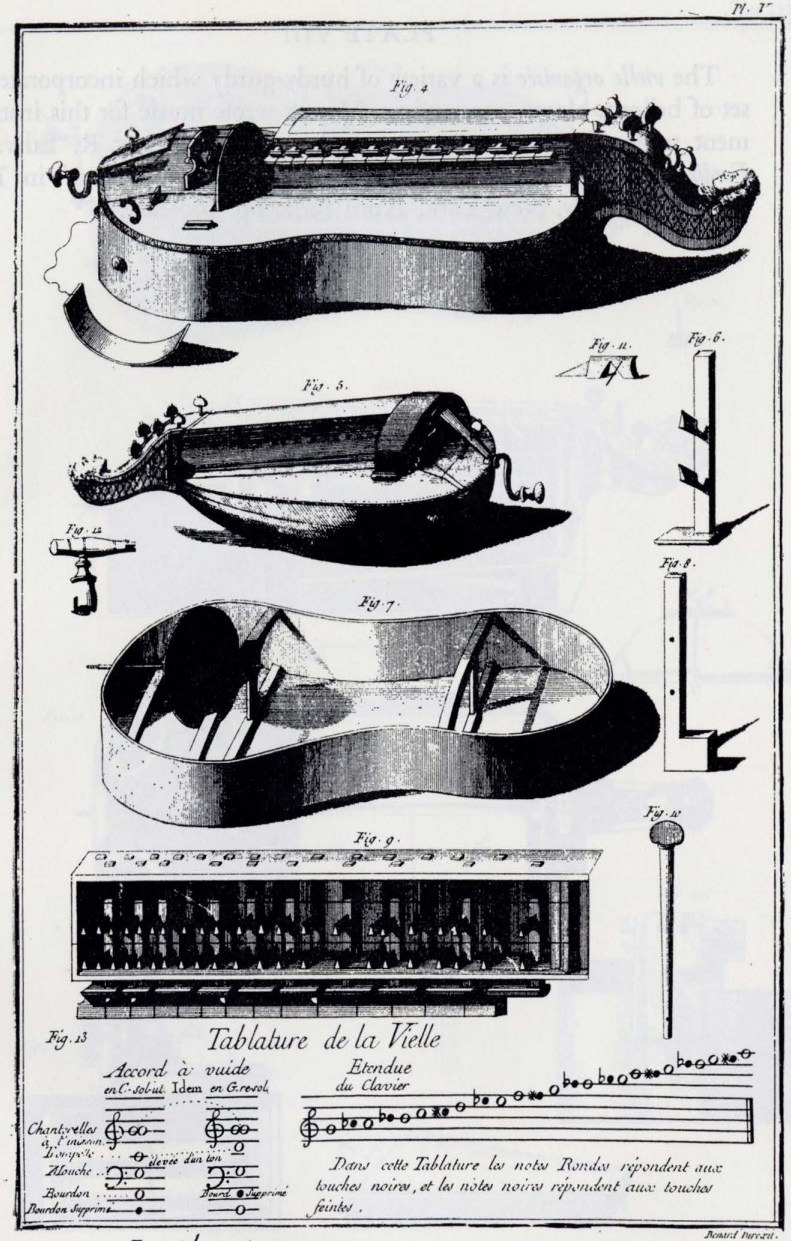
1 Adrian Le Roy, *Brève et facile instruction . . .*, Paris, 1565.
2 Sixt Kärgel, *Toppel Cythar*, Straszburg, 1578.
3 Michel Corrette, *Nouvelle Méthode . . .*, Paris, 1772, p. 2.

PLATE VII

The hurdy-gurdy or *vielle* is strung with gut. In the sixteenth century it had one or two melody strings and one or two drones or *bourdons*. In the eighteenth century, the drones became more numerous and sympathetic strings were added.

Tuning 1. Melody strings: g′, g′.
Drones: Trompette c′
Mouche g
1er Bourdon c

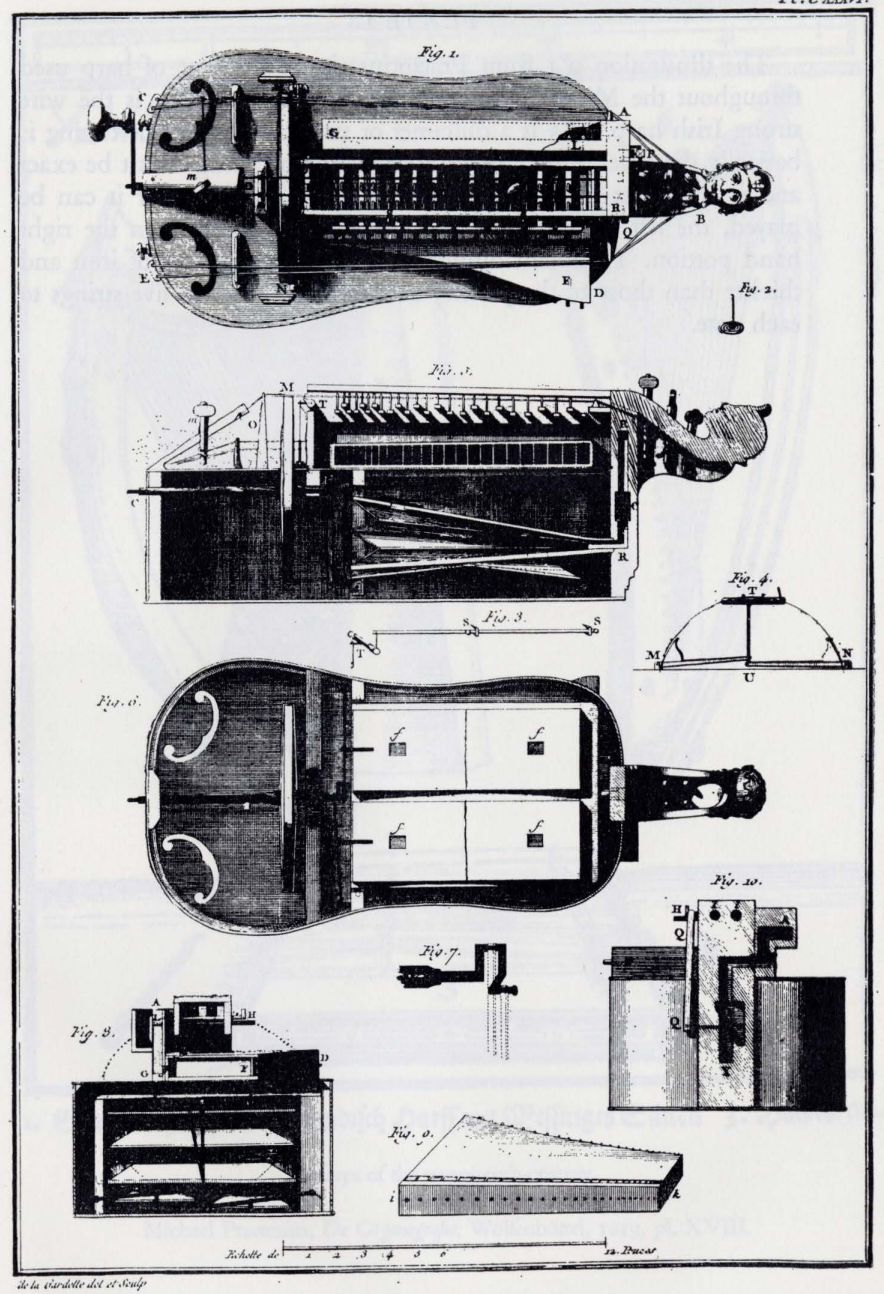
Tuning 2. Melody strings: g′, g′.
Drones: Trompette d′
Mouche g
2e Bourdon G



Hurdy-gurdy
D'Alembert et Diderot, *L'Encyclopédie . . .*, Paris, 1751–1778, Seconde suite, pl. V.

PLATE VIII

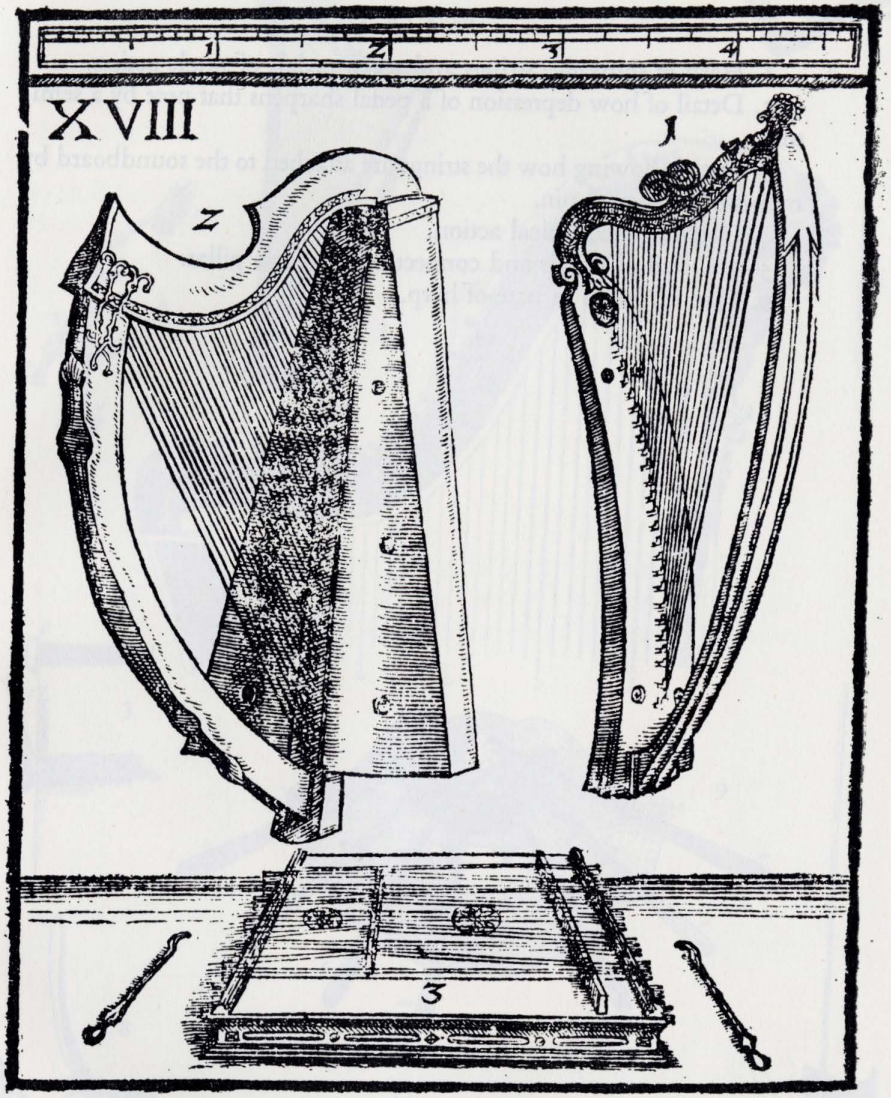
The *vielle organisée* is a variety of hurdy-gurdy which incorporates a set of bellows-blown organ pipes. Haydn wrote music for this instrument under the name of *Lyra organizzata*. (See Harry R. Edwall, *Ferdinand IV and Haydn's Concertos for the "Lyra Organizzata"* in *The Musical Quarterly*, New York, April 1962, pp. 190–203.)



Vielle organisée
Dom Bedos de Celles, *L'Art du Facteur d'Orgues*, 1776–1778, pl. CXXXVI.

PLATE IX

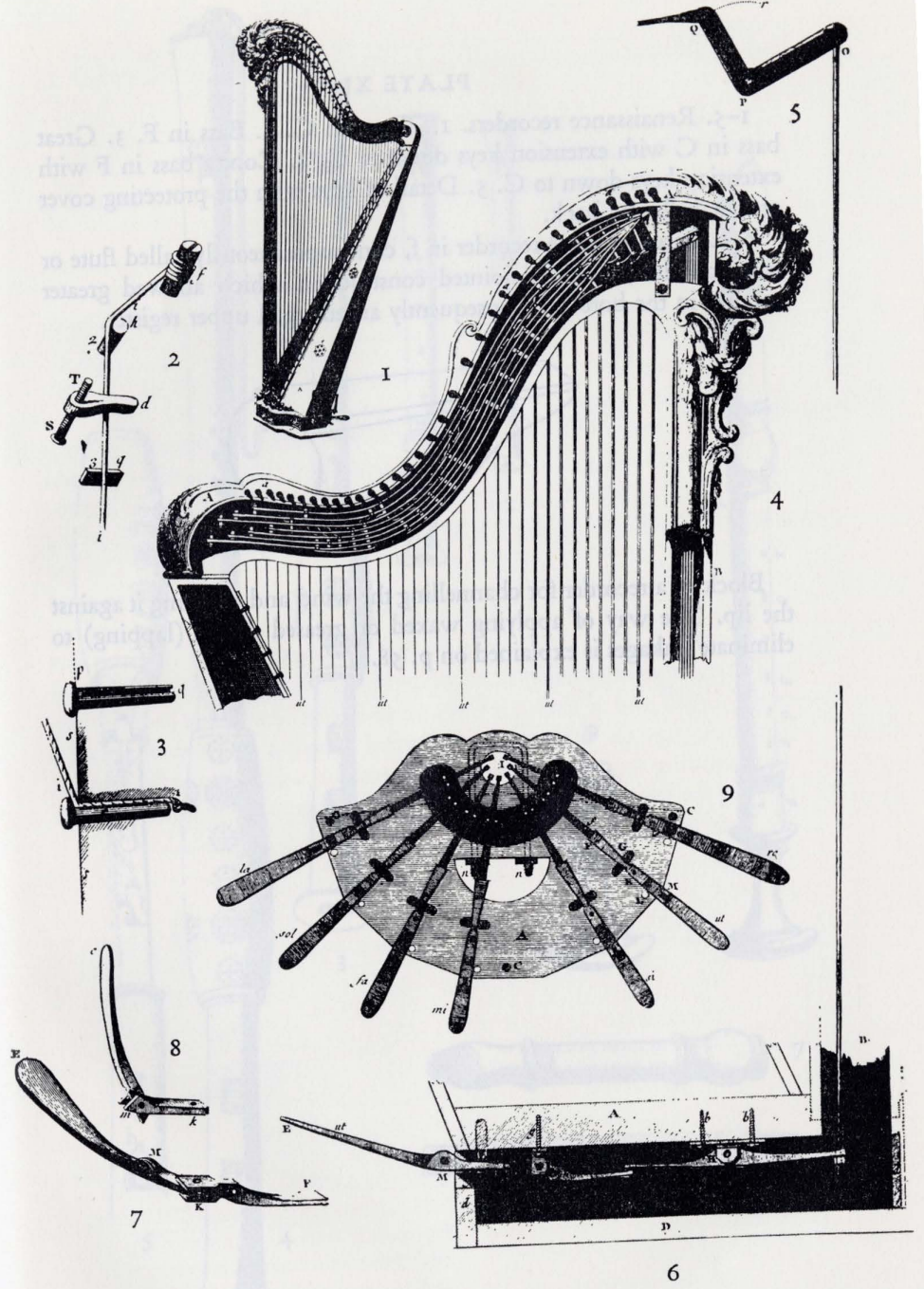
The illustration n°1 from Praetorius shows the type of harp used throughout the Middle Ages and the Renaissance. N°2 is the wire strung Irish harp. N°3 is a dulcimer or struck psaltery. The tuning is basically diatonic. The position of the left hand bridge must be exact and is such that both portions of the strings passing over it can be played, the left hand portion sounding a fifth higher than the right hand portion. To obtain fullness of tone the strings are of iron and thicker than those of the psaltery and there are three to five strings to each note.



Harps of the seventeenth-century
Dulcimer
Michael Praetorius, *De Organografia,* Wolfenbüttel, 1619, pl. XVIII.

PLATE X

1. Harp of thirty-five strings and seven pedals of single action.
2. Detail of how depression of a pedal sharpens that note by a semitone.
3. Detail showing how the strings are attached to the soundboard by means of a grooved pin.
4. Detail of mechanical action.
5–8. Detail of pedals and connections through pillar.
9. Plan of pedals in base of harp.

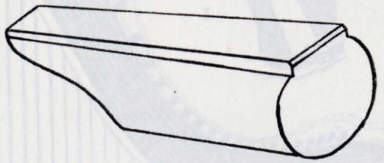


Harp of the eighteenth-century

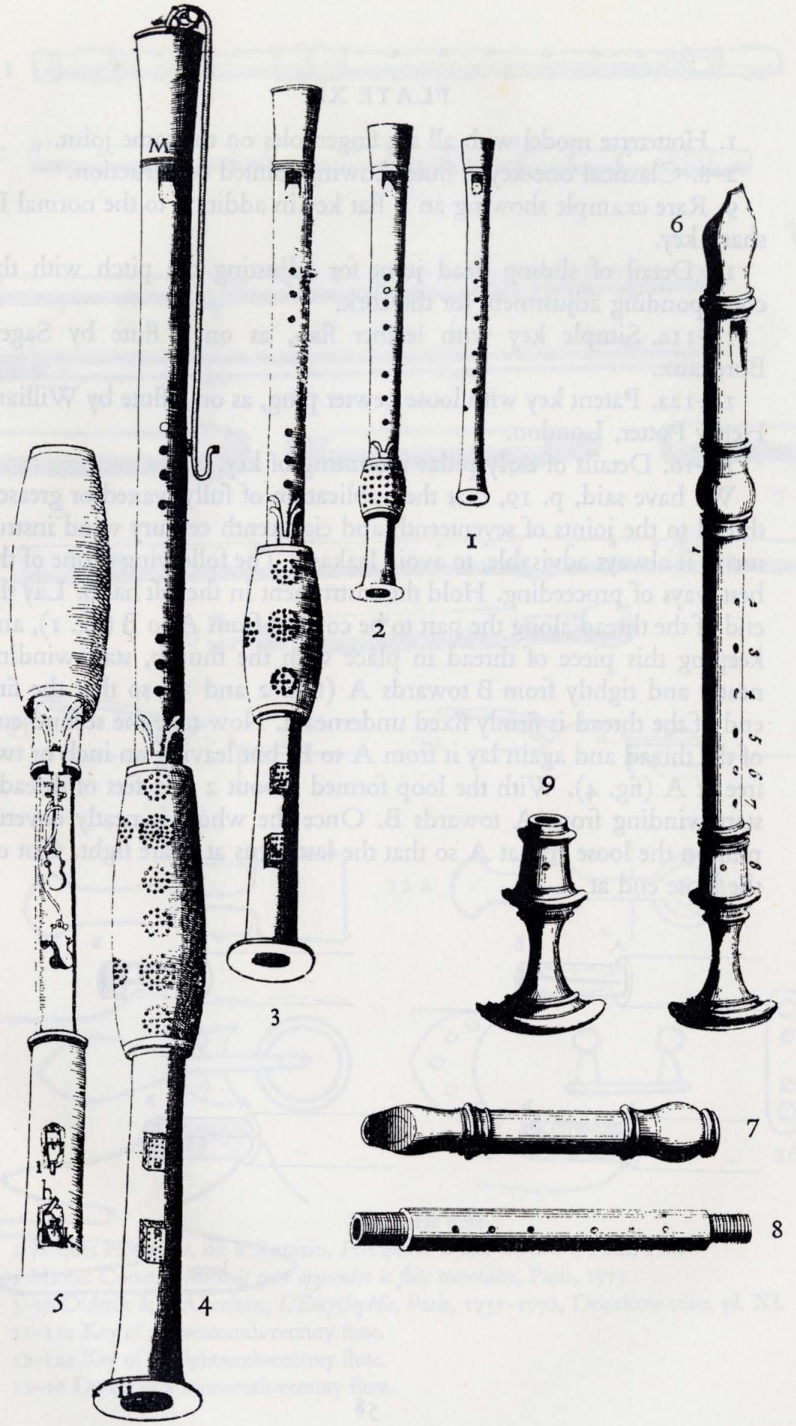
Diderot et d'Alembert, *L'Encyclopédie . . .*, Paris, 1751–1778, Seconde suite, pl. XIX–XX–XXI.

1–5. Renaissance recorders. 1. Tenor in C. 2. Bass in F. 3. Great bass in C with extension keys down to G. 4. Contra bass in F with extension keys down to C. 5. Detail of keys with the protecting cover or fontanelle slid back.

6–9. Baroque treble recorder in f, contemporaneously called flute or common flute, showing jointed construction which allowed greater subtlety in the bore and consequently an enlarged upper register.



Block of a recorder for channelling the wind and directing it against the lip. The way of applying waxed or greased thread (lapping) to eliminate leakages is explained on p. 58.



Recorder

1 Tenor. 2 Bass. 3 Great bass. 4 Contra bass. 5 Detail of the keys. Marin Mersenne, *Harmonie Universelle*, Paris, 1636, p. 239.

6 Treble recorder. 7 Head. 8 Body. 9 Foot-joint. Diderot & d'Alembert, *La grande Encyclopédie*, suppl. pl. 4.

PLATE XII

1. Hotteterre model with all six fingerholes on the same joint.

2–8. Classical one-keyed flute showing jointed construction.

9. Rare example showing an E flat key in addition to the normal D sharp key.

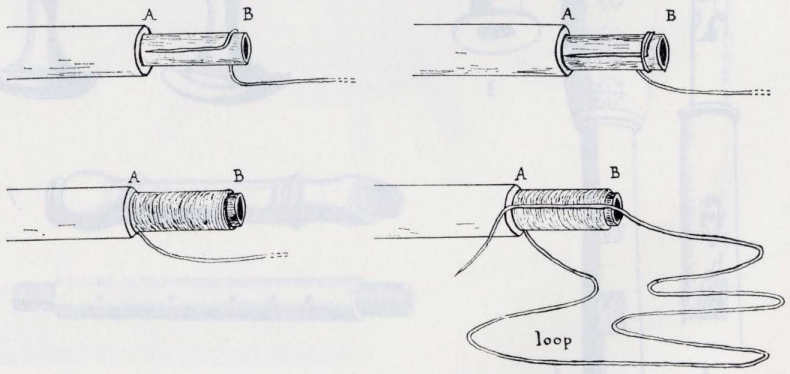
10. Detail of sliding head joint for adjusting the pitch with the corresponding adjustment for the cork.

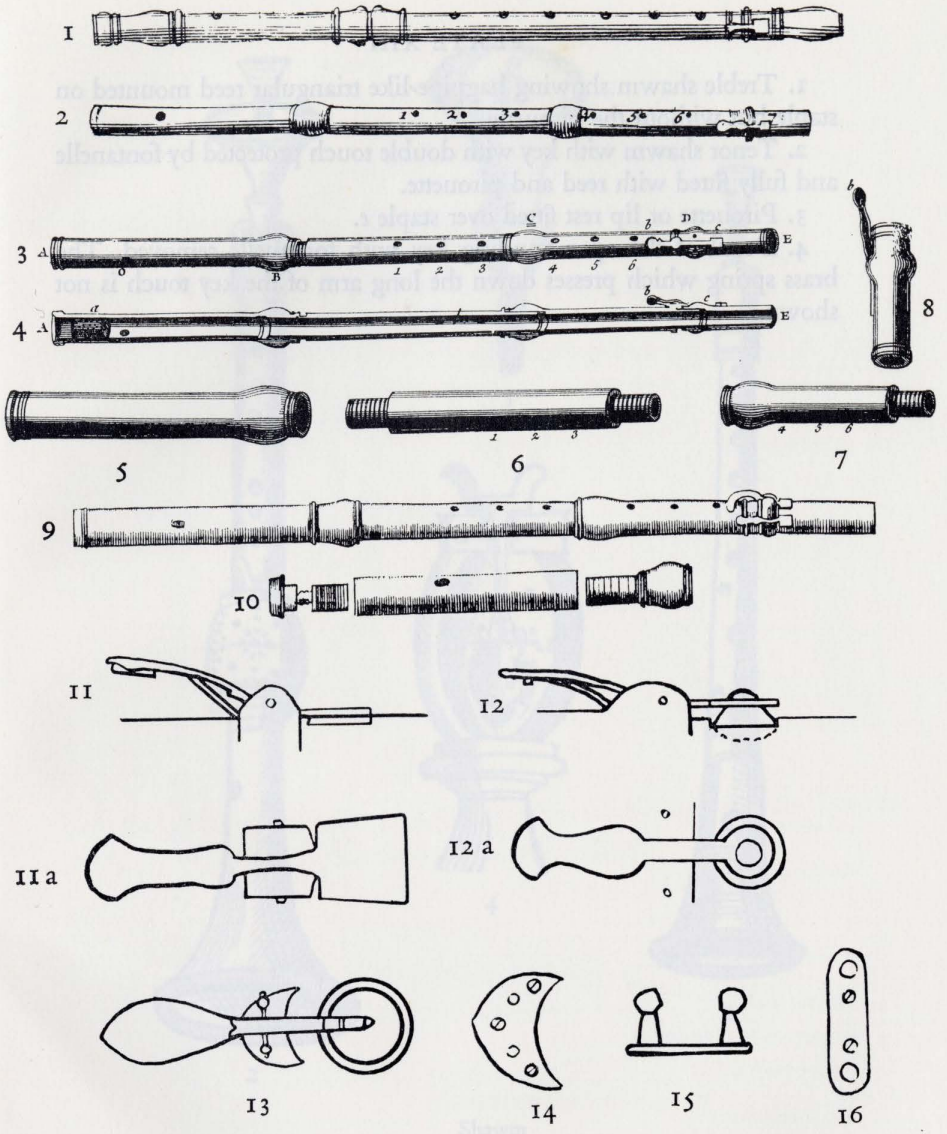
11–11a. Simple key with leather flap, as on a flute by Saget, Bordeaux.

12–12a. Patent key with loose pewter plug, as on a flute by William Henry Potter, London.

13–16. Details of early pillar mounting of key.

We have said, p. 19, that the application of fully waxed or greased thread to the joints of seventeenth and eighteenth century wind instruments is always advisable, to avoid leakage. The following is one of the best ways of proceeding. Hold the instrument in the left hand. Lay the end of the thread along the part to be covered from A to B (fig. 1), and keeping this piece of thread in place with the thumb, start winding neatly and tightly from B towards A (figs. 2 and 3), so that the first end of the thread is firmly fixed underneath. Now take the second end of the thread and again lay it from A to B, but leaving an inch or two free at A (fig. 4). With the loop formed (about 2 or 3 feet of thread), start winding from A towards B. Once the whole is neatly covered pull on the loose end at A so that the last turns at B are tight. Cut off the loose end at A.





Transverse flute

1 Jacques Hotteterre, dit le Romain, *Principes de la flûte traversière,* Paris, 1707.

2 Michel Corrette, *Méthode pour apprendre la flûte traversière,* Paris, 1773.

3–10 Diderot & d'Alembert, *L'Encyclopédie,* Paris, 1751–1778, Deuxième suite, pl. XI.

11–11a Key of a seventeenth-century flute.

12–12a Key of an eighteenth-century flute.

13–16 Details of a nineteenth-century flute.

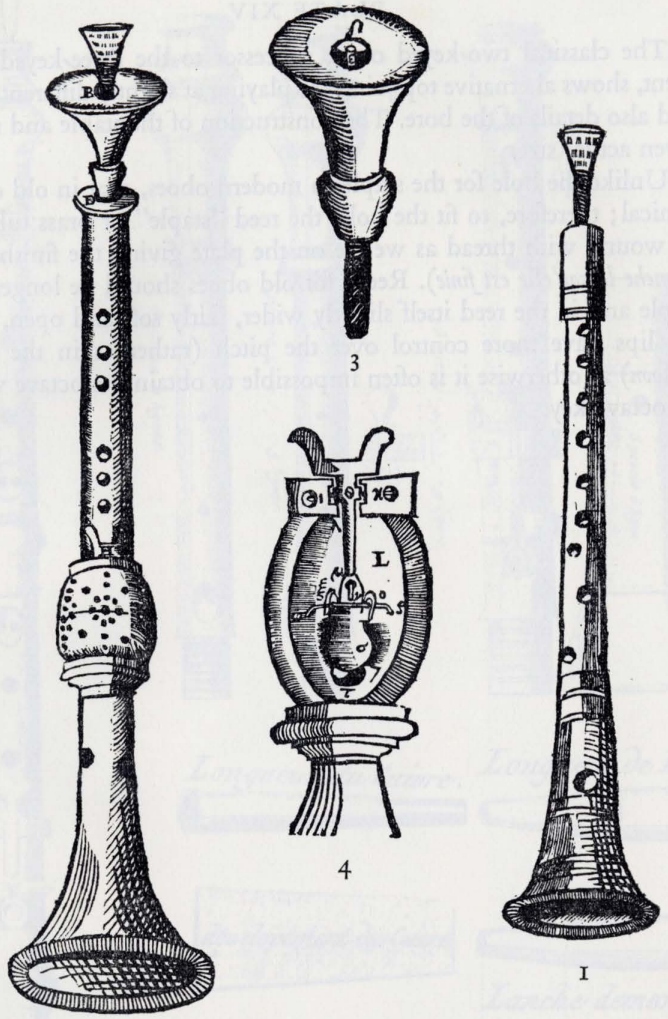
PLATE XIII

1. Treble shawm showing bagpipe-like triangular reed mounted on staple but without the pirouette.

2. Tenor shawm with key with double touch protected by fontanelle and fully fitted with reed and pirouette.

3. Pirouette or lip rest fitted over staple *e*.

4. Detail of the open-standing key with fontanelle removed. The brass spring which presses down the long arm of the key touch is not shown.



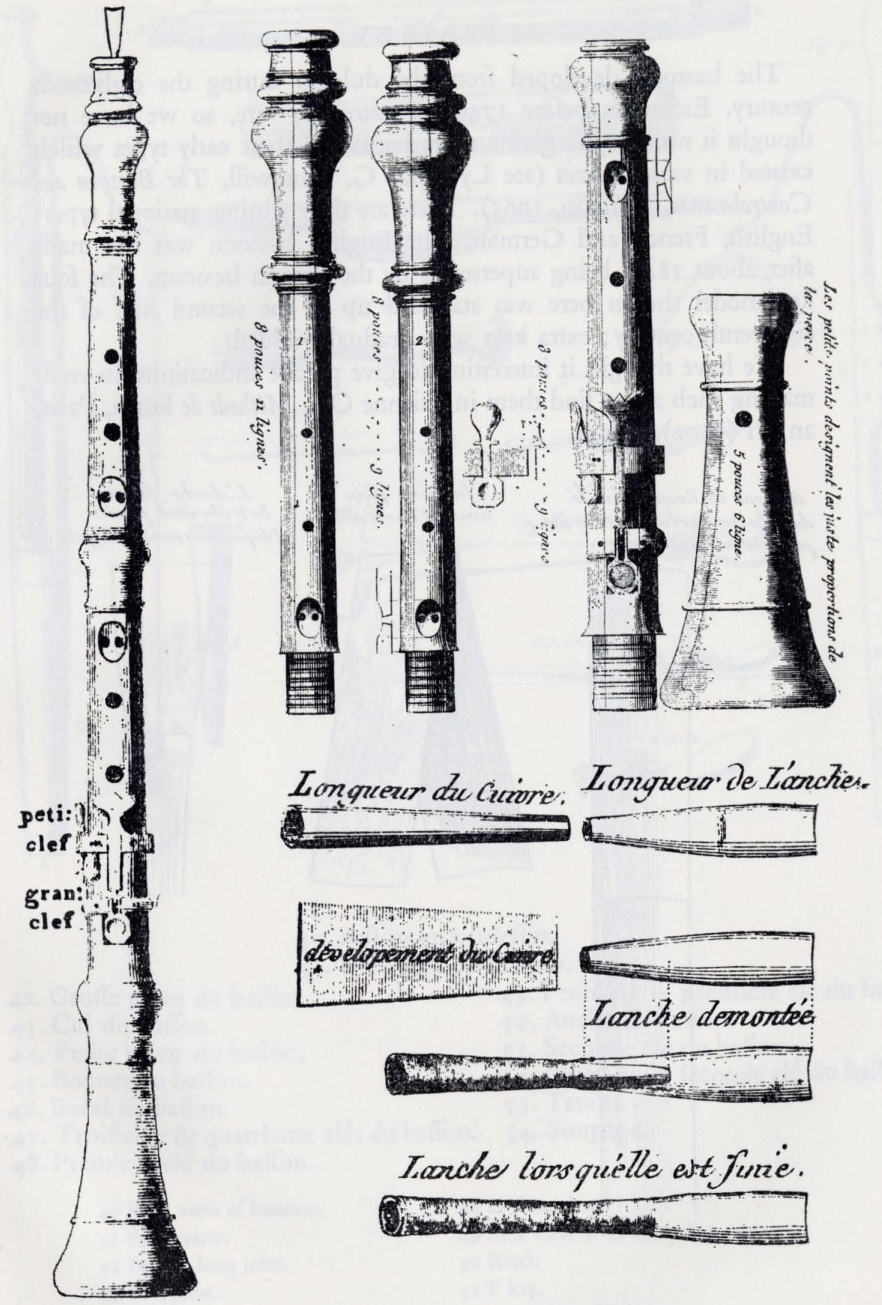
Shawm

1 Treble. 2 Tenor. 3 "Pirouette". 4 Detail of the key.
Marin Mersenne, *Harmonicorum Libre,* Paris, 1636, p. 84.

PLATE XIV

The classical two-keyed oboe, successor to the three-keyed instrument, shows alternative top joints for playing at slightly different pitches and also details of the bore. The construction of the staple and reed are given actual size.

Unlike the hole for the staple in modern oboes, that in old oboes is conical; therefore, to fit the hole, the reed "staple" or brass tube must be wound with thread as we see on the plate giving the finished reed (*l'anche lorsqu'elle est finie*). Reeds for old oboes should be longer in the staple and in the reed itself slightly wider, fairly soft and open, so that the lips have more control over the pitch (rather as in the French *bassoon*) as otherwise it is often impossible to obtain the octave without an octave key.



Eighteenth-century oboe
François Garnier, *Méthode raisonnée pour le hautbois,* Paris, ca. 1800, p. 12.

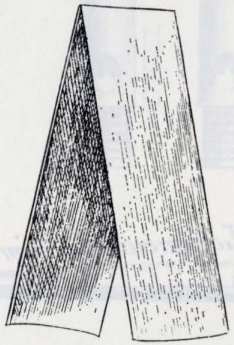
PLATE XV

The bassoon developed from the dulcian during the eighteenth century. Examples before 1740 are extremely rare, so we have not thought it necessary to give a reproduction of these early types which existed in various sizes (see Lyndesay G. Langwill, *The Bassoon and Contrabassoon*, London, 1965). There are three distinct national types: English, French and German. The English bassoon was not made after about 1845, being superseded by the French bassoon. The four key model shown here was standard up to the second half of the eighteenth century; extra keys were gradually added.

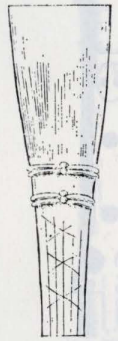
We have thought it interesting to give precise indications on reed-making such as we find them in Etienne Ozi, *Méthode de basson*, Paris, an XI (1802), p. 144.

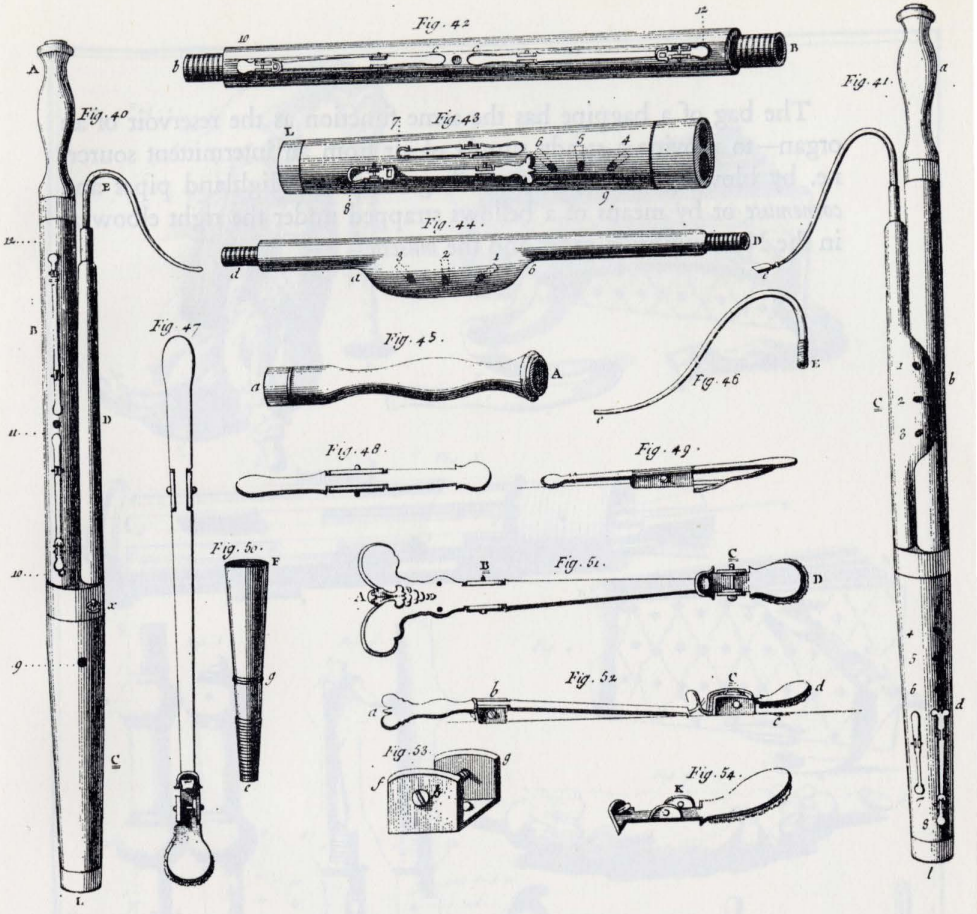
Morceau de Roseau évidé dans les proportions prescrites pour établir une Anche.

Le même ployé avant d'être taillé



L'Anche formée les brides étant placées et disposées à recevoir la Ligature.





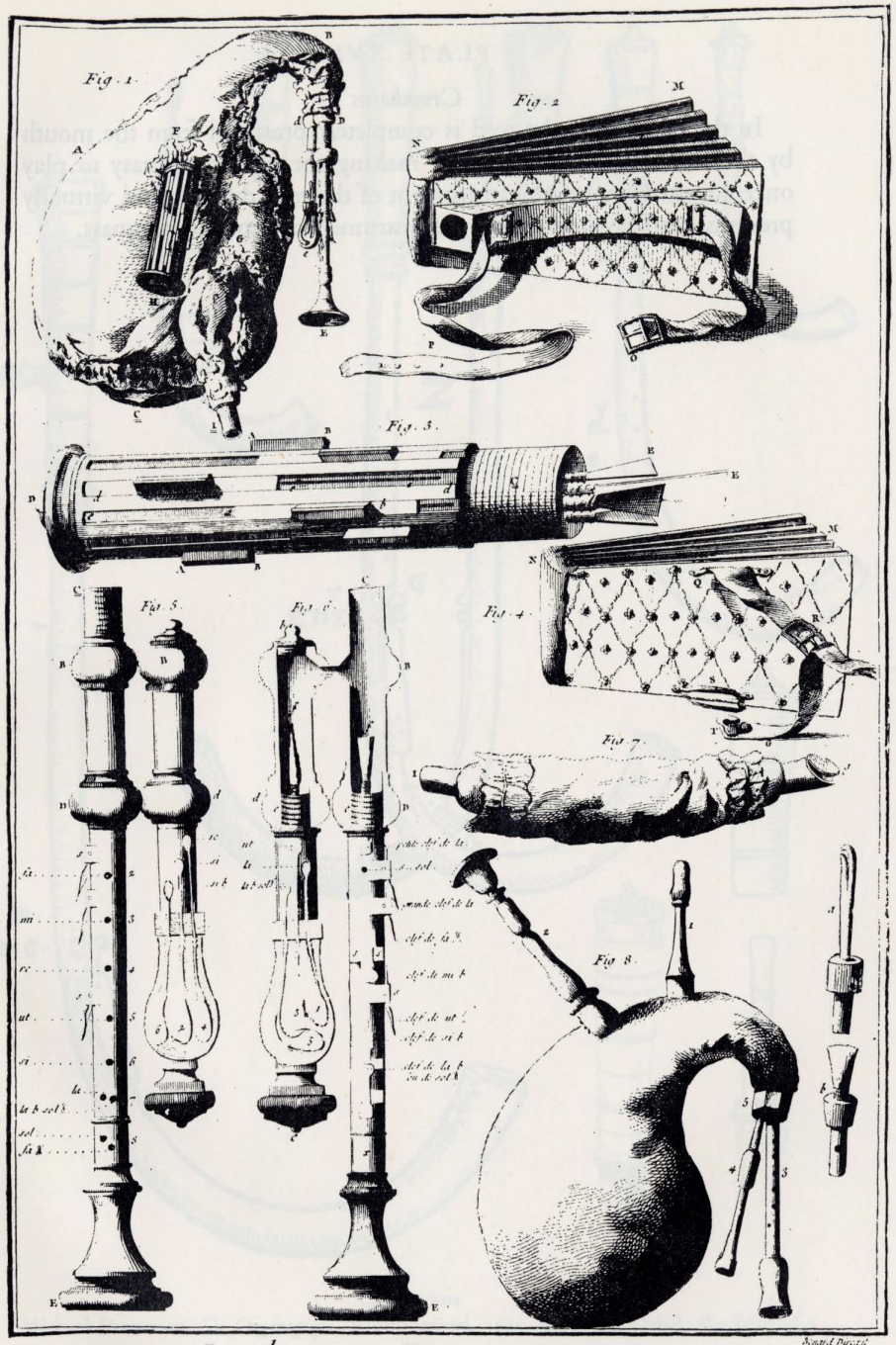
40. Baſſon vu pardeſſus.
41. Baſſon vu pardeſſous.
42. Groſſe piece du baſſon.
43. Cul du baſſon.
44. Petite piece du baſſon.
45. Bonnet du baſſon.
46. Bocal du baſſon.
47. Troiſieme & quatrieme clés du baſſon.
48. Premiere clé du baſſon.
49. Profil de la premiere clé du baſſon.
50. Anche du baſſon.
51. Seconde clé du baſſon.
52. Profil de la ſeconde clé du baſſon.
53. Tenon.
54. Soupape.

40 Back view of bassoon.
41 Front view.
42 Bass or long joint.
43 Butt joint.
44 Wing or tenor joint.
45 Bell.
46 Crook.
47 D and BB flat keys.
48 G sharp key.
49 Side view of G sharp key.
50 Reed.
51 F key.
52 Side view of F key.
53 Key saddle.
54 Key flap of open key.

Diderot & d'Alembert, *L'Encyclopédie . . .*, Paris, 1751–1778, p. 3, Deuxième suite, pl. IX.

PLATE XVI

The bag of a bagpipe has the same function as the reservoir of an organ—to provide a steady supply of air from an intermittent source, i.e. by blowing directly into the bag as in the Highland pipes and *cornemuse* or by means of a bellows strapped under the right elbow as in the Northumbrian pipes and the *musette*.



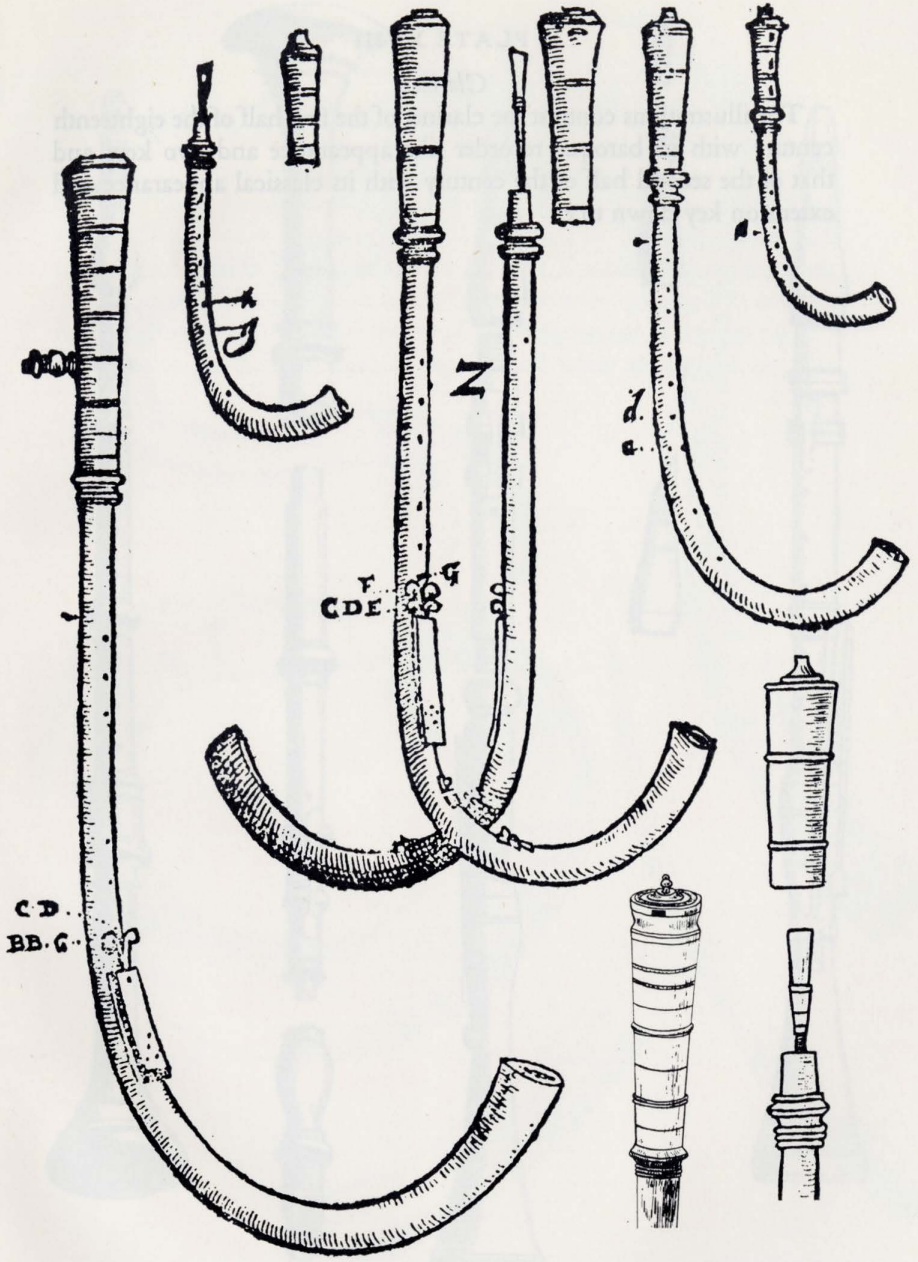
Lutherie, *Instruments à vent: Musette. Cornemuse.*

Musette and Cornemuse (Bagpipe family)
Diderot & d'Alembert, *L'Encyclopédie . . .*, Paris, 1751–1778, Deuxième suite, pl. VI.

PLATE XVII

Crumhorns

In the crumhorn, the reed is completely protected from the mouth by the reed cap. This, although making the instrument easy to play once adjusted, makes the adjustment of the reed difficult and virtually prevents overblowing, giving the instrument a restricted compass.



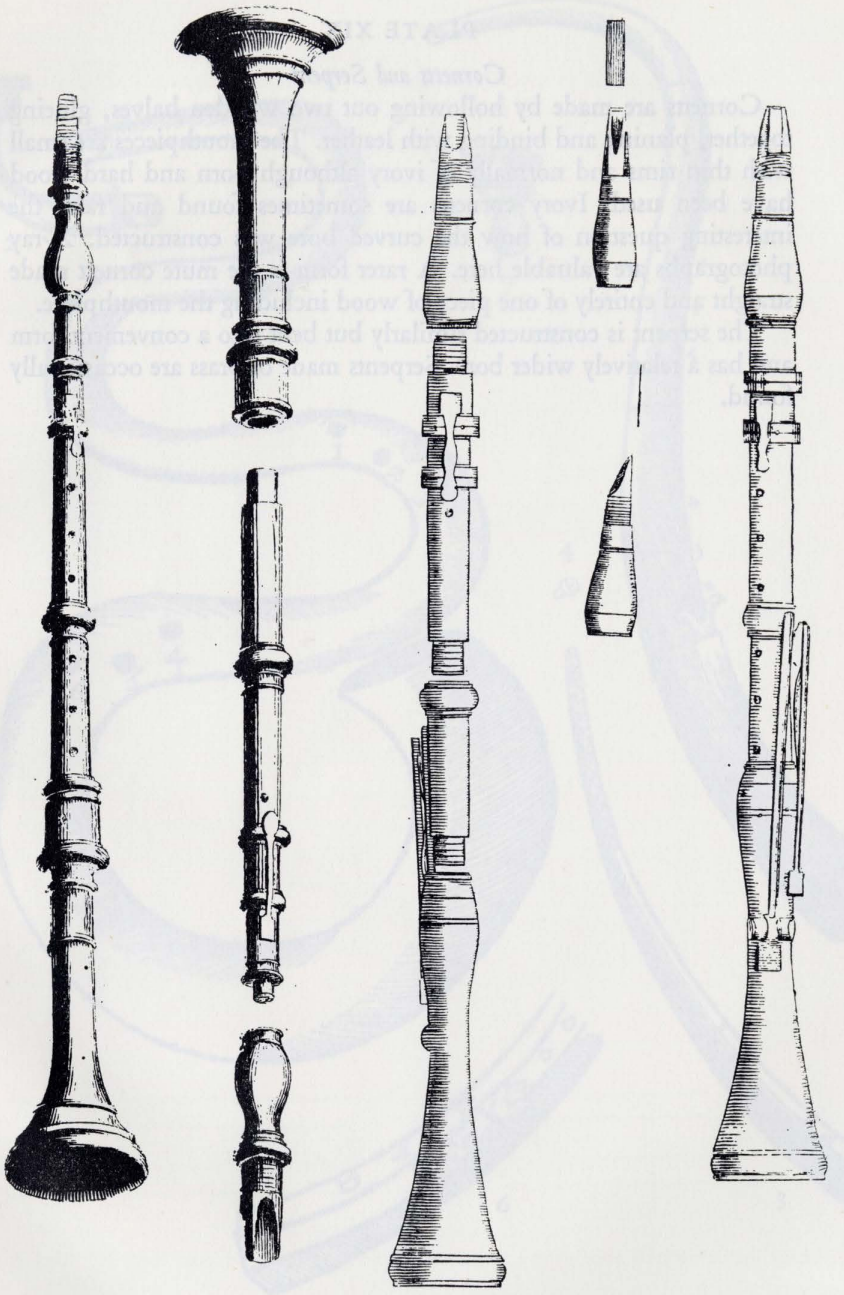
Crumhorns

Michael Praetorius, *De Organografia*, Wolffenbüttel, 1619, pl. XIII. Detail: the head of a tenor cromorne.

PLATE XVIII

Clarinets

The illustrations contrast the clarinet of the first half of the eighteenth century with its baroque recorder like appearance and two keys and that of the second half of the century with its classical appearance and extension key down to *e*.



Clarinet, eighteenth-century types

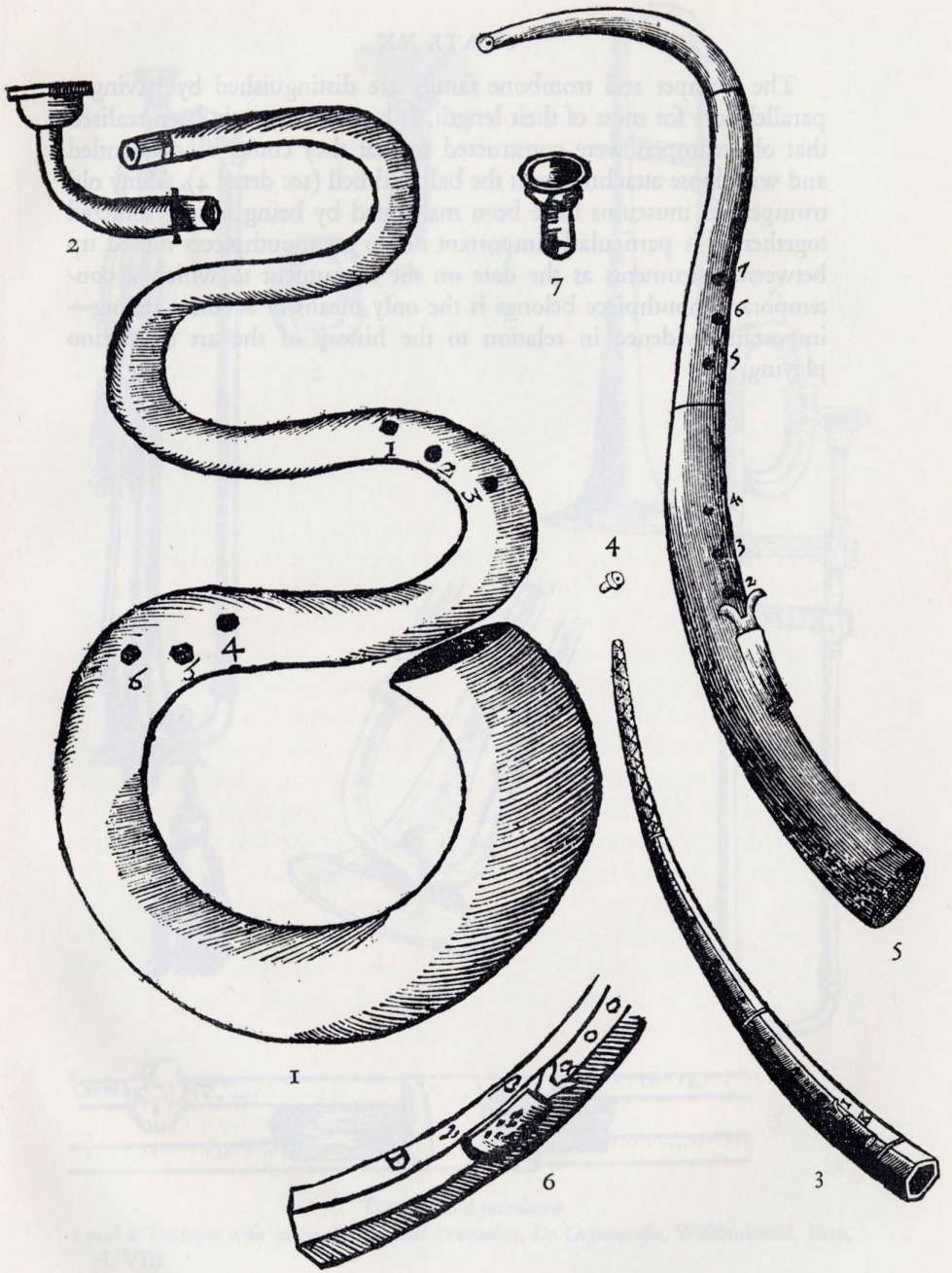
Diderot & d'Alembert, *L'Encyclopédie* . . ., Paris, 1751–1778, Deuxième suite, pl. VIII; supplément, pl. 4.

PLATE XIX

Cornetts and Serpent

Cornetts are made by hollowing out two wooden halves, glueing together, planing and binding with leather. The mouthpieces are small with thin rims and normally of ivory although horn and hard wood have been used. Ivory cornetts are sometimes found and raise the interesting question of how the curved bore was constructed. X-ray photographs are valuable here. A rarer form is the mute cornett made straight and entirely of one piece of wood including the mouthpiece.

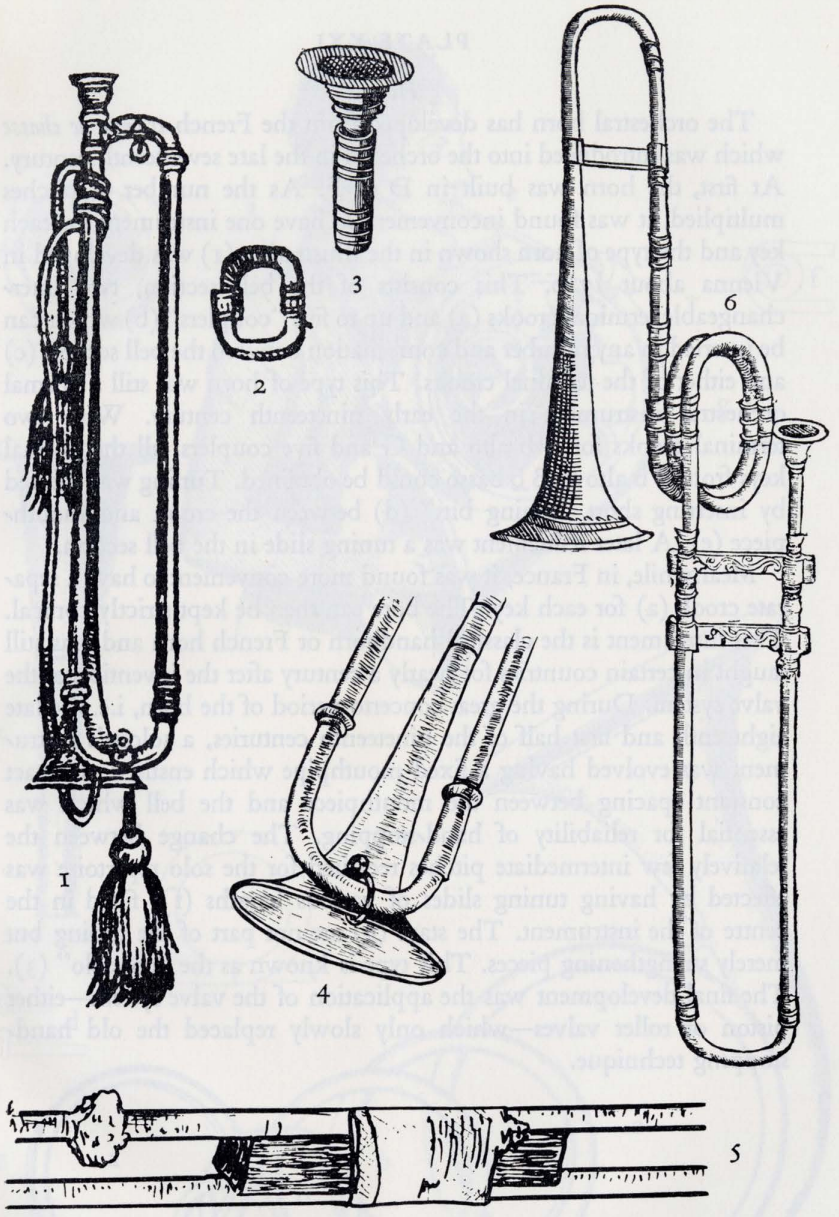
The serpent is constructed similarly but bent into a convenient form and has a relatively wider bore. Serpents made of brass are occasionally found.



Cornetts and Serpent
Marin Mersenne, *Harmonicorum libre*, Paris, 1636.
1–2, p. 101. 3–4–5, p. 99. 6–7, p. 98.

PLATE XX

The trumpet and trombone family are distinguished by having a parallel bore for most of their length. It has only recently been realised that old trumpets were constructed so that they could be dismantled and with loose attachments at the ball and bell (see detail 4). Many old trumpets in museums have been maltreated by being rigidly soldered together. It is particularly important not to get mouthpieces mixed up between instruments as the date on the instrument to which a contemporary mouthpiece belongs is the only means of accurate dating—important evidence in relation to the history of the art of clarino playing.



Trumpet and trombone

1 and 2 Trumpet with its crook, Michael Praetorius, *De Organografia,* Wolffenbüttel, 1619, pl. VIII.

3 Mouthpiece of a trumpet, Marin Mersenne, *Harmonie Universelle*, Paris, 1636, p. 248.

4 Detail of the bell.

5 Detail of the wood block.

6 Trombone, Marin Mersenne, *Harmonicorum libre,* Paris, 1636.

PLATE XXI

Horn

The orchestral horn has developed from the French *trompe de chasse* which was introduced into the orchestra in the late seventeenth century. At first, the horn was built in D or F. As the number of pitches multiplied, it was found inconvenient to have one instrument for each key and the type of horn shown in the illustration (1) was developed in Vienna about 1720. This consists of the bell section, two interchangeable terminal crooks (a) and up to five "couplers" (b) which can be inserted in any number and combination between the bell section (c) and either of the terminal crooks. This type of horn was still a normal orchestral instrument in the early nineteenth century. With two terminal crooks for B b alto and G and five couplers, all the normal keys from B b alto to B b basso could be obtained. Tuning was effected by inserting short "tuning bits" (d) between the crook and mouthpiece (e). A later refinement was a tuning slide in the bell section.

Meanwhile, in France, it was found more convenient to have a separate crook (a) for each key. The bore can then be kept strictly conical. This instrument is the classical handhorn or French horn and was still taught in certain countries for nearly a century after the invention of the valve system. During the great concerto period of the horn, i.e. the late eighteenth and first half of the nineteenth centuries, a soloist's instrument was evolved having a fixed mouthpipe which ensured an exact constant spacing between the mouthpiece and the bell which was essential for reliability of hand-stopping. The change between the relatively few intermediate pitches required for the solo repertoire was effected by having tuning slides of various lengths (f), fitted in the centre of the instrument. The stays (g) are not part of the tubing but merely strengthening pieces. This type is known as the "cor-solo" (3). The final development was the application of the valve system—either piston or roller valves—which only slowly replaced the old hand-stopping technique.