The Evolution of Player Voiced Aerophones Prior to 500AD

The Development and Use of Brass Instruments in Ancient Europe

By

Dr Peter Holmes

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Scanned from original thesis

Original typed by Elfriede Holmes

Contents

Dedication

Dedicated to:
Nellie Mil(l)ward/Holmes/White
me mam

Elfriede Arbogast/Holmes
Companion/friend/wife

John M Coles
The man who guided me back in time

Introduction

The term 'player-voiced aerophones' was one I coined many years ago as a more-descriptive term for the family of musical instruments more-generally referred to as 'brass instruments' or the 'brasswind' or lip-reed instruments'. To the man on the Clapham omnibus, the family of trumpets and horns.

The book is a (very) slightly edited version of my PhD thesis to which I have added some footnotes while leaving the text almost entirely as written some 45 years ago. This of course means that some aspects of its content reflect a bygone age, such as the use of BC and AD but that is the way it was way back then. Another feature which a read-through of this text has highlighted is the shadow of diffusion casting itself over much of the text. This too is of that time.

There are many sentences/paragraphs/ideas/interpretations which now make me cringe but, nevertheless, the chapters on the Late Bronze Age have stood the test of time and my ideas then on the Irish Horns and the Bronze Lurs have changed little. Other chapters have not faired so well but they're left in warts an'all!

With the passage of time, I have changed my views many times and would no longer used the same terminology as I did way back when. Examples are with the 'Celtic Lituus' which I would now describe as the Short Lituus and the 'Celtic Curved Horn' which I have elsewhere described as the Long Curved Horn. I would no longer attribute these to 'Celtic' peoples but to Native European Peoples, meaning those tribes who inhabited Europe before the Romans ravished their lands.

When trying to understand the form and use of musical instruments from societies which left us no complete instruments or written descriptions of their use, it is first necessary to strip away our preconceptions about the trumpet and horn based upon their use in modern-day and recent societies. For this reason the first chapter of this book discusses the instruments in their pure form, stripped as far as possible of their cultural attributes. Only by understanding the instruments pure and simple in this way, can we hope to allow ourselves access to the instrumental usage of the past and the thoughts of those who made and used them.

The Story of this Book

In 1978, when I had completed my thesis, I carried on doing research in the same field and have published many papers since. However, despite the good advice and encouragement, I never published the PhD. Over time, I began to feel that the work was dated and no longer worthy of publication. I no longer hold that view.

Two things have served to bring this about, one of these being the passage of many years since these ideas were committed to paper. The term ‘Music Archaeology’ had not yet been aired at that time and the efforts of the few people working in the field were chanelled into directions which differ markedly from those followed today. The youth of the endeavour is often reflected in the approach of the time which could, from a current perspective, be characterised as naïve.

While we were, indeed, ploughing new furrows, there were still many who had gone before, on whose shoulders we stood. What our early years in the field witnessed was a considerable increase in effort put into the field of music archaeology, the increase in sophistication of research effort was to follow a decade or so later.

The second development which has changed my view of the worthiness of this publication project lies in the recent dramatic changes in IT. Existing as only five poor photocopies of a typewritten text, the PhD had a massive barrier separating it from the world of modern electronic publishing. That barrier was lifted by the development of efficient and accurate Optical Character Recognition software has made the enterprise feasible.

As a document of recent historic record, the thesis would stand without change. The aim, however, is to point to the changes which have taken place without going into their full detail. That’s a task for another day. However, recent research which updates the text is referenced wherever is thought to be useful to you, the reader.

The diagrams have been reworked into an electronic form, starting from scans of the originals. They are, therefore pretty faithful to what I drew 45 years ago. Only one diagram has been added, this being Plate 6.5bb. It was added as I wasn’t sure how well the photo in 6.5 would reproduce so this was belt and braces. One other change which has been made in Appendix 1 is the spelling of the Ancient Israelite trumpet as chatzozerah as the diacritical marks which I drew in by hand on the original document were not available on my keyboard.

The current text is the result of scanning in from my photocopy of the thesis. At times, the OCR software is a little over-enthusiastic and inserts characters which were not in the original. I apologise if any of these have slipped through the editing process.

Chapter 1

An Introduction to Player-Voiced Aerophones

The Meaning of Sound

To a primitive man, sound is an awesome phenomenon[1] and the ability to interpret sound is an essential component of the ability to survive. If sound had this function then it was indeed, to man living with nature, the voice of nature, the universe and hence of his God. The stories of many peoples tell of the creation "In the beginning was the word." Equipped with his own vocal apparatus man could join in with this sonorous nature, to add his own dimension and, by imitation of nature to draw off her power. The voice must rank as the first of man's instruments, to be soon augmented by voice modifiers and simple idiophones.

Sound, however, is part of the order of things. It is only to be trifled with at the risk of crossing nature and the Gods and then at one‘s peril, and thus, forms of sound must be integrated into this fabric of existence. This integration constrains their form and limits their use both in time and in their availability to members of a particular society. The priest or shaman may be the guardian of the sacred instruments and perhaps too, the only permitted performer on these. He alone, by ritual cleansing or other rites, can commune with nature at this intimate level free from danger. In many societies, contact with the sacred instruments is forbidden to all but the initiated and seeing these or, in some cases hearing them can lead to death. This is the place of music in an archaic culture, something of value, integrated and awesome.

[1] This statement was challenged right at the beginning of the viva. How do I know this? The statement was rash and could have been phrased better

The Human Voice

The human animal, as do the majority of other members of the animal kingdom, generates sounds for most of the time while active. Some of these are involuntary, resulting from the processes of digestion, physical exertion etc. but others are deliberately produced to signal to members of the same and other species. In the human, these sounds have become specialised and highly developed into groups of languages mutually intelligible to the user of that specific form. The elements of sound available for the production of speech are generated by the movement of parts of the human anatomy, particularly the lungs, the larynx, the pharynx, the nose and the mouth. As a generator of sound the "voice organ" has three major units; a power supply (the lungs), an oscillator (the vocal folds), and the resonator (the vocal tract). The pressure of air stored in the lungs is increased by muscular tension and maintained at this pressure as a power source. On allowing this air to escape from the lungs, the vocal folds are alternately pushed back by the air flow, only to recover when the force extended by the laryngeal muscles exceeds that resulting from the air flow, i.e. the Bernoulli effect.[2] This oscillatory air flow then appears in the vocal tract as an oscillating air pressure or a sound source, having a frequency spectrum as shown in Figure 1.1[3].

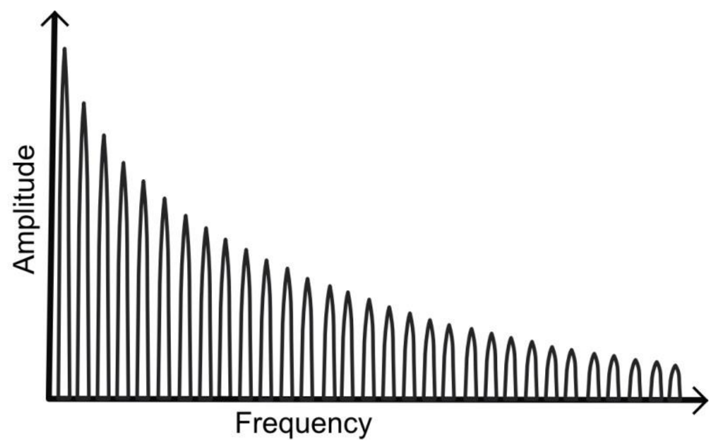

Figure 1.1

In this figure, the bass frequency can be seen with the successive higher frequencies decreased in amplitude uniformity with frequency at a rate of about 12 decibels per octave.

Passing into the vocal tract, the sound spectrum is modified by the physical properties of this resonator. Here a frequency-dependant effect causes some frequencies to be attenuated considerably, while others are less affected. Thus the radiated sound is a modified form of that generated by the vocal folds, with some frequencies attenuated, giving the radiated sound a characteristic tone-colour or frequency spectrum. Which of the frequencies originally generated are subsequently supressed depends upon the group of resonant frequencies of the vocal tract itself, known as formants. It is the nearness of a frequency to that of a formant which determines whether or not it will be attenuated, those coinciding with formants being only slightly affected, while those being midway between formants are considerably attenuated. See Figure. 1.2.

[2] Benade 1976, 365
[3] Sundberg 1977

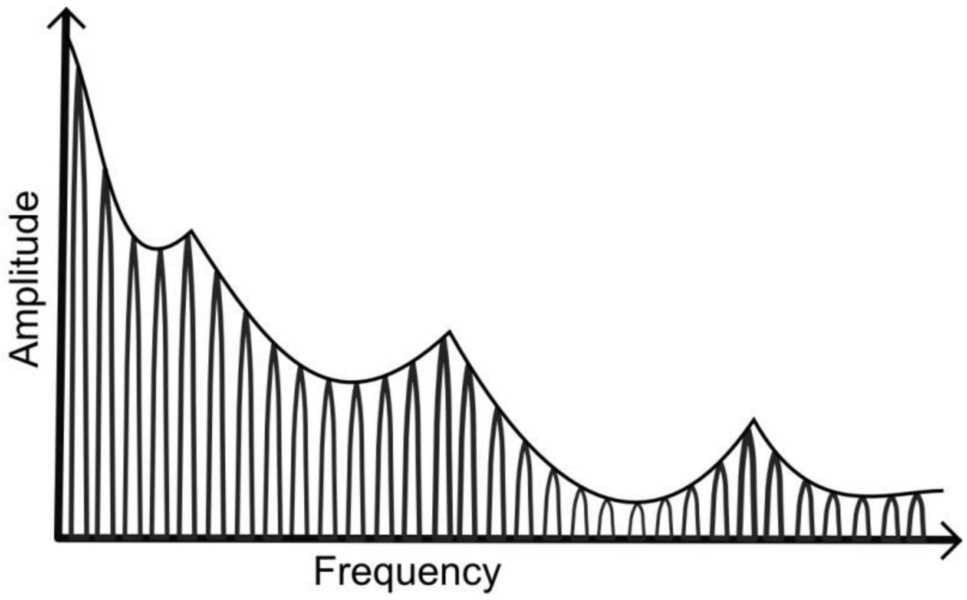

Figure 1.2

Three major parts of the vocal tract can be used to modify the spectrum of sound emitted, the jaw, the body of the tongue and the tip of the tongue. Manipulation of these, changes the formants of the vocal tract and hence the nature of the voiced sound.

Music was probably developed by use of the voice, as was speech itself, and one can only speculate on where and when the ability developed, to encode and decode emitted sound in such a way as to convey the delicate shades of meaning present in all known languages. However, the nature of the encoded signal remains generally uniform throughout the thousands of these languages, being generated principally by variation of the vocal tract characteristics and distinguishing one sound from another by changes in attack, duration, amplitude and tone-colour, along with a range of pitch changes. A number of languages change the meaning of words by pitch variation, especially in Africa.[4] It is by mechanisms such as these that player-voiced aerophones can be used to communicate. Personally, I have been unable to find references in other tone-language areas to such use of talking player-voiced aerophones. The possibility is worth bearing in mind, however. One reference to such a use of musical instruments is in Carrington's 'Talking Drums of Africa'.

When a developed language form has evolved, it attains its position in the culture as a medium of communication. As such, it may be used quite freely by all members of that society, in order to communicate. In many societies, however, different forms of speech develop which are used to express the possession of a specific role by the user of that form. Probably the most frequently-varied element of speech in this situation is that of pitch. Its range may be narrowed to produce a monotone speech or chant, or it may be widened to produce singing. Either modification differentiates it from everyday speech and, hence, identifies the user and his role. Thus the form used receives its powers from the perceived difference between "normal" speech and this specialised form and the value of the actual words used becomes of less importance.[5]

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[4] Personal communication from JeremyMontagu.

[5] Jeremy Montagu commented in a personal communication that it is questionable whether the actual words of chants become less important when they are sung; the melody may be important but its function tends to be mnemonic – to help remember the words, which are the more important element. The tune of the chant may later substitute for the words but this is because the hearer remembers the words. For instance, in the use of the In Nomine or Dies Irae, the tunes only have an impact *because* the hearer remembers the words.

The Generation of "Musical" Sounds

Once the value of the language content of the sound produced in a ritual has declined sufficiently, the way is open for gross variation of the tone-colour of the sound to be practised.

Such modification of sound can be attained by abnormal use of the vocal tract, or by modification of the radiant energy once it has passed beyond the vocal apparatus. This may be achieved by placing the hand over the mouth, speaking into the cupped hand, or through a tubular or into a hollow object. When an object, such as a megaphone, is used in this way, the basic sound source remains the vocal folds, the emitted sound being modified both by the formants of the vocal tract and the regimes of oscillation of the air contained in the megaphone cavity.[6] While this device was not classified as a musical instrument by Hornbostel and Sachs (1914), in my opinion wrongly so, (see the section: Classification of the Instrument Group, below,) a variety of this was classified by them as "24 Ansingtrommeln" (Mirlitons). These are instruments in which a membrane is caused to vibrate sympathetically with the speaking or singing voice, thus modifying its tone-colour.

The role of a secondary external resonator may be further extended by utilising the resonance characteristics of its contained air, and exciting sympathetic resonances of this by singing through it at the appropriate pitch, the vocal folds remaining the generator of the pressure oscillations of the air column. However, while singing into the resonator at a frequency coincident with or close to the tube's resonant frequency, the vibration of the lips can be induced. Having noted this phenomenon, it is a short step to the use of lip-induced vibrations. These may be produced by tensing the lips using the buccinator muscles, and forcing air through them from the lungs and through the external resonator. By adjustment of the applied pressure and the tension of the muscles, the frequencies of vibration can be made to coincide with that of the resonator's characteristic frequencies or formants and a very strong resonance set up, this being the basic mechanism of trumpet or horn blowing. (See the section: The Acoustic Potential of Player-Voiced Aerophones, below) During this operation, a function similar to that performed by the vocal apparatus is being simulated, with the lips taking the part of the vocal folds and the resonator the part of the vocal tract.

A fundamental difference in the modes of operation of these exist, however, in that motion of the lips is reinforced by feedback from the upper partials in the tube's formants, thus facilitating their continued oscillation[7]. Nevertheless, when a sung note is superimposed on a lip-voiced note two complete generator/resonator combinations operate in series[8].

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[6] Collaer 1968 ,9, no. 6, provides an example of such a use.
[7] This phenomenon is covered in detail Campbell & Greated, The Musician's Guide to Acoustics, Oxford, 1998, p.308ff.
[8] As is done on the didgeridoo, when creating the sung tones while blowing.

The Development of Musical Instruments

Having developed the technique for producing sound from resonators external to the body, selection or development would take place to find or make objects that respond to the technique more readily. It is here where complications inevitably begin, as a development which enhances the ability of a megaphone to be sounded by the vocal folds, inhibits the range of harmonics that can be generated by means of the lips of the player. For sounds to be recognisable as words, the lips must have considerable freedom of movement to "mouth" these words. However, the production of the upper partials on a harmonic series requires the lips to vibrate at a high frequency with a resultant low amplitude, a condition best met by use of a small mouthpiece. Resulting from this conflict, a divergence of morphology takes place, with one group of instruments remaining suitable for use with the human voice alone, another for use with both the voice and the lips and the third group developing characteristics which enable an extended harmonic series to be sounded by use of the lips alone[9]. It seems reasonable to say that all of these groups may be described as musical instruments, although a whole spectrum of types exists with the dividing line between them being very unclear. However, if a broad view of the term "musical instruments" is accepted, the whole range of external lip and vocal-fold resonators are quite reasonably classified as such.[10]

The Player-Instrument Interface

The critical contact area between the player and the instrument is the aperture through which the vibrating column of air is introduced.

However, when a resonator is to be excited at one of its resonant frequencies by lip vibration, a seal between the lips and the instrument is essential as the pressure required to cause the lips to vibrate and create an air-flow through the tube would otherwise not be readily maintained by the lungs. The lips and facial parts are therefore restrained by this contact with the resonator and are unable to form identifiable words. Thus, development improving the lip vibrating characteristic of the tube impairs and, in the limit, destroys its ability to serve as a megaphone.

A tube with an aperture, equal to the tube diameter, of the order of 15-30 mm diameter and a metre or so long can be blown by a person with normally formed facial features, and fairly readily sounds the first characteristic frequency of that tube. This note will require little pressure to maintain a steady continuous note. But, in order to excite the tube at its next harmonic[11], the frequency of lip vibration must be doubled. This may be done by increasing the air flow through the lips considerably, by tensing the lip muscles and increasing the air flow by a much lesser amount or, more commonly, by a combination of these. The same effect can also be achieved by reducing the effective supporting diameter of the mouthpiece. This reduces the free area of lips available for

[9] The three being the megaphone, the variable tone-colour instruments (didgeridoo) and the trumpet/horn instruments.
[10] The use of the term *sound tools* which has emerged since the 1970's may well be more-suited to some of these forms.
[11] The term *partial* would, most-probably be better used here.

vibration, and hence reduces the vibrational amplitude and increases its frequency for a given air pressure. Such an organological change increases the ease with which the second harmonic can be played at the expense of ease in playing the first. Further reductions in size of the mouthpiece may result in an instrument upon which the first harmonic cannot be sounded at all. Thus, one of the key parameters in mouthpiece design is the range of frequencies over which the instrument is to be played

The Instrument Body

A trumpet or horn is made up of a matched mouthpiece/resonator combination joined together by an air-tight seal. The resonator part of the combination may be of the form of a cylindrical or conical tube or of a more complex shape, such as a hollowed-out anthropomorphic object.

One commonly-used external resonator that has been found in this study to have almost world-wide application is the hand. In questioning subjects from many different cultures, the "blowing of a raspberry" appears to be a virtually universal modern phenomenon. In doing this, the hand, being placed over the mouth, restricts the amplitude of vibration of the lips and raises their vibrational frequency. Presumably, this higher frequency sound output more closely resembles that produced by the bodily function simulated. Needless to say, this "raspberry" device, universally interpreted as it is as "rude" or offensive, remains the simplest instrument of this type in general use today!

An enormous variety of materials has been used to form the external resonators of instruments, among the commonest being animal horns, shells, hollowed wood/reeds and ivory. Analogues of these have been made in ceramics, wood and metal and simple tubes from sources such as sea-weed utilised. Many other materia1s, which are naturally of a horn or bell-like form, such as armadillo tails and gourds have been used to terminate tubular instruments, and flexible materials such as willow and birch bark have been formed into the appropriate shape to form a resonator. With the availability of metals, restrictions placed on morphology by the availability of naturally occurring shapes were replaced by those that were intrinsic to the technical processes utilised.

Tubular and conical instruments are undoubtedly the most common among the lip-voiced instruments, and can be sub-divided into end-blown and side-blown varieties. Both varieties are found in cylindrical and conical instruments, end-blown instruments generally being much more common than the side-blown variety.

Classification of The Instrument Group

In accepting that at least some of the group of instruments studied are "musical instruments" one is faced with a further problem of attaching a name to them which is clear, unambiguous and scientifically acceptable. Common parlance seems to present little problem in this respect, the term ‘brass instruments’ being generally used and understood outside the US and ‘brasswind’ within the US. However, in scientific circles a greater problem is experienced in devising a less ambiguous title.

In a recent book Anthony Baines[12] proposes a further term "labrosone" but this seems only to further the surplus of names for the instruments. That the group of instruments are aerophones, the air in the resonator vibrating, is generally accepted. Hornbostel[13] conditions this by adding "tubes blown with lip vibration." Bessaraboff[14] attaches the condition of lip excitation to produce the name lip-vibrated aerophones. This term, as has lip-reed and lip-voiced instruments, achieved wide general usage. While the instruments considered in this study are frequently lip-vibrated aerophones some, like the variable tone-colour group[15], have the further attribute of being suitable for the exploitation of vocal-fold generated sound. Even modern western orchestral instrument players are required by some composers to utilise facial parts other than the lips to generate an air- column modulation by use of the tongue to interrupt the air flow (so-called "flutter-tonguing."[16] These forms of sound generation would appear to be excluded by the term "lip-vibrated" and a suitable term would need to include those parts of the player used as sound generators. I, thus, propose the term 'player-voiced aerophones' (hereafter abbreviated to PVAs) which covers the use of the player's vocal apparatus as well as the lips and tongue in the generation of sound.

In the classification of instruments proposed by Hornbostel and Sachs in 1914 and since then generally accepted, the PVAs are classed under the heading "423. Trumpets," this having arisen from 4 = Aerophones.

4.2 Wind instruments proper; the vibrating air is confined within the instrument itself (Translation from Baines (1961, 27).

423 Trumpets; The air-stream passes through the player's vibrating lips, so gaining intermittant access to the air column which is to be made to vibrate.

[12] Baines 1976, 40. Interestingly, although he proposes the term labtosomes, his book is entitled "Brass Instruments, Their History and Development".
[13] Hornbostel 1914
[14] Bessaraboff 1941
[15] Didgeridoos, etc.
[16] I have discussed this with Jeremy Montagu who disagrees with this statement. However, I have not yet seen the function of the tongue described during flutter tonguing although its motion certainly does disturb the flow of air through the instrument

Their subdivision then continues.

423.1	Natural trumpets	Without extra devices to alter pitch
423.11	Conches	A conch shell serves as trumpet
423.111	End-blown	
423.111.1	Without mouthpiece	India
423.111.2	With mouthpiece	Japan (rappakai)
423.112	Side-blown	Oceania
423.12	Tubular trumpets	
423.121	End-blown trumpets	The mouth-hole faces the axis of the trumpet
423,121.1	End-blown straight trumpets	The tube is neither curved nor folded
423.112.11	Without mouthpiece	Some alphorns
423.121.12	With mouthpiece	Almost world-wide
423.121.2	End-blown horns	The tube is curved or folded
423.121.21	Without mouthpiece	Asia
423.121.22	With mouthpiece	Lurs
423.122	Side-blown trumpets	The embouchure is in the side of the tube
423.122.1	Side-blown straight trumpets	S. America
423.122.2	Side-blown horns	Africa
423.2	Chromatic trumpets with extra devices to modify the pitch	
423.21	Trumpets with fingerholes	Cornetti, key bugles

From this entry on, the remainder of their trumpet group of instruments are outside the scope of this study.

The major problem in categorising the instruments studied here arises from the variable tone-colour group. These are quite capable of being blown as straight-forward members of 423.111.1 "trumpets, natural, without mouthpiece" and utilising their first formant. However, as discussed above, they are considerably more versatile than this categorisation allows, and are not adequately covered by it. Neither is it as easy as simply creating a new sub-group to cater for them, as many instruments, for example, the Irish side-blown horns, have blowing apertures so large that they could function quite adequately as megaphones. In this case, the instrument would receive or be denied the title musical instrument depending on its use, and this might vary from time-to-time during a single performance.

Under the heading 423, the term 'trumpets' is qualified by a statement that the air stream passes through the player's 'vibrating' lips. In that a vibration is an alternation in movement at an unspecified frequency with an unspecified uniformity of repetition then speech itself involves the passage of air through the "vibrating" lips. One way of avoiding this problem is to define 423 Trumpets as dependant on lip-vibration re-enforced by the standing wave in an instrument cavity, i.e. by a feedback-induced vibration. However, as well as excluding the hunting horn from the category, this would also exclude the conventional trumpet or horn when played in its high register, see below, p. 21.[17].

A better solution to the problem would be to accept the megaphone as a PVA, i.e. a 'trumpet' under 423 as:

423. Instruments where an air' column is principally modulated by means of the facial and vocal parts of the player.

This would include the variable tone colour instruments as:

423,121.13 Trumpets, natural, tubular, end-blown, with mouthpiece suitable for use in a variable tone colour mode. Types include didgeridoo

425,122.21 Horn, natural tubular, side-blown with mouth- piece suitable for use in a variable tone-colour mode. Types include Irish Bronze-Age horns.

Establishing Sequences of Instruments

The instruments under study were all manufactured prior to c. 500 AD and are representatives of a sequence lasting several thousand years. Hence, one of the pre-requisites for study of such a sequence is the establishment of a chronological ordering of the material.

The major problem when attempting to define a chronological sequence of artefacts is that each item has attributes related to discrete sequences encompassing different

[17] see Section: Range of Sounds of Player-Voiced Aerophones

facets of the culture. Such facets include technological, aesthetic and the functional needs that led to the creation of that particular item. In the case of musical instruments, the functional factors in design are described in the term "organology," this covering the whole area of use of the instrument in the production of music. It is thus possible in any group of instruments that are fully representative of a developmental sequence to define three distinct sub-sequences viz: technological, aesthetic and organological. Such sequences, however, are not necessarily mutually exclusive and problems may arise in defining to which sequence a change belongs.

Each sequence consists of discrete steps that can be individually defined but are not necessarily exclusive, the steps possibly belonging to two or even three different sequences. A discrete technological step might be the joining of two tubes by use of brazing to replace casting-on. See Figure 1.3.

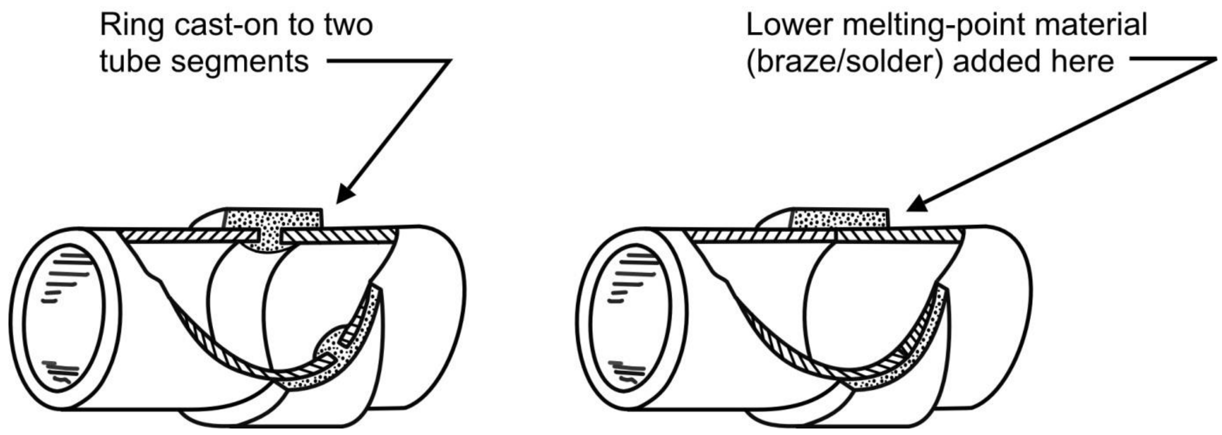

Figure 1.3

This step could produce a tube with the same aesthetic impact which was organologically identical.

An aesthetic step could be the introduction of extra decorative rings on a portion of instrument tube. This would require no new technology and organologically speaking would not change the instrument.

Having developed the technology for manufacture of a basic instrument, many organological changes could readily be introduced. In particular, so critical is the influence of mouthpiece in enabling a standing wave to be initiated and then controlled that many variations of mouthpiece morphology are seen. A change in the diameter of the mouthpiece throat for instance, would affect the ease with which the instrument's higher formants could be sounded without requiring new technology or affecting the aesthetic impact of the instrument.

Not all changes are peculiar to one sequence, however, and some affect all three; for instance the change from a "natural" mouthpiece i.e. a hole cut in a horn tip, to a metal mouth support or mouthpiece would be a change involving all three sequences.

Such sequences may be described as positive or negative depending on whether they represent increasing or decreasing sophistication of that particular facet of an instrument.[18] Developmental pressure would tend to create a positive gradient of

[18] The question of intentionality impacts strongly upon how one sees a step change of any type and this is the most-difficult of all features of ancient design change to get a grasp of: what did the designer/maker actually have in mind when they made that change.

development, increasing the technological, aesthetic or organological complexity of any particular item. A caveat is necessary when attempting to equate any sequence with chronological events as the gradient of any sequence may not remain positive and will certainly have a different slope in different areas. Thus, the interchange, or diffusion, of ideas between areas will affect the developmental gradient producing quantum jumps in development that, lacking a complete sequence of artefacts, cannot readily be detected.

The Diffusion of Ideas

When looking at early examples of instruments one is continually faced with the problem of deciding from where the ideas and technology came, i.e. were they indigenously developed or did elements of either design or technology come from elsewhere? However, it is not enough to cry "diffusion" and to state that "this" diffused from "here to here." Any artefact is made up of several, frequently many, design elements created by specific technological processes and, in the case of musical instruments, is required to perform its task in a highly specific way.

One degree of diffusion can be proposed, that of 100%. In this a manufacturer would move along with all his necessary tools, designs and equipment to an area where his products are equally desired by the market for the same purpose and the necessary raw materials are equally readily available. However, should any of these criteria not be met then the diffusion would be less than 100%.[19]

It might be better when talking of diffusion to speak of "maker" and "user" diffusion as clearly recognisable strains. In the first case the geographical move could still allow a complete transfer; if all the above criteria are met the most conservatively maintained elements of the artefact are those deriving from the technology applied in its manufacture.

In the second case, however, the functional aspects of an artefact would be better conserved even when a totally different technology is used to manufacture them. A further possibility is the diffusion of a design, "design diffusion," emphasising conservation of the aesthetic aspects of an artefact.

Thus, in the case of a musical instrument a maker would transfer the technology without necessarily understanding all the intricacies of design from an organological point-of-view. A player would tend to conserve the functional - in this case organological - features of an instrument, to some extent, at the expense of technological and aesthetic features. A ruler, shaman or priest for whom the instrument is played would be interested in the aesthetic and/or the musical impact of the instrument perhaps showing little interest in the technology employed in its manufacture.

[19] Close links between cultures, trading and otherwise, can serve to obfuscate technological/design relationships. We are told in ancient literature, for instance that the Etruscans produced many goods specifically for the Greek market and this leads to the needs to separate out the cultural aspects of an object and its source of manufacture.

In all the above cases, the transferee of information might perform the transfer of information more or less well. The maker who took with him the manufacturing technology may have lacked understanding of a part of the manufacturing process. His knowledge of clay preparation or the alloying of metals might have been defective, perhaps previously having been carried out by other members of a workshop. In a similar way, the "idea" of a horn-shaped metal tube with certain magic powers may have been all that was transferred, giving a very low level of design diffusion. Obviously, it is generally not possible to define the nature or degree of diffusion in a particular case as, to do this, the exact level of manufacturing technology and the nature of the artefact usage in both the donor and receptor societies would need to be accurately defined at the time of interchange. However, it is important to recognise the different facets of the diffusion of ideas in order to inter-relate the products of different societies in a more realistic way. In this study, therefore, where diffusion is considered to have taken place, the nature of this is conditioned by a pre-fix such as, maker, user or design, along with, where possible, some indication of the order of this diffusion.

Reconstruction of Ancient Music

No examples of musical notation exist for the instruments studied other than written descriptions of shofar calls for use in the temple and synagogues of ancient Israel. Thus, to reconstruct their music, use must first be made of all the material available, be it complete and fragmentary instruments, iconographic references or contemporary documentary accounts. From this a realistic attempt may be made to reconstruct the individual sounds that were components of this music. Herein however, lies a problem as any instruments being studied are likely to have evolved over centuries, perhaps even millenia as also would the performance techniques associated with them. The contemporary performer, would therefore, be heir to this knowledge and the product, therefore, of a school of performance. Obviously, it is not now possible to re-connect the traditional tie and it may be that the awareness of the problems inherent in re-creating a realistic performance is in itself a valuable asset. Clearly, the contemporary performer would possess expertise in the use of his instrument and, presumably, the necessary developed facial musculature associated with excitation of the instrument. It is, thus, apparent that, while some expertise in blowing would be of value, rigid training in a modern traditional school could render a performer quite unable to adapt to the different blowing technique required of a different instrument. Equally unsuitable for performing on such instruments is the outright amateur! Obvious as this statement may seem, several learned gatherings particularly where ancient instruments have been discussed have seen a speaker pick up an instrument and "have a go." Were such a test to be applied to the magnificent 17th and 18th century trumpets, our current view of these would be that they were little more than fancy bugles. No amateur would have dreamt that such an instrument would - or even could - have performed Bach's 2nd Brandenburg Concerto, for instance. A near approach to the authentic sound will only come from an awareness of the possibilities in performance technique allied with practice over a long period on accurate reproductions or the instruments themselves.[20]

Fortunately for studies of this type many instruments survive in what is presumably their original condition. These horns and trumpets, being of integral construction and made entirely of metal, have survived and give us the opportunity to recreate their sound.

The Acoustic Potential of Player-Voiced Aerophones

As discussed earlier, a megaphone, or simple external resonator modifies the tone-colour of the voice and, when used with lip vibration, modifies somewhat the buzzing of the lips. As the length of the air-column of this resonator is increased, the number of its characteristic frequencies of vibration, i.e. those frequencies at which its wave impedance brings about the establishment of standing wave patterns, progressively increase in number. However, with a straight tube, i.e. one with no conicity or flare, the sound that escapes from its end, to be heard by the listener, is nearly inaudible. This is due to the wave-impedance discontinuity at the open end of the bell where the tube diameter expands instantaneously to infinity, i.e. into the open air. The energy transfer from tube to open air is facilitated by the provision of a flare of the type generally seen on modern instruments or, to a much lesser extent by a bell disc (to an acoustician a "flanged termination.") In addition, this flare increases the effective length of the instrument as its increasing cross-section provides progressively greater impedance to wave propagation and hence increases the time for a wave to travel from the mouthpiece to the "bell-end" and back.

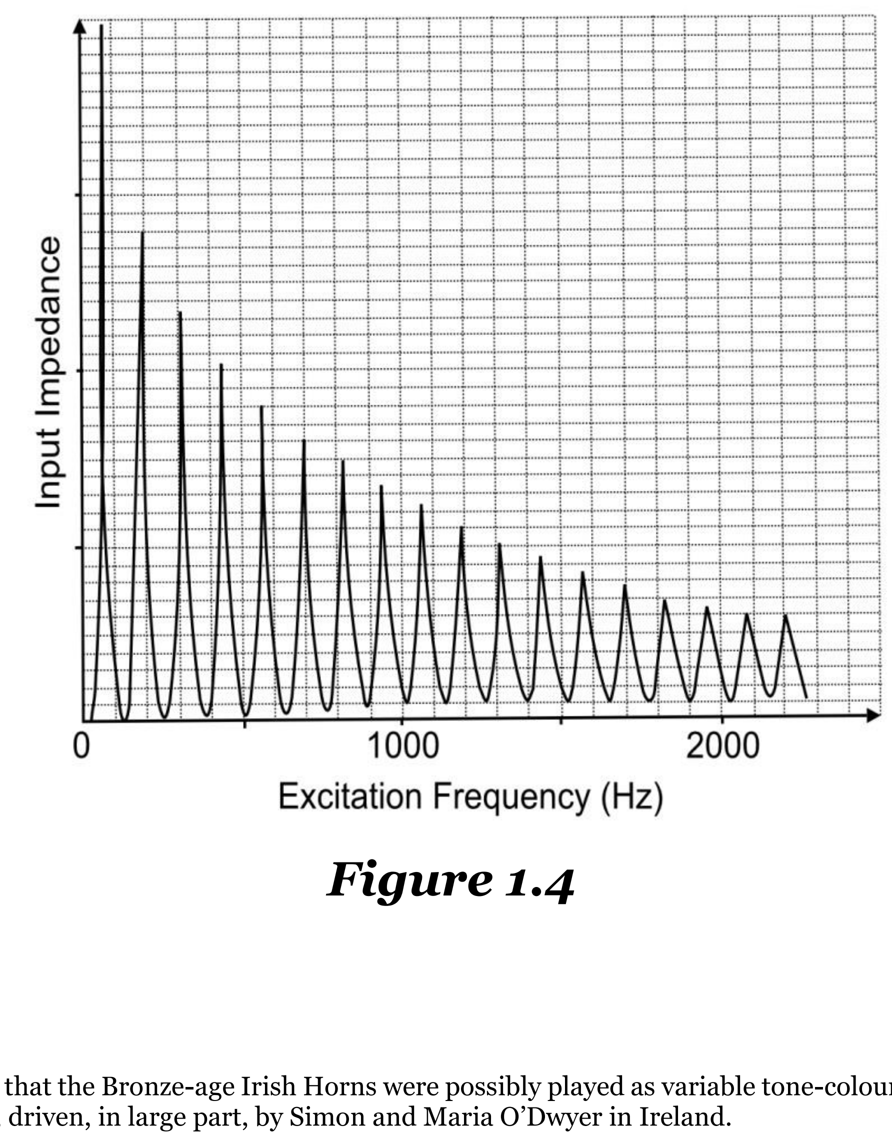

Figure 1.4

[20] Since this work originally suggested that the Bronze-age Irish Horns were possibly played as variable tone-colour instruments (à la didgeridoo) a school of performance on these has emerged, driven, in large part, by Simon and Maria O'Dwyer in Ireland.

The addition of a flare to an instrument, therefore, modifies the impedance curve from that Shown in Figure 1.4 to that in fig, 1.5[21] by shifting the resonance peaks towards lower frequencies as well as decreasing their amplitude because of the greater dissipation at the tube walls. Also, above about 1500 Hz the impedance curve has a very low amplitude.

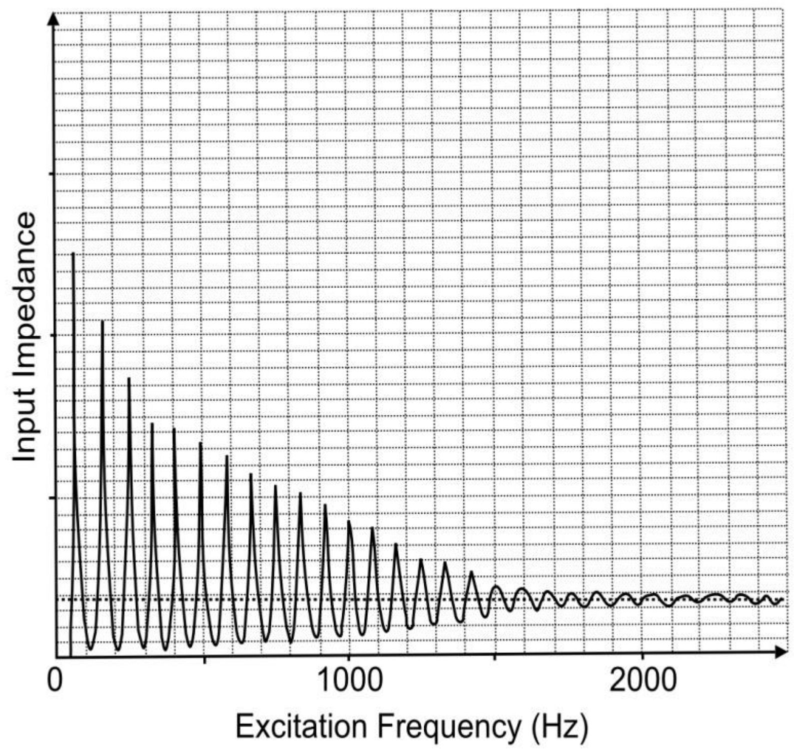

Figure 1.5

In spite of the presence of the standing waves, shown in Figure 1.4, however, the lips can only resonate readily at those characteristic frequencies to which higher formants are related harmonically.[22] Where the higher frequencies are not related in this way to the vibrational frequency of the lips, pressure waves arrive back at the lips out of phase with their motion. These waves then damp the lip movement and prevent vibration at that particular frequency. Thus in Figure 1.5, for instance, a player attempting to produce a 60 Hz tone would find this difficult to do, as its upper harmonics almost all fall near to dips in the resonance curve. Returning waves from these upper harmonics disrupt the lip vibration preventing the establishment of a steady standing wave. If, on the other hand, (s)he attempts to blow a note based on the 165 Hz resonance,they are aided by the 2nd, 4th and 8th harmonics that are reasonably well related harmonically and combine to form a well-defined regime of oscillation. Several other such tones could be played on this, a1though they would lack the brilliant tone of a trumpet even more than the 60Hz tone did.[23]

The Mouthpiece

Many of the instruments considered in this study lack developed mouthpieces of the type that modern instruments have. On some of these, the edge of the tube is simply radiused to cushion the lips, on others the rim of the tube is rolled back to form a rim such as on the Tutankhamen instruments (My refs, SD201/2) On others,

[21] From Benade, 1976, Fig.20.4
[22] The term 'harmonically' should be interpreted here as referring to frequencies which are integer multiples of the fundamental frequency and carries no implication of cultural interpretation.
[23] This aspect of the acoustics of brass instruments, particularly with respect to the function of the mouthpiece, is covered in detail Campbell & Greated, The Musician's Guide to Acoustics, Oxford, 1998, p.308ff.

particularly the bronze-age Irish horns, for example those from Drumbest (My refs, SD16A and 16B), the tube ending opens out to form a larger diameter rim to give support to the lips. None of these instruments can be said to have true mouthpieces and in this study these have been referred to as mouthsupports. The acoustic effect of the addition of a mouthsupport to an instrument is negligible, its main function being to cushion the lips. However, a true mouthpiece has its own acoustic characteristics which, when combined with a length of tubing, produces an overall acoustic effect different from either of its two component parts.

In fact, when combined with a pipe alone, a modern trumpet mouthpiece has little effect at low frequencies, the impedance of the combination being virtually that of the pipe alone. At higher frequencies, however, the wave impedance increases up to about 850 Hz and thereafter decreases steadily until above 3500 Hz where it is actually lower than the wave impedance of the tube alone. The nature of this phenomenon leads one to suspect that the mouthpiece has a characteristic frequency at about 850 Hz. This can be verified by smacking the mouthpiece with the palm of the hand when it produces a tone at 850 Hz. Known as the "popping frequency" of a mouthpiece, this exerts a considerable influence on the mouthpiece/instrument combination giving rise to a peak response at this frequency.[24] This is illustrated in Figure 1.6. Thus, the combination of a mouthpiece with a suitable contoured tube produces the acoustic performance that one expects of a modern instrument and was arrived at as long ago as the Scandinavian Late Bronze-Age (See Chapter 4.)

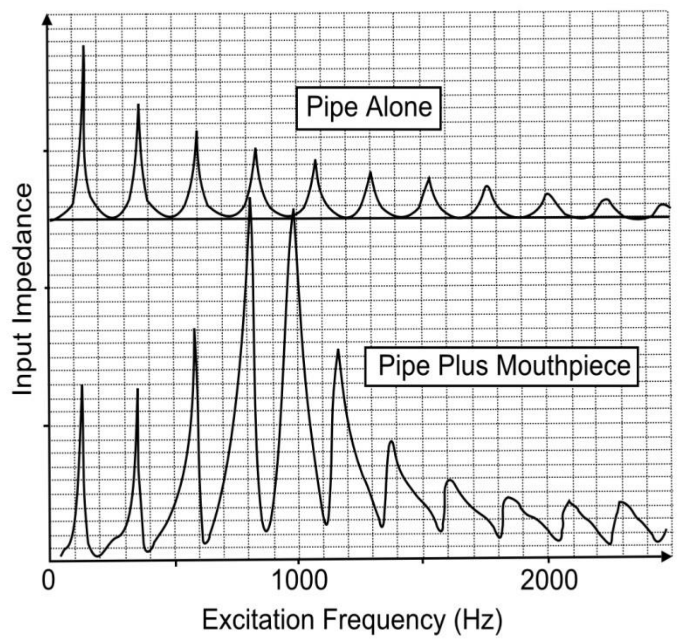

Figure 1.6: Input Impedance of a Cylindrical Tube

The Range of Sounds of Player-Voiced Aerophones

Having no detail of ancient performance techniques, other than those of the Hebrews[25], we can only guess what range of formants were actually used during performance. It is known that during the Baroque period the trumpets of the period were played — and were designed to be played - up to the 20th harmonic.[26] However,

[24] Benade, 1976, 401
[25] In fact, we have only modern interpretations of the ancient calls which were used, no concrete references surviving from ancient times.
[26] Jeremy Montagu comments on this statement that Baroque trumpet parts have occasional excursions up to the 24th harmonic and that the resonance curve of a modern b-flat trumpet (which is essentially a cornet with a wider mouthpiece) is not relevant to Baroque trumpet parts which were designed for a tube two thirds or more cylindrical and a mouthpiece with a hemispherical cup with sharp edges to the throat.

such high frequencies are clearly very difficult to attain even on specially designed instruments. Figure 1.7 shows the resonance curve of a modern Bb trumpet, along with the regimes of oscillation for the notes written G5, C6 and E6.

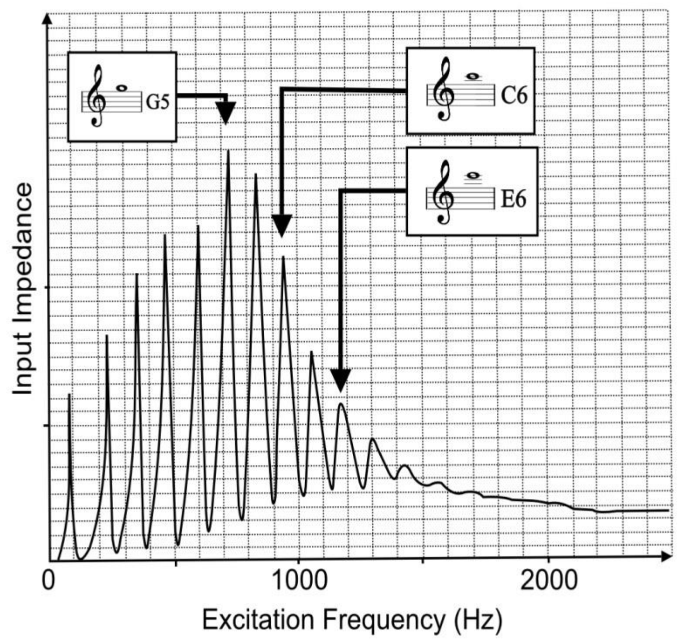

Figure 1.7: The Resonance Curve of a B-flat Trumpet

In this figure it can be seen that, when playing G5, Lip vibration is aided by the large standing wave associated with the 6th tall peak plus a marginal contribution from the G6 peak. The same is true, for C6 although, in this case the peak associated with C7 itself is minute. This complication in pitching the note, i.e. adjusting the lips' vibrational frequency appropriately, is additional to that of getting adequate tension in the lips to cause them to vibrate at this frequency. When blowing E6, however, no higher frequency wave assists the lips and their vibration is maintained solely by Bernoulli forces. At this level, then, the instrument ceases to act as a conventional PVA and becomes analogous in operation to a megaphone. Admittedly the lips remain the source of excitation but they are acting essentially independently of the tube itself as do the vocal folds on a megaphone.

The Effective Lengths of Instruments

A cylindrical tube when blown as a PVA behaves as a closed tube, hence, giving modes of vibration in which the frequencies are in the relationship 1:3:5 etc. Thus, a piece of cylindrical tubing about 12 mm bore and 1.27 m long would produce the notes shown in Figure 1.8.

Figure 1.8: The Notes Produced by a Cylindrical Tube

These are also shown in Figure 1.9, column (a) where they are displayed on a frequency scale, on which is superimposed a musical staff.[27]

[27] Adapted from Backus, 1970, fig. 2

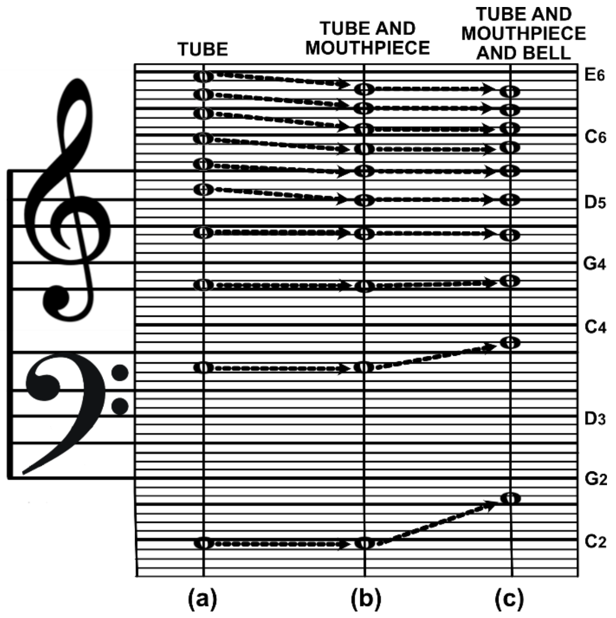

Figure 1.9: The Evolution of a Trumpet

When a mouthpiece is added to this tube it lengthens it; the effective increase at low frequencies being the length of tube which contains the same volume of enclosed air as the mouthpiece itself. Thus, Fig, 1.9, col.(b) shows the notes produced on this tube when shortened to bring the first harmonic back to the original frequency. (ln the actual case quoted, the mouthpiece had a volume of 6.5cc, this being equivalent to a 57mm length of 12 mm bore diameter tube.) However, the mouthpiece has a greater effect on the higher harmonics, depressing them to a greater extent than the lower ones, as shown in Figure 1.9, col.(b).

When a flared bell is added to the combination, this further modifies the harmonics but, in this case, affects the lower ones to a greater degree than the upper ones. Thus if the tube length is again "corrected", this time to leave the upper harmonic unchanged, the notes shown on Figure 1.9, col(c) are obtained. In this the higher modes of resonance are in the ratio 1:2:3:4, i.e. those expected of a "natural" instrument, such as the modern bugle.

Many instruments in the archaeological record have achieved this transition from a simple sound generator to a generator of harmonically[28] related sounds, albeit in an empirical way. Nevertheless, many instruments can produce this harmonic series and cou1d,thus, be played in ways that utilise this phenomenon for harmonic purposes.[29]

Effect of Cone Angle on Conical Instruments

Conically-bored tubes do not suffer from the lack of a harmonic relationship between their formants as do cylindrical tubes. However, in the limit, a conical tube degenerates, on the one hand, to a parallel tube and, on the other, to a flat disc. One must, therefore consider the magnitude of cone angle, when speaking of conical instruments, this being an important parameter controlling the acoustic performance of a tube.

In a paper of 1975, Smith and Mercer examined the acoustic performance of cones, analysing their formants and relating these to the dimensions of the cones. These were excited in their study by means of a bassoon reed and the tubes were designed with a

[28] Harmonic, it has to added, to a western ear. This comment should be similarly read as applying to othe such references in this chapter.
[29] This would probably be better expressed as 'for purposes of polyphonic performance'.

range of semi-vertical angles (α) from 22.7 millirad (mrad) to 6.5 mrad. See Figure 1.10.

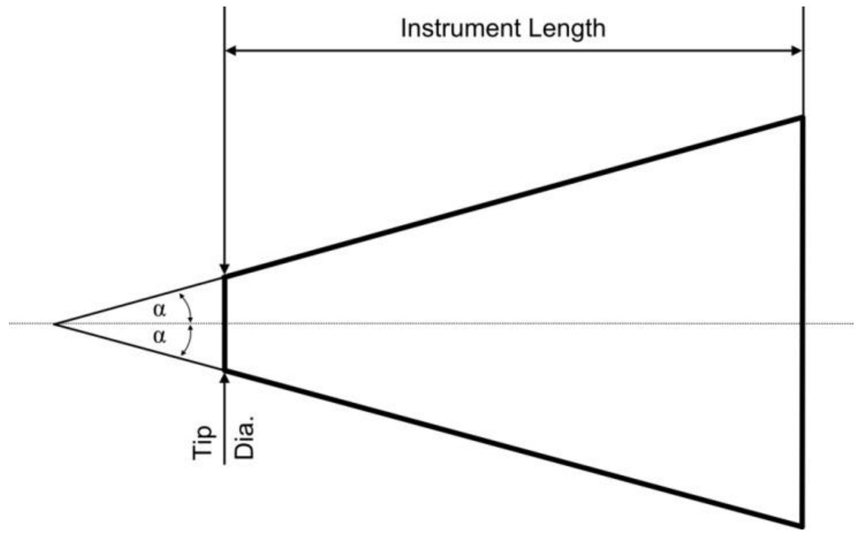

Figure 1.10: An Instrument's Semi-vertical Angle

Their lengths were chosen such that they all had the same fundamental frequency of 200 Hz.

In preliminary work they found that the cones with α greater than 22.7 mrad produced a "coarse and penetrating" tone, concluding that the cone angle was too great to allow reflection of the wave to occur inside the horn. The narrower cones, somewhat less than 6.5 mrad, (actual value not stated) were unstable and hence represented cases where the cone was degenerating to a cylinder, with the resulting change in acoustic performance,

Modern conical instruments have a wide range of values of α, that for the Alphorn being of the order of 6.5 mrad.

MUSICAL OCTAVE NOTATION

Throughout this study, the musical octave notation used is that proposed by the Acoustical Society of America and adopted by the USA Standards Association. This is outlined on Figure 1.11. It starts at the C with a frequency of 16.352 Hz (about the lower level of hearing) and designates this C_0. The octaves above this are then designated C_1, C_2, C_3 etc. All notes in the octave above C_0 are given the subscript 0, all those above C_1 given the subscript 1, etc. In terms of ease in reproducing and interpreting this was considered the optimum system to use in the present study.

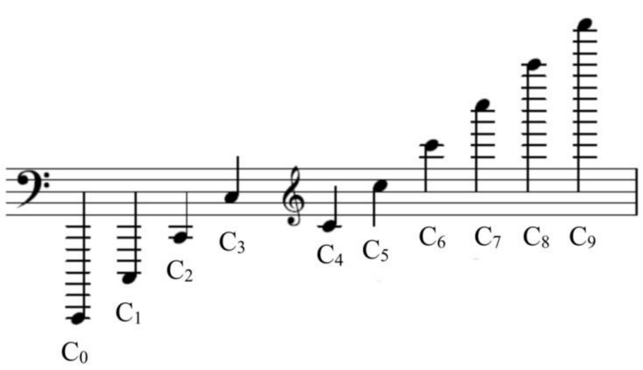

Figure 1.11

The Sounds of Player-Voiced Aerophones

Throughout the long history of PVAs, an enormous variety of forms was used, some in a naturally-occurring form and some manufactured. Probably the most commonly-used type is that of the animal horn, as in this, nature provides a convenient, conical, form which needs only to be provided with means of blowing to produce a playable instrument. To do this, part of the tip may be removed, and a mouthpiece carved from the solid material remaining. From this an instrument, such as the shofar, capable of sounding about three notes can be made, although a longer, narrower horn such as that from an antelope could produce an instrument with more playable notes. Such a horn could also be provided with fingerholes, as on the two Scandinavian Iron-Age instruments (my refs: SD271 and 272), providing more closely—spaced notes capable of use to play simple melodies. Instruments of this type led to the medieval cornett and, finally, the ophicleide. Modern Swedish fingerhole horns also use hand-stopping (the placing of the hand in the bell) to achieve changes in pitch and we do not know if such was the case in the past as the practice leaves no archaeological record. As a group these instruments produce what may best be described as a mellow ("horn-like!") tone, and have a very restricted range.

To increase their musical possibilities, the horn part of the instrument was extended by the use of a simple reed, bamboo, or similar long, tubular, object. The actual form of the material used, particularly its diameter, was of great consequence, for a long large-diameter tube would produce an instrument with few formants that could be played, the upper ones being incapable of being excited. (for example, the Irish Bronze-Age horns). These higher notes would be made playable by the use of a smaller bore tube (tube-yard) which would give the lips greater support (for example, the Greek salpinx, early Lurs such as Gullåkra).

With the ability to manufacture in metal, the restriction of form, to those which occur naturally, is removed. Thus, the tube yard can be made to have both a small tip diameter to suit the requirements of the lips and a large exit diameter to suit the entry diameter of the horn (Bell-yard). Such is the form taken by the later lurs. A further accommodation in metal can also be made to suit the lips, i.e. the provision of a mouthpiece in the modern accepted terminology. This is a device that provides some form of smoothly-formed rim which supports the lips: a cup, spherical or conical in form which leads into the throat, a small diameter constriction which, in turn leads into a back-bore or, in many of those instruments which have an integral mouthpiece, into the tube-yard. (for example, the Scandinavian Lurs).

Such instruments as the lurs (See Chapter 4) and the Celtic Lituus (See Chapter 6) lacked little more than the flare to give them a form that would be acceptable today. Their performance, therefore, is comparable with modern valveless or so-called "natural" instruments, the nearest modern analogy to the same forms of the lurs being a horn, and that to the Celtic Lituus a bugle. With their range of playable notes, 13 or so on the lurs and around 5 on the Celtic Lituus, one would be able to perform something like an l8th century natural horn player on the lur and like a modern bugle player on the Celtic Lituus.

A range of end-blown instruments also emerged from simple straight tubes and it is possible that these, by the addition of some form of bell, could converge with the group that began with the animal horn, and then added the bell. Having thus converged, no evidence would remain of their ancestry.

Variable Tone-Colour Instruments

Several instruments have remained as simple tubes, developing neither mouthpiece nor bell-yards, and their origins can thus be recognised. Generally-speaking, these instruments are of a fairly large diameter and, lacking a developed mouthpiece, are used as simple instruments to sound their lowest playable tone and a second formant. In societies with poorly-developed technology, these instruments may well form an important part of the total instrumental range available and, in the case of Australian Aboriginals, were the only musical instruments other than idiophones, which they possessed.[30] This aboriginal instrument, the didjeridu, is a very simple hollow wooden tube modified only at the mouth-support end. Here, the jagged material, left by the insects that hollowed out the wood, is smoothed to a slightly-flared form. This hole is then lined with wax which can be manipulated with the fingers to form an oval aperture to suit the lips of the players. On an experimental instrument, made in metal during this study[31], the mouthpiece was made to suit an experienced player of this instrument. The final optimum dimensions of this were 40 x 25mm, although it was found that he could play almost as well with a mouth aperture considerably larger than this.

On these instruments, the lips are relatively free from restriction to vibrate and, being able to do so at large amplitude can generate low frequencies. In addition, other than the Buccinator muscles can be used to control the Orbicularis Oris muscles. See Figure 1.12.[32]

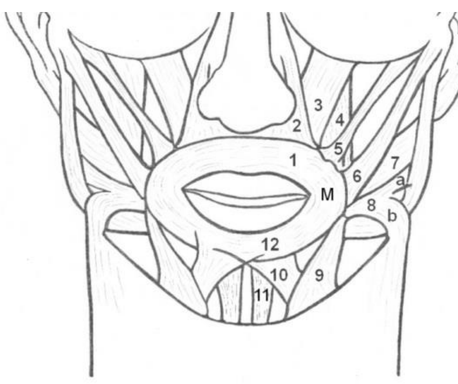

Figure 1.12:Scheme of Musculature of Embouchure

This allows control inputs to be introduced around this muscle, creating a situation where the fundamental frequency of vibration can be maintained, while harmonics are introduced by controlling specific parts of the Orbicularis Oris muscles separately.

[30] A plate of a First Australian playing the didgeridu was removed at this point as it is now felt to be inappropriate and not to advance the argument further.
[31] This was a slide didgeridoo made by the author for the Artist Rolf Harris who needed and instrument he could tune in order to fit in with orchestras instead of them having to tune to him. Possibly the first-ever, chromatic didgeridoo.
[32] Figure 1.12 is adapted from Porter, 1967, fig. 3.

For instance, on an experimental side-blown instrument made for this study, the first formant F3 was produced with a very relaxed embouchure and very low applied pressure. On slight tensing of the mentalis muscles, the lower lip is tightened slightly, resulting in an audible modification in tone-colour by the addition of an A4 into the spectrum. Then when the Mentalis muscles are relaxed and the Depressor labii inferioris muscles tensed slightly the A4 disappears and a C4 appears in the spectrum.

Thus, when the cycle of : relaxed - tensed Mentalis - tensed Depressor - relaxed, is repeated, the characteristic hollow beat of the didjeridu is generated. Only when the blowing aperture of an instrument is large enough, however, can such a sound be produced, the smaller aperture restricting lip movement.

The tone colour can be further enhanced by means of tones generated by the vocal folds and "spoken" through the instrument. Such sounds may be used in a sustained way to enhance the tone colour generally, to inject regular rhythm into the performance or to create special highlights with loud interjections.

An additional feature of modern didgeridoo playing is the use of circular breathing, i.e., the sustaining of the note by means of controlled breathing in through the nose while continuing to blow out through the mouth.[33] When doing this, the cheeks are used as a reservoir in much the same way as bagpipes use the air bag for a constant supply of air. By use of this technique, the instrument can be used as a drone to accompany singing or chanting, at the same time providing rhythm by varying the tone-colour of the sound.

Thus, with variable tone-colour instruments it is difficult to define the individual instrument sound in isolation from the performance. The sound that emerges from the bell of such an instrument contains its own, very characteristic, mixture of harmony and rhythm. As now used, the didgeridu lays down a basic sound pattern to which is added rhythmic accompaniment; with simple idiophones, the performer frequently tapping the instrument itself and adding the sung component. (Jones, 1967, 23ff.)

Side-Blown Player-Voiced Aerophones

A further usage of the animal horn to produce musical instruments is seen on side-blown instruments. On these, an aperture is cut downstream of the tip so that, when blown the instrument lies across the face of the player from right to left (a right-hand instrument) or vice-versa. For ease of playing, the blowing apertures of these instruments are frequently built up to form a mouth-support and, hence, the instruments are often made of material that has a thicker section at the tip such as ivory. Other materials are also used to build instruments up from separate parts, such as gourds and other organic material.

[33] It might be apposite to mention, at this point, that the didgeridoo and its mode of playing were both relatively rare when this was written in the 70s. If someone in the UK had heard of the instrument, it was almost certainly through the efforts of one Rolf Harris entertainer/artist and not as a result of their ethnographic studies or membership of a hippie circle.

Because of their short length and rapidly-opening bore, the archaeological side-blown instruments generally only allow one note to be produced. However, very long side-blown horns of wood are not uncommon in the ethnographic record.

Some instruments, particularly those of instruments where a hole bored through the tip which allows a second tone to be produced by opening and closing this. This is also used along with hand-stopping in Africa.

Shell Instruments

One other material commonly used for both end and side-blown instruments is the shell from marine gasteropods, such as Turitella, Concha and Triton. The living cavity of these shells is in the form of a cone which spirals around a central axis. Thus, to convert such a shell into a musical instrument, an entry has to be made into this cavity either at the tip, for an end-blown instrument, or the side, for a side-blown one. These instruments are still widely used throughout the world and hand-stopping to increase their range is widely used.

Ensemble Playing using Player-Voiced Aerophones

A general association with PVAs are idiophones of various types. These are used to this day in Australia and are reported generally in other ethnographic work. In Australia, the didjeridu player frequently uses the instrument itself as an idiophone, and a similar situation obtains where rattle plates and similar devices are fixed to instruments, such as the lurs. (See Chapter 4)

By their nature, PVAs are not suitable for playing melodic lines unless their length is such that their upper formants are reasonably close together, as on the Baroque instruments. (See Baines, 1976, 27 for discussion on this point). Their potential is, of course, increased where two instruments play together and, as with most other instrument types, a common pattern of usage is for two instruments to be played together. Thus, as the upper and lower formants of conical PVAs have a frequency relationship, of integers 1, 2, 3, 4, 5 etc. there will be octave correspondences at 1:2:4, etc. and it seems likely that these would have been exploited, leading to polyphonic music being performed almost naturally. In fact, when two such instruments play together, it is harder to play in unison than to play polyphonically.

Of all instruments, the PVAs as a group might be said to be most naturally polyphonic. When sounding their first five playable tones, they produce all the notes of what we, in the western musical tradition, see as a major chord based on their lowest formant. See Figure 1.13. Thus, any difference between two players in terms of notes played would result in a composite tonal output which was richer in the spectrum of sound and may have been exploited as increasing the quality of the performance produced.[34]

[34] This section has been re-written slightly to remove references to the 'harmonic' nature of the first five formants of a conical instrument.

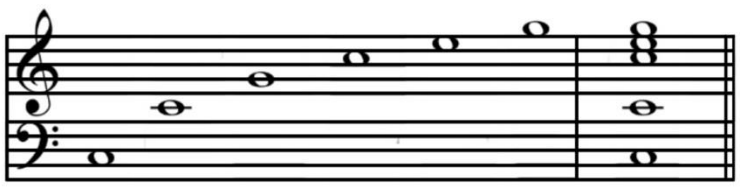

Figure 1.13: The First Six Formants of a Conical PVA expressed in Moderm Musical Notation

Several authors have considered that, for instance, the lurs were played polyphonically, others that they were used to answer each other, and yet others that they simply played in unison.[35] However, recent studies in musical usage throughout the world has revealed that many geographical areas can be found where polyphony is used. Collaer[36] calls these areas of zones of natural polyphony and recognises several of these which he considers to be independent of each other.[37] Thus, instruments such as the lurs could well have been used melodically, with a polyphonic or duet accompaniment as on the record made by the Danish National Museum. (Side 1, track 1; Side 2, track 6).

Side-blown instruments are, generally restricted in range to one or two notes. This second note when it is available, is frequently obtained by the use of a hole bored through the tip of the instrument which can readily be covered by the thumb or finger. The opening of this hole allows air to flow through the section of tube between the mouthpiece and the tip and, on the instrument studied, raised the note of the horn by about a fifth. Thus, a rapid alternation of pitch of the horn can be achieved by opening and closing this hole.

However, in spite of this versatility, the instrument only has a range of two notes, and is not of much use as a melodic instrument. To overcome this limitation, several societies have developed a group technique where a number of side-blown instruments are used, each having a different basic note.

The Uses of Player-Voiced Aerophones

The societies which utilised the instruments studied here are very different from modern western society; music plays many parts in any society, but in the simpler non-industrial ones is generally better-integrated with day-to—day life, both sacred and secular. Of Australian aboriginal music Ellis[38] says:

> *"There are three distinct groups..... The first and largest group consists of the sacred and secret ceremonies. These songs have no connection with pure entertainment but are songs which can only be performed in a particular place and for a specified purpose....*
>
> *The second type of music is the semi-sacred of which there is a large amount.... (These songs) were sung at the initiation ceremony of a young boy, and were performed by the men while the women danced.*

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35 See Oldeberg, 1947, 5-11 for a summary of these.
36 Collaer, 1968, 5.
37 Collaer, 1968, op. cit. map 2.
38 Ellis, 1964, 5.

The third type is the non-sacred or pure-entertainment music. The songs comprising this group are the only form of Australian aboriginal music that can be performed by any person, man, women or child - any time, and at any place."

In the case of aboriginal music, the didjeridu is, of course, their only blown aerophone and is, naturally, subject to the restrictions of the music of which it is part. This is equally true of the other PVAs used in other societies where they may perform alone or as part of an ensemble using other instruments. However, in most societies there are uses to which PVAs are put which are particular to this group alone. This arises from the characteristics of these instruments, in that they are generally robust, compared with other musical instruments, and that their sound is loud, clear and capable of travelling over a great distance. The uses specific to PVAs can be grouped under the headings: Ritual, Military, Musical, Social and Industrial. These headings are not mutually exclusive as there is considerable overlap between them but they characterise the major uses to which different societies have put PVAs.

RITUAL USES

Religious

In these, the folk memory appears to maintain the more ancient view of the instrument sound as the voice of their God. Later, this may be interpreted as speaking to God or contain such symbolism as the remembrance by Israel of the ram sacrificed by Abraham instead of his son.[39] Later still the blowing of the shofar was "invested..... with the faculty of raising awe and devotion in the heart and soul of the people. Furthermore, the sounding of the shofar was to remind man of his duties to God."[40] Instruments were used in funeral processions in the Roman world where, "The procession, led by flute players, lituus player and horn-blowers is an elaboration of the Journey to Hades on late Etruscan urns".[41]

As a signalling instrument in religious practice, PVAs serve to call the faithful to prayer and to mark the progress of religious acts such as in the Roman sacrifice where cornu players frequently attended. Again, here, their voice may serve a symbolic purpose but it is also possible that they serve an altogether more practical purpose - that of covering the cries of the animal to be sacrificed.[42] Both in the Lustration. of the troops and Suovetaurilia, cornua and litui were used both in procession and during sacrifices performed at that time.

Civic, State and Ceremonial

In these uses, the specific character of PVAs is utilised, principally for the sounding of fanfares and similar musical forms that have become associated with the pomp and ceremony of civic and royal occasions. It is probably the characteristic tone-colour

[39] Sendrey, 1969, 545.
[40] Sendrey, 1969, 545.
[41] Ryberg, 1955, 56 foot-note.
[42] Ryberg, 1955, pl. XLIII.

of the PVAs, along with their impressive appearance when made in a straight form, from precious metals, that has given them this role which they now fill almost world-wide.

In civic life, in Roman times, the bucina called together the elders to meet "Buccina cogebat priscos ad verba Quirites".[43] In Britain, however, a property seems to have been attached to the particular instrument which was used, this generally being a horn. These Burghmote Horns are kept within the civic building, to be blown on occasions to which the instrument added authority. Such assemblies were often called *Hornblowen*.[44]

Symbolic

In their use as Burghmote horns a degree of symbolism is seen, but with the practice of Cornage or Horn Tenure this is taken to a much higher degree. In such a practice, the ownership of an estate was symbolised by the ownership of a horn. Thus, the willing of such a horn was the willing of the estate and was held in law to be so.[45]

Military

Signalling

The major military use for PVAs in the ancient world is in signalling, both to keep time in marching and to give orders on the battlefield. Egyptian iconographic references are the first to demonstrate the use for timekeeping (IC 51, c. 1500BC), and this practice seems to have been continuous to the present day. Of their use to give orders, the Roman documentary references give the earliest detail (DR 72) although it is quite likely that such use was made of these instruments at a much earlier date. Again usage of PVAs to perform this function is continuous, the bugle being the common modern instrument used.

Psychological.

The Celts[46] seem to have made use of their instrument, the carnyx, to strike terror into the opposing army. They used instruments in enormous numbers to obtain a vast and terrifying volume of sound. (See Chapter 6)

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[43] Propertius DR175.
[44] Bridge, 1904, 158.
[45] Bridge, 1904, 92.
[46] I would now use the term *Native Iron Peoples* to refer to this population, as the major references are Roman and, principally to the Gallic areas.

Musical

Artistic Performance

Instruments are used extensively today in performance for an audience. This is not so generally true in simpler societies, where music as most other social actions, involves the whole community, as it presumably did in ancient societies. However, iconographic references give many indications that groups of musicians played before the royalty of Ancient Egypt (e.g. IC164), and specific references are made to the prowess of particular performers such as Hosy. In ancient Israel, music "was looked upon as a necessity in every day's life, enjoying equal rights with the other two primitive professions, as a beautifying and enriching complement of human existence".[47] It was thus regarded as equal in status to the work of the herdsman and the metal forger.[48]

Of course, music also played a part in the theatre as an accompaniment. Here, PVAs were used together and with other instruments, as depicted on the two mosaics from Zliten (IC12 and IC 40). On these a tubicen and two cornicines, along with a hydraulis, are accompanying the butchery of a gladiatoral combat. (Plate 2.5 (b).

SOCIAL

Personal Entertainment

Enjoyment of an individual when playing his instrument was, no doubt, as great as that enjoyed by an individual today and, the same must have applied to the group in rehearsal. Similarly, the social occasion, when accompanied by a group would have benefited equally. However, the PVAs, generally, are loud instruments, and it was in the arena, as mentioned above, and in the hunt, that they were extensively used. Several iconographic references depict their use such as on IC140 from a tomb at Marisa.

INDUSTRIAL

Control Devices

Several uses of PVAs are described in connection with the employment of the players. One documentary reference, for instance, tells of the use of horns by shepherds and of the knowledge that the animals gained of the calls. In hunting for food, instruments were used to signal calls identifying danger or the presence of prey. Calls were also used in a quasi-military role to co-ordinate the efforts of a large number of workers such as in the moving of the colossal bull at Nineveh (IC10).

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[47] Sendrey, 1969, 60.
[48] The Bible, Gen. IV:20 – 22.

The Cataloguing of Data on Instruments

During the course of this study it has been necessary to locate references to PVAs of various types. Considerable difficulty has been experienced in this task, as many authors refer to instruments without giving any location for these or adequate cross-reference to allow the instruments to be found. In books such as Behn's "Musikleben im Altertum und Fruhen Mittelalter" (Behn, 1954), which must rank as the classic study of ancient instruments, the greatest difficulty has been experienced in locating all the material cited. In fact, some of this has not yet been located. It was decided, therefore, that a major part of this study would be the creation of a comprehensive catalogue which could form the basis for future studies, giving ready access to the material located during this particular work and facilitating the grafting-on of future knowledge onto this data base[49].

This catalogue, which is included in the study as Appendix 1, is sub—divided as outlined below:-

Specimen Detail

All extant instruments and fragments are catalogued under this heading, and given a reference number prefixed by "SD." In the case of the Irish horns the catalogue numbers assigned in John Coles article, ‘Irish Bronze Age Horns and their Relations with Northern Europe[50], are adopted, simply being prefixed by "SD." As Coles catalogued these on find-spot. i.e. assigned the same reference number to all those from a particular find, individual instruments are differentiated by means of a suffix - A, B, C etc. In this respect this listing differs from others in the catalogue, but as this paper is well established as a standard on these horns and the assignment of numbers is a purely arbitrary exercise, the maintenance of this difference was felt to be acceptable. In the case of the Lurs, the numbers assigned to these by Broholm[51] were changed from 1 to 55 to 101 to 155, prefixed and used thus.

Iconographic Reference

All pictorial representations, e.g. reliefs, rock carvings wall paintings etc. are catalogued under this heading and given a reference number prefixed by "IC."

Documentary Reference

All ancient contemporary documentary references to PVAs are catalogued under this heading and given a reference number prefixed by "DR."

[49] This catalogue is now available at: http://www.hornandtrumpet.com
[50] Coles 1965, 549 ff.
[51] Broholm 1949, p. 12 ff.

Specimen Representation

All representations, e.g. statues, are catalogued under this heading and given a reference number pre- fixed by "SR."

CHAPTER 2: The Horn and Tuba in the Ancient Mediterranean World

Throughout the modern world, in the ethnographic record and, it appears, much of the ancient world, the animal horn has been used as a PVA. By its form and nature it provides a hollow cavity which is easily entered, to provide an instrument's resonant cavity, or when left intact provides a hollow container that is useful for the storage of liquid or for drinking. Within this duality of function lies a problem, that of determining in a specific case whether a "horn" is adapted for use as a drinking horn or as a musical instrument. With fragmentary finds, this problem can be acute, the only answer being to consider, on its merits, each particular case. The presence or absence of the horn tip may be a guide but the horn, being capable of use as an end blown or a side-blown instrument may retain this or lose it to suit the specific case.

As the cavity of the horn itself is designed by nature, man's influence is felt most on the mouthpiece design. Kept with a small throat, a horn can be capable of yielding two or sometimes three notes, these being the 2nd, 3rd and 4th formants of its resonant cavity and this form of PVA is seen in a myriad of forms in societies utilising the wide range of animal horns from which instruments can be made.[52] Probably the best known of this group is the Shofar which has a long recorded history and is still utilised today in Jewish ritual.[53]

Almost as ancient in the archaeological record is the simple trumpet, a straight tubular instrument which developed by the end of the Roman era to the tuba. However, following the demise of the Romans, the practice of writing in Latin continued and early medieval authors retained the name for the long instrument which later became the buisine. In the present study, this group of instruments will be referred to as the Tuba.

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[52] See Diagram Group 1976, pp. 66 and 67.
[53] Sendrey, p. 542.

Being made of metal, it probably represents the first actually manufactured PV aerophone that man had, and is thus among the earliest outputs from the metal instrument industry.[54] However, ethnographic evidence shows that a wide variety of naturally-occurring tubular objects such as wood, bamboo, bark, gourds and reeds are used to make what are essentially cylindrically-bored instruments.[55] It is not proposed in this study to maintain a rigid distinction between "horns" (i.e. conical bores) and "trumpets" (cylindrical bores) as this distinction cannot be readily applied to the ancient instruments considered here, although its value in acoustic terms cannot be gainsaid. (as discussed in chapter 1) In this chapter, therefore, the horn and tuba are examined, representing as they do the typical combination of PVAs in use prior to Etruscan times.

ANIMAL HORNS

The earliest reference to the use of these as instruments is in an inventory, (DR 6) where the instrument name "Sim" is prefixed with the copper determinative and the item is included in a list of copper articles dating from the middle of the third millenium BC.[56] A somewhat later reference (DR1) tells of 40 horns given to Amenophis IV, c. 1400BC. These were covered with gold and some were studded with precious stones, 17 of these being specifically referred to as ox horns.[57] The earliest iconographic reference to depict a horn of this form is on a painting in a palace at Thebes, (IC195) which dates between 2160 and 1580BC. The earliest references found, where the morphology of the instrument is seen, is on the Carchemish reliefs (IC7), c. 1250BC, where a horn is blown alongside a large frame-drum.[58]

[54] The award for the earliest is rather populist and it is equally likely that a cast form of instrument was among the first.
[55] See Diagram Group, 1976 , pp. 58, 59.
[56] Galpin, Sumerians 1957, p. 25.
[57] Sachs, 1940, p. 75.
[58] Galpin, Sumerians 1957, pl. III. See fig. 2.1.

Figure 2.1

So suitable is the design and manufacture of the material that nature provided, that little development of this basic instrument took place. Its outer surface was covered by metal, as described above but no ancient examples were found in which the natural material was totally replaced.[59] This seems to be as true of recent material, where metal may be used to provide a mouthpiece, carrying ring mounts or a garland or, in some cases, to cover the whole instrument as on the Bolivian horn in the Naprstek Museum Prague.[60] Although such fittings have been found elsewhere in ancient contexts (for examples from North Germany, see Chapter 5) no such material is forthcoming from this area.

One iconographic reference, IC151, shows the Roman army in Egypt with one of the group blowing an animal horn. Around the bell of this instrument is a considerable annular bell—disc and it seems reasonable to suppose that the remainder of nature's product had been adorned, perhaps with a mouthpiece and decorative bands.

Instruments made in horn form are known widely from the iconography of the Mediterranean area, those found in this study being: IC156, Assyrian c. 700BC; IC96, Greek c. 550BC; IC100, Etruscan; IC145 from Este c. 50BC; IC150, Roman Spain c. 70AD; IC149, Shofar, Hebrew c. 200AD; IC21 and IC147, Sassanian. It is not possible to say from the illustrations whether these instruments are of

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[59] This statement might really call for some modification as, in the case of the Irish horns, some of the instruments are metal analogues of animal horns.

[60] Diagram Group, 1976, p. 67.

horn or metal but IC96 clearly has some feature at its tip, most probably a mouthpiece.

In spite of the utility of natural horns, however, analogues were made in other material. In Northern Italy, for instance, in the Po valley, a clay animal horn form of instrument was found in a Terremaren cultural context of roughly 1200BC. On this instrument (0.43*m* in length, with an obliquely cut tip) the first formant can be sounded and, with great difficulty, the second.[61] However, this instrument, a manufactured horn analogue tells of manufacturing activity in this region at a time roughly contemporaneous with SD201 and 202, the Tutankhamen instruments. This could suggest the independent evolution of these instruments (See also Chapter 6) and their manufacture in a medium, well understood by these urnfield people who migrated South from the Danube area.

One other clay horn found in the Fayum dates from the first century BC and is identified in Bessaraboff[62], as a Graeco-Roman Bacchic horn. It is red earthenware and elaborately decorated with low reliefs, and appears to have a mouthpiece of about 17*mm* rim diameter, The use of a clay medium to reproduce a naturally occurring object undoubtedly resulted from the knowledge that the properties of the animal horn could be replicated in a medium that the maker could control and, in return, gave him the ability to decorate it in a way appropriate for its use. Given the ability of the Greeks to manufacture ceramics, their use in this case is not surprising, nor is their lack of organological imagination in retaining the natural form and rejecting the opportunity for change that this medium offered.

A further analogue from about the fourth century was found at Etruscan Populonia. This instrument is in the shape of a curved horn with a well-developed mouthpiece, probably cast integrally with the horn body. Unfortunately few other details of this instrument have been found, nor has its current location[63]. However, the presence of an instrument such as this, a well-constructed bronze analogue of an animal horn, shows that this form was not simply regarded as inferior to the other types that had been developed by the fourth century BC, but was a type in its own right.

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[61] Behn, 1954 , p. 127.
[62] Bessaraboff,(1941, p. 156, no. 154)
[63] The instrument is now known to be in the Museum in Florence and has a relatively simple mouthpiece in the form of an oval plate joined, probably by brazing, to the wrought body of the instrument.

The Tuba

One of the earliest instruments to break away from naturally occurring forms and to be constructed from a variety of materials was the Tuba. Being essentially a straight tube of cylindrical or conical form, its natural beginnings would seem to lie with hollow reeds, bamboo, bone or similar material. However, the ethnographic evidence illustrates the enormous variety of materials that can be taken from nature perhaps used initially as voice modifiers and later utilised as PVAs. Interestingly, from 4th Dynasty Egypt (2725 - 2565 BC) comes a reference to the use of a megaphone to summon troops, paralleling exactly the use of the trumpet seen from the 18th Dynasty onwards and, perhaps, pointing to a sequence of development from megaphone to PVA.

The first reference to an instrument of a tuba type is probably an illustration carved from a limestone fragment from Khafajah, (IC9) c. 2600BC.[64] Figure 2.2(a). This is a straight conical instrument, about 0.74*m* long (scaled), with a semi-vertical angle (α) of 55*mrad*. (See Chapter l, Figure 2,2,(a)).

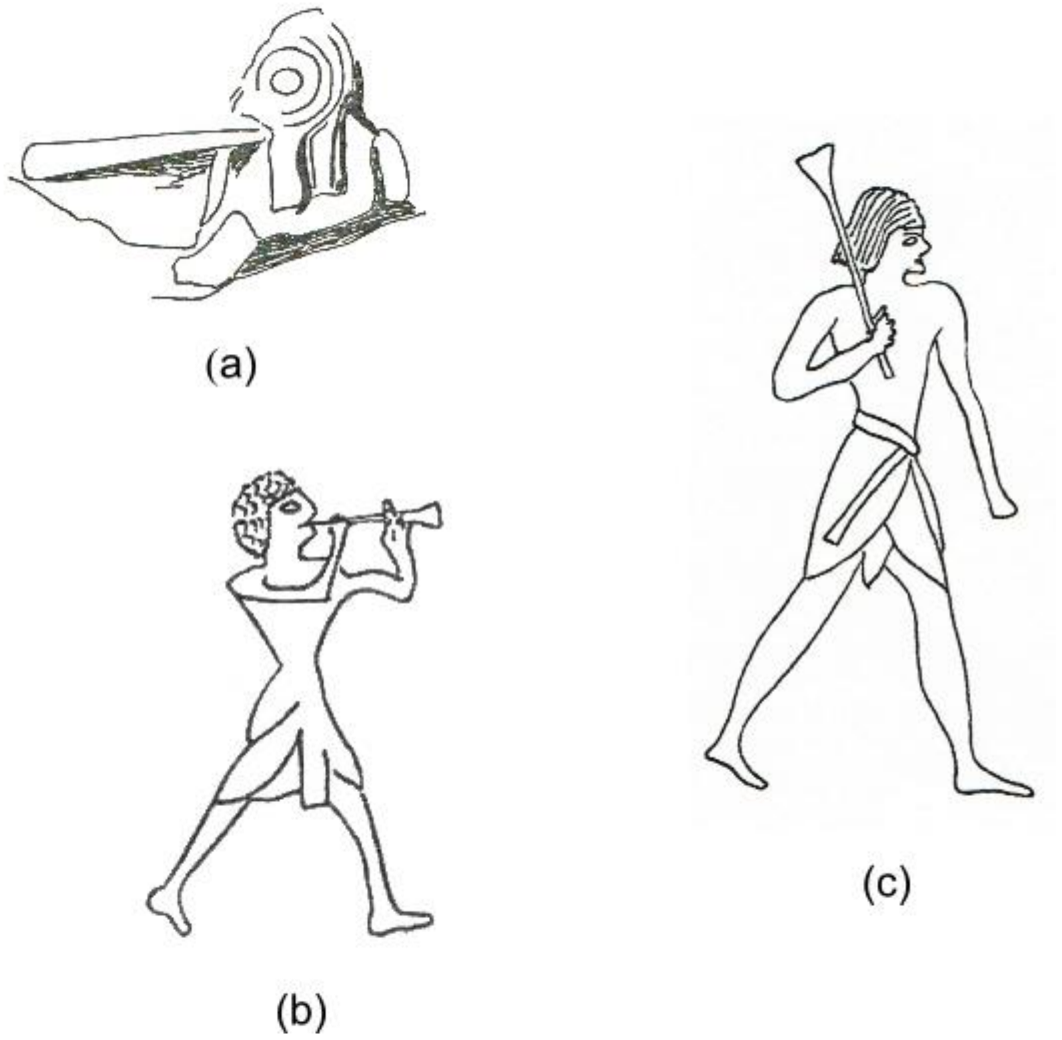

Figure 2.2

[64] Frankfort, 1959, pl. 100(c)

The tuba is again referred to shortly after this, in text found in a pyramid in Egypt, dating from c, 2423BC, giving the name snb. An iconographic record contemporary with this text (IC152), shows a trumpet player on a boat crossing the Nile. Unfortunately, this carving has lost its upper portion and only the bell of the instrument can now be seen, with its end diameter scaling at about 120 mm, i.e. of the same order as in the much later references , which appear some 900 years later.

The first of these later instruments, IC51, on the temple of Deir el Bahari (1505 - 1484BC), shows the form of this instrument clearly. On this illustration (See figure 2,2 (b)), it consists of a tube yard which is depicted by a single line and a bell yard which is short and opens out rapidly i.e. (length = 0.29*m*. α = 0), hereafter written: (0.29, 0.0 (tube-yard) 0.14, 5.18 (bell-yard)). Other depictions such as IC52, from shortly after this (c. 1400BC), show clearly parallel tube-yards represented by two lines. (Figure 2.2 (c)).

Thus, the form of these instruments is different from that seen at Khafajah (Figure 2.2 (a)) and, on IC52 mentioned above, the soldiers in this representation have feathered head- dresses which Hickman describes as typical Lybian.[65] The two-cone type of instrument with defined bell and tube yards could well have originated either in Egypt or perhaps further to the west, in North Africa. Whatever its origin, however, it remained the key instrument of the military unit up to at least 1000BC, when the iconographic evidence ceases. Several instruments are depicted as having separately made bell yards, and for technical reasons (discussed below) this would be the obvious way of constructing the instrument. However, the form of this bell yard varies greatly both in size and morphology, and the flared bell can be seen alongside the straight conical bell throughout the iconographic record. Indeed the Tutankhamen instruments themselves (SD201, SD202) consist of one with a conical and one with a (slightly) flared bell.

THE TUTANKHAMEN INSTRUMENTS

These instruments, found in the tomb of Tutankhamen and known as Tutankhamen's Trumpets, date from about 1350BC and are made, one of silver with gold mountings and the other of bronze with

[65] Hickmann, 1961, p. 74 and Abb. 52.

somewhat longer gold mountings.[66] They are 494*mm* (bronze) and 582*mm* (silver) in length, the remainder of the dimensions being as shown on Figure 2.5. Further valuable information about the bronze trumpet's mode of construction came to light in 1975 when the Tutankhamen exhibition visited London[67] and this demonstrates, from the very high quality of technical skill involved in manufacture, that this instrument would clearly be a highly valued object. They are made of 9 parts:-

1. Tube yard
2. Bell yard
3. Mouthsupport forming ring
4. Rivets (four-off)
5. Mouthpipe decoration
6. Tube/bell yard decoration

Both yards are fabricated from thin sheet metal, the tube yard of 0.2 — 0.25*mm* thick sheet and the bell yard of 0.1 - 0.13*mm* material. Four rivets fix the two yards together the tube yard fitting into the bell cone and this joint is covered by a very-thin gold sleeve. At the instrument tip a scarfe-jointed ring is placed over the tube and the end of this swaged over this ring to form a smooth mouthsupport. The ring appears not to be fixed in position by means other than an interference fit between it and the tube and it appears to have slipped down the tube somewhat since manufacture. (Plate 2.1 (a))

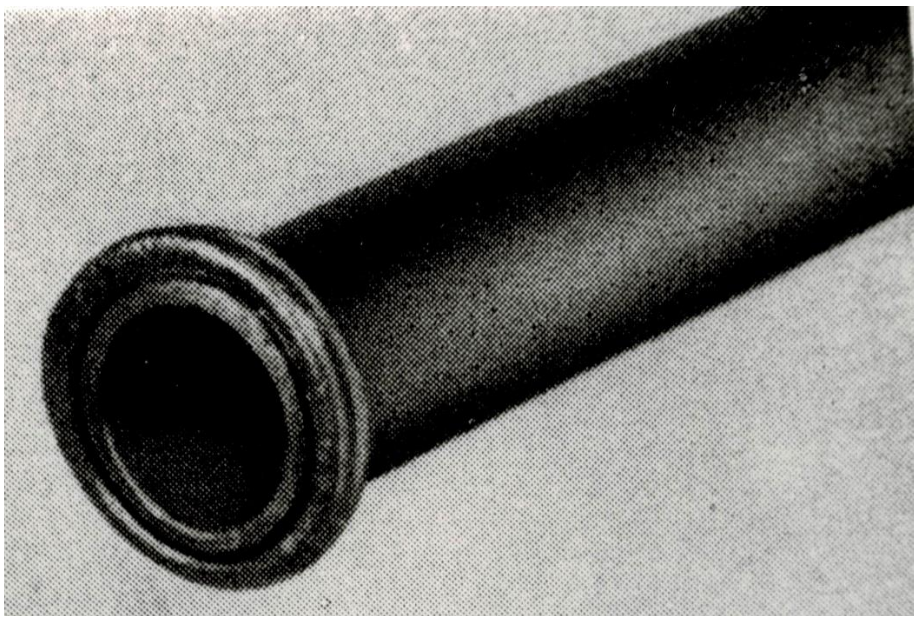

Plate 2.1: Tutankhamun Trumpet Lipsupport

[66] Kirby, 1946, p. 55, Hickmann, 1946, p. 62 plus many other references.
[67] Montagu, 1976, p. 115.

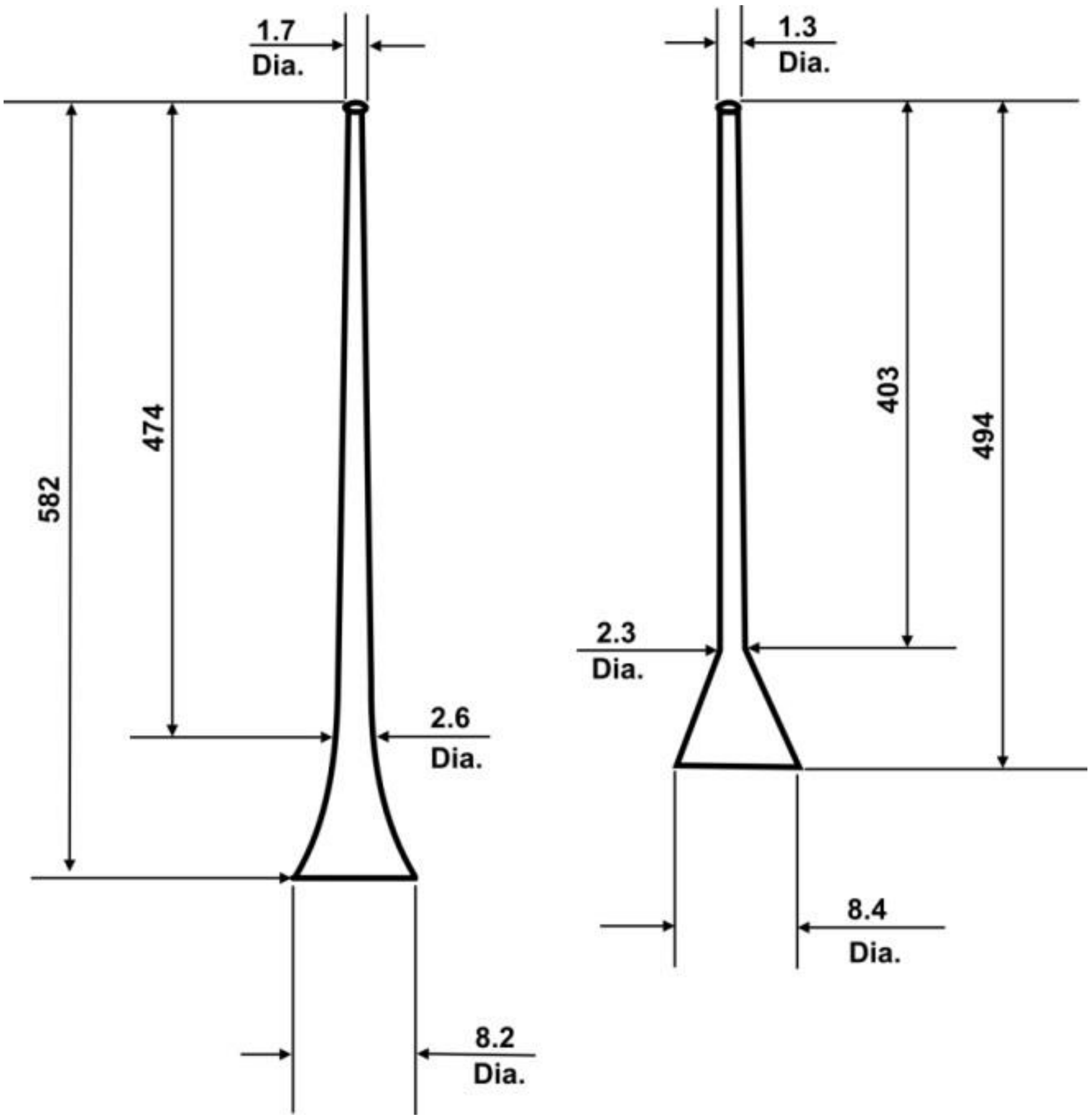

Figure 2.3: Dimensions of the Tutankhamun Instruments

Along the tube yard, the seam can be detected; it was formed by interlocking the slotted edges of the sheet and then brazing as is done in modern instrument manufacture. On the bell, no seam was visible and Montagu[68] suggests that it 'was pressure welded."[69]

Being very fragile, by virtue of its fine wall thickness, this instrument is provided with a decorated wooden stopper which slides into the bore. To the manufacturer, this stopper would probably represent an analogue of the mandrel used in forming the tube. In this area the tradition of beating metals, perhaps initially native copper and gold, over carved wooden patterns was already old by the time of Tutankhamen, although the seaming of the metal as described above was probably of no great antiquity at that time. In the case of the bell,

[68] Montagu, 1976, p. 115.
[69] While this might have been possible with the gold pieces, some other method must have been used with the silver and copper components.

the seam of any gold components could indeed have been produced by hammer welding, but it would seem more likely to have been raised from sheet over a mandrel. If formed from sheet, from a developed shape, the process of hammer welding would be quite difficult to carry out on a seam such as this.

In view of the delicate nature of this instrument's mouth support, and the apparent lack of fixing to the tube yard, Montagu[70] considers that only the middle note of the three playable on this instrument (see Figure 2.4) would have been used.

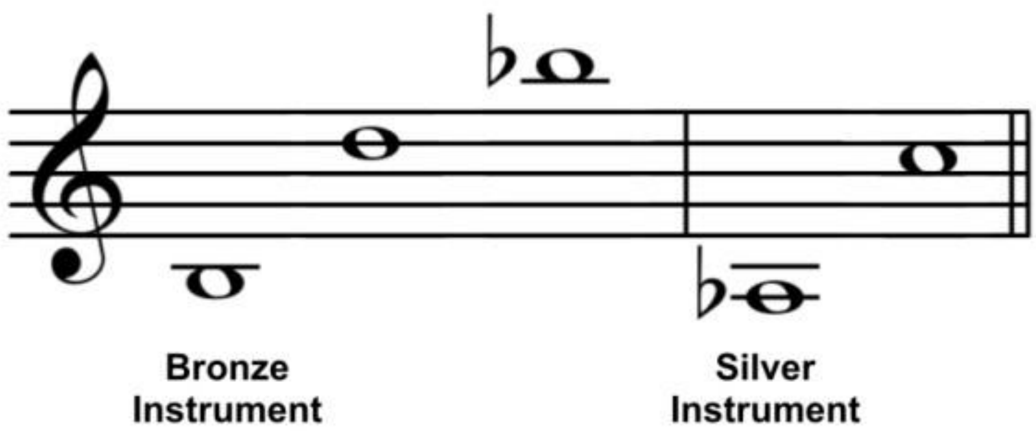

Figure 2.4: The Range of the Tutankhamun Instruments in Modern Notation

This seems reasonable in view of the fact that the lower note is rather poor, the middle note is a good trumpet tone, and the higher note requires a considerable pressure to be applied in order to sound it. However, it was possible to sound this, higher, note on a copy of the instrument made for this study using metal of the thicknesses quoted above. Indeed, in spite of the thin gauge of the metal, the instrument proved to be surprisingly robust.

On the silver instrument, SD201, the bell is slightly flared. Acoustically-speaking this helps a little in easing the wave-impedance discontinuity at the bell opening and also produces an instrument which may have been more attractive to the users. In addition, the flared bell has much greater rigidity than the straight cone, being structurally superior in terms of resisting deformation due to banging, dropping etc.

[70] Montagu 1976, p. 117.

One of the peculiarities of the two Tutankhamen instruments is that they are not a pair in any sense of the word. They are tuned a second different (C_5 and D_5), made out of different material, and have different bell shapes. One could accept the difference in tuning, as the instruments could have been made to be used alternately, but the other differences seem unacceptable in a pair. Furthermore, a passage in the talmud tells that the sacred trumpets used at various rites were of exactly the same dimensions[71], and, although this refers to a different religious usage at a different time, the parallels are generally quite close. It seems, therefore, that as with other aspects of his burial, Tutankhamen's untimely death led to a certain amount of haste, and the requirement for a pair of trumpets was met by the use of two "odd" instruments.

INSTRUMENTS OF THE TUTANKHAMEN TYPE

The majority of the instruments seen in Egyptian iconographic records are of the type with bell and tube yards of different conicity. On some of these the slightly flaring bell runs smoothly into the tube slope, the joint between the two being visible. One instrument of this flared-bell type dates from the time of Cleopatra, c. 120BC (SD217). It is 540*mm* long with a tube yard tapering from 15 to 25*mm*, and opens out to a bell of 160*mm*, thus having a very pronounced flare.[72] As with the other instruments from this area, it is made of sheet, having a seam down its length, which has now failed. In spite of the late date of this instrument, it is interesting to note that it still retains characteristics more typical of this area than the Roman North and, were its bell to be convex rather than concave would be a perfectly good example of a Salpinx.

The latest of the Egyptian iconographic references found in the present study (IC164) dates from the Roman period, 30BC to 395AD, and a gap of approximately 1000 years exists between this and the previous record. However, the instrument in IC164 could easily be mistaken for one from 1000 years earlier. It has the same morphology and, in particular, retains the same tube/bell yard form of construction seen in the early instruments. In fact, Hickmann (1946) illustrates an Arab

[71] Sendrey, 1969, p. 356.
[72] Kirby, 1946, p. 56 and fig. 2.

trumpet from the Middle Ages (Plate II), and this too remains, in all its essential features, unchanged from ancient times.

However, to the North-West of Egypt, contemporary illustrations depict instruments of the straight conical type which seem more related to those coming from the East, as on IC9 (See figure 2.2 (a)). Only one other group of instruments, the Greek salpinges have similar form to these double-coned Egyptian instruments.

The Greek Salpinx

This instrument has a most-distinctive form being made up of a long narrow cylindrical tube-yard, with a cup-like bell at its end. Figure 2.5, (IC75).

Figure 2.5: A Greek Salpinx

It could quite simply have been a development indigenous to the Greek people, alternatively an import from North Africa where instruments of this type were being made from about 1500BC onwards, or it could have been adopted, (the accepted Greek view) from the Tyrrhenian people. In fact, about 560BC, the Greeks established a colony at Cyrene in Libya, thus creating a suitable link with an area that, around that time was alternately just inside and just outside the Egyptian Empire.

The Greeks, however, held the view that the Salpinx and the musical horn were invented by the Tyrrhenians, (Peoples of western Italy including the Etruscans). (DR57). According to Greek tradition, the instrument was frequently used by Tyrrhenian pirates as a signal instrument,and was thus taken over by Greek sailors who gave it the name "pirate- trumpet". The earliest certain reference to its use, in DR72 , dates to the 5th century BC. Certainly, about this time Greek colonies were being established on mainland Italy, bringing them into cultural contact with this area. As is discussed in Chapter 3, a wide range of instruments were being produced in Italy around 500BC, and one of these types (SR2) has a very salpinx-like form. It was found in Campania and dates to about 470BC and, although it appears to be a side blown type, its tube and bell form are of the forms adopted on the Greek salpinx.

About this time, the representations of Salpinges also begin to be seen on Greek ceramics viz. IC95, 527-514BC; IC74, 525-500BC; IC97, 520-490BC; IC75, c. 510BC. For this century or so they are seen, and then they disappear, a similar pattern to that seen for the Egyptian trumpet between 1500BC and 1200BC. This is perhaps a sign that the form is novel and imported, it being depicted frequently during its early days. However, literary references to the continued use of the salpinx are seen, but no illustrations within Greece itself found. For some reason, the instrument did not spread beyond the range of Greek influence but was taken by them into Thrace. At Kazanlik, two salpinx players are illustrated in a scene from a funeral,dating from 280BC.[73] In this Scene, (Plate 2.1 (b)) the two players are blowing salpinges held in their right hand. It gives the only illustration of a salpinx where the cup shaped form of the bell can be seen clearly. This cup is attached to a tube yard which is parallel over most of its length and then over the last quarter of this, flares out slightly to run into the cup shaped bell. With its total length of 580*mm* and a cup diameter of 159*mm* (both

[73] IC90; Zhivkova, 1975; Venedikov, 1974.

scaled), this instrument presents an oblique view which appears like a tube with disc attached at its end as seen on IC70 and IC74. Lacking an extant instrument, little can be said of the presence or absence of a mouthpiece on this instrument, as no illustrations clearly show one.

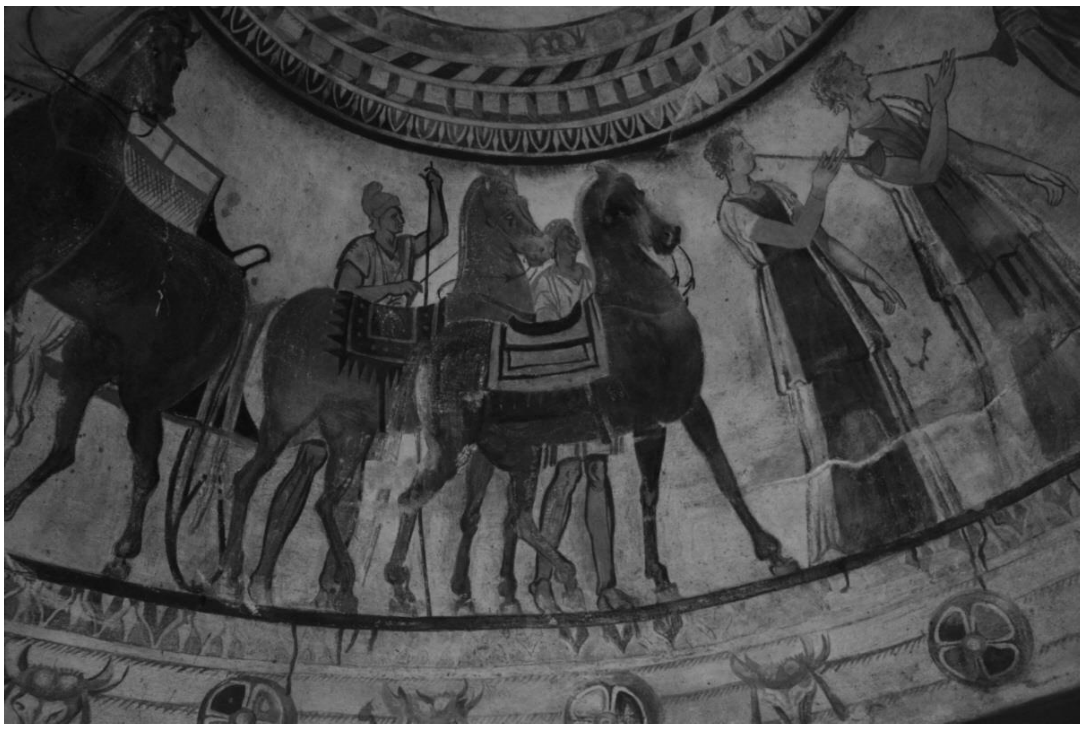

Plate 2.1b: The Khazanluk Salpinges Photo Courtesy of Klearchos Kapoutsis

The illustration of a salpinx in Behn[74] does appear to show a mouthpiece but this is a line drawing, and the slight bulge at the tube end is not visible in the photograph published in Boardman[75]. Behn[76] does say that the mouthpiece of the Salpinx was of bone but he quotes no authority.

Thus, from the iconographic record, the salpinx had a very uniform form and restricted distribution. So uniform, in fact that one can be certain that SD262, the so-called Salpinx in the Boston Museum of Fine Arts is not a salpinx but comes from further East, possibly being contemporary with the Salpinx.[77]

USE OF THE TERM "SALPİNX"

[74] Behn, 1954, Taf. 66, Abb. 151)
[75] Boardman 1975, No. 169.
[76] Behn 1954 p. 118
[77] Having carried out much more work on Greek instruments since this date, I would no longer agree with this statement.

The Greeks used the term ‘salpinx’ to describe not only their characteristic instruments but also, in a general sense, as "trumpet." Similarly the nations that used the Greek language were constrained by the use of this term. For instance, Diodorus Siculus writing of the Celts (DR9) refers to their trumpets ("Salpinx") as "peculiar as well to themselves as to other nations." Polybius refers to the use of an infinite number of horns (bukinaton) and trumpets in the armies of the Celts. Also in the translations of the Bible into and from Greek, confusions abounded in the use of terminology in describing instruments such as the Salpinx, Bucina, Keras and Karnyx. An attempt was made by Jerome to clear up this confusion about 400AD, (DR177) he says: "Buccina pastoralis est et cornu recurvo efficitur, unde et proprie hebraice shofar, graece keratine appelatur. Tuba autem de aere conficitur vel argento quae in bekkus et solemnitatibus concrepabant." "The buccina is the instrument of the shepherds, made from curved horn, therefore, it is called in Hebrew shofar, in Greek keratine, The tuba, however, is made of brass or silver and its resounding tone is used in wars and festivities."

THE SINGLE CONE INSTRUMENT

As discussed above, IC9 from Khafajah is the earliest illustration of a single cone type of horn (c. 2600BC). However, it is followed only shortly after this by a roughly-contemporaneous illustration of a much more complex instrument, IC155. This is a slim 900*mm* long (very approximate) instrument with a gentle flare on the bell. It confirms the presence of this design of instrument during the third millenium BC. A similar instrument is seen around 700BC, where two trumpeters are giving signals during the hauling of a colossal bull, IC10.

Whether or not this instrument evolved from a tube plus bell yard, is hard to say, none of the three early instruments (IC9, IC10, IC155) show signs of having been made in two parts but are of a uniform form. However, a documentary reference (DR5) from Ur, c. 1950BC, records the invention of the trumpet by Gilgamesh. This he makes from two hollow pieces of wood, the "pukku" and "mekku", presumably the tube and bell yards.[78] Presumably this instrument would be of a form that had a break in morphology between the yards, as on the Egyptian instruments. Presumably too, it would require some form of seal between these two yards which, when simply constructed would produce some form of boss. Features such as these are seen on the Tepe Hissar (SD254/5) and Asterabad horns (SD256/7) c. 2000BC but these seem to be too far north and east to suggest a relationship between these and Ur.[79]

A further reference from this period is found in an inventory of presents from King Tushratta of Mitanni in Upper Mesopotamia to King Amenophis III (DR1, c. 1580BC). Some of these were trumpets, "the pattu, reed or tube corresponding to the older mekku being bound, probably with willow bark or bast and the Kizallu (gourd or bell), the older pukku, made of wood overlaid with gold."[80] Once again the actual outline of the instruments cannot be deduced from this reference.

Shortly after this date, an instrument of this Northern type is seen on a stela found at Tell Horbet, dated to between 1298 and 1232BC. It is quite clearly straight-coned with a slight flare to the bell and lacks the usual clear break in outline between tube and bell yards which is seen on most Egyptian instruments. It scales at (0.91, 19.8) with the narrow mouth-support of the instrument about 12 mm diameter and, although some feature can be seen in this depiction, its exact form cannot be determined. Being longer and slimmer than the other instruments of this area, this instrument would be considerably better in terms of its playable range. It is significant that it is shown in the hand of Hosy, who according to Hickmann[81], was the first named trumpeter in Egyptian history.[82] Perhaps this instrument represents the choice of the virtuoso with the regular military use being satisfied by the standard instrument previously in use over several centuries. The new type probably came from the North, not necessarily on the occasion referred to in DRl but quite probably from contacts with Palestine during one of the periods when Egypt dominated the region prior to that date. Depending on the detailed form of the mouthsupport of this instrument, it would be possible for an accomplished player, as one supposes Hosy was, to sound I three or, at the most four, notes on this

[78] Galpin ,1957 , Sumerians, p. 22.
[79] Piggott, 1967 , p. 96, fig. 23 and 24.
[80] Galpin, 1957 , Sumerians, p. 24.
[81] Hickmann, 1961, 122.
[82] Hickmann, 1961, pl. 2.2 (a), p. 55.

instrument, Thus, the performance on this would be markedly different from that on the simple Tutankhamen instrument of earlier times. It seems probable, therefore, that the two other trumpet players named from the 20th Dynasty, c. 110BC, Perpetschau and Amonchau would also have used instruments of this form.

The Trumpets of Israel

“And the Lord spake unto Moses saying, make thee two trumpets of silver; of a whole piece shalt thou make them." Thus Israel was told to make its trumpets or chatzozerah, for use in "the calling of the assembly..... the journeying of the camps...... (to) blow and alarm" etc. Undoubtedly, after the sojourn in Egypt, they would be of the Egyptian pattern, either to the old design or to the northern pattern. Technically speaking, the difference is considerable, as the break in outline where the old type bell meets the tube yard, is of a form difficult to produce from a single sheet of metal. Figure 2.6 (ii) shows the developed surface - shapes of sheet to produce the tube and bell yards shown in Figure 2.6 (i).

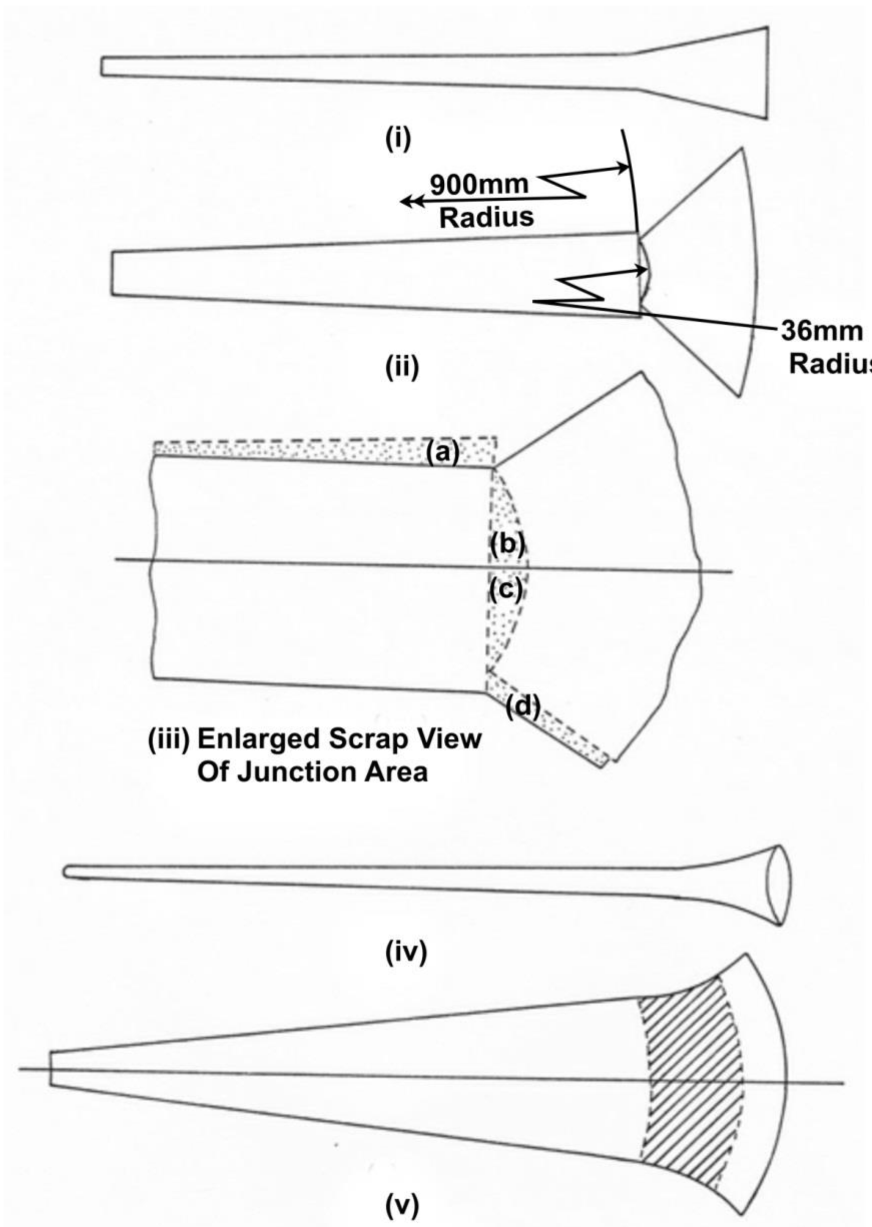

Figure 2.6: Cutting Out Material to make a Tutankhamun-Style Trumpet

Plate 2.2a: Hosy the Egyptian Trumpeter

In (ii) a gap can be seen between the two sheets where the 900*mm* radius of the tube surface butts up against the 36*mm* radius of the bell surface. The top half of (iii) shows where the tube-yard surface development has been trimmed to blend in smoothly with the bell yard surface. In this case, the tube yard section is now deficient by the amount of 'a', and the piece between the yards in surplus by 'b'. To accommodate this, the tube would have to be stretched by about 25% during working, and the material in the area of 'b' differentially thickened. The bottom half of (ii) shows the situation where the bell yard‘s developed surface has been enlarged to blend in with the tube yard. In this case both pieces 'c' and 'd' are now surplus, and the metal must be thickened here to accommodate this.

From the point of view of the smith working material of this very fine gauge, both the stretching and contracting are difficult to achieve. When stretching the material the danger is of thinning excessively, thus breaking through the wall altogether. When contracting the material i.e. thickening it, the problem is one of avoiding ripples in the sheet.

In addition, Moses had his metal specified as silver which, because of its work-hardening characteristic, would require frequent annealing. Had gold, or an alloy rich in this been used, then this problem would have been far less severe and the construction feasible. Indeed, the problem of joining together the two yards is so simple compared with the task of producing the tube seam that construction would be unlikely to be undertaken in any way other than that of the Tutankhamen instruments. Figure 2.6 (v) shows the developed shape needed to produce the straight single-cone instrument with a slight flare as shown in Figure 2.6 (iv). It can be seen that only a slight stretching of the metal is required in the area where the tube form is slightly spherical (shaded in on (v)). Were the cone to be made perfectly straight, i.e. without flare, no stretching of the metal would be required.

Thus, from the point of view of technical simplicity, and the fact that Moses was told to make the instrument of a single piece of silver, it seems probable that the northern type of instrument was made. By 1240BC, at the time of the exodus, this type of trumpet had been seen in Egypt for some time (IC167, Hosy, is approx. 1298BC), and was perhaps the type sent to Amenophis IV about 1400BC. In addition it would probably be the type that the Israelites would have met during their travels prior to the instruction to Moses.

Only three illustrations of the chatzotzerah exist, two on coins, IC55, IC194, 152-155 AD[83] and one from the Synagogue of Dura-Europos, IC154, 250 AD.[84] However, these are all late instruments, over one thousand years removed from the instruments in use at the time of the exodus. Nevertheless, they all show instruments of a single-cone form, one, of the two Bar Kokba coins, IC55, appearing to show a developed mouthpiece or mouthsupport. IC154 depicts a slender instrument, which scales at 400*mm* (very approximately). This dimension accords well with the figure quoted by Josephus (DR149)[85] of one Ell (457*mm*)[86] and an instrument of this length would be capable of sounding two notes. Because of the interchangeability of the trumpet and Shofar[87] prior to the destruction of the Temple in AD71, these two notes would be all that the chatzotzerah was asked to perform.

Because of the carefully regulated religious use of the instrument, it seems unlikely that it developed significantly for secular purposes and that the figures of Josephus (DR149) are reliable as a basis for reconstructing this instrument. It is surprising, therefore, that all students of this subject identify the two instruments on IC8 as chatzotzerot. In that scene, showing the Roman Army carrying off trophies after the sacking of the temple, two instruments can be seen pointing into the air. These scale at (0.99; 50) and (1.02; 25), thus being about twice the length of a chatzotzerah, but quite normal for a Roman tuba of that period. That Roman tubae, such as these, should be present at such an event, is not at all surprising. They are a normal feature of scenes depicting the Roman army in action, (see below, this Chapter) and were commonly carried and blown in this way, thus being quite in place here as, indeed, are the other accoutrements of the army seen in the illustration.

Had the chatzotzerot from the temple been captured by the Romans, it is unlikely that Roman tuba players would have played them, preferring their own instruments for several reasons: Roman tubae had developed mouthpieces while there is no evidence for the presence of these on chatzotzerot: Roman instruments had developed for complex military and entertainment usage; Roman players would be unskilled in the use of this, different type, of instrument. Thus the army would tend to display the trophies and play on the instruments they

[83] Sendrey, 1960, p, 64/65.
[84] Baines, 1976 , Fig. 5f.
[85] Josephus
[86] Tarr, 1977, p. 15.
[87] Wulstan, 1975, p. 29.

knew, in the manner they know rather than perform poorly on alien instruments designed for an alien religious observance.

The Use of the Chatzotzera and Shofar

Although the shofar itself is not discussed until later in this chapter, its use is so interconnected with that of the chatzotzerah that this is discussed here. No attempt is made to deal with this subject in more than summary form, as it has been dealt with in such detail previously.[88]

As early as in DR82, Numbers 10.1,when the Lord told Moses to make the trumpets, the ground rules for their use was laid down. He told that they were to be used for the calling of the assembly, to sound the alarm to use in days of gladness and at time of sacrifice. Their use was reserved for the sons of Aaron although, on secular occasions, people other than priests were allowed to blow them.

At the daily sacred service, the chatzotzerot were used to mark the progress of the ritual and the practice is mentioned by the Rabbinic scribes, "When they reached a break in the singing they (the priests) blew upon the trumpets and all the people prostrated themselves." DR180.[89]

As mentioned above, the chatzotzerah was used in battle but Yadin[90] characterises the difference between the Israeli use and those of other cultures as a very basic one "While with the others they were mainly for tactical purposes, to encourage the warriors and frighten the enemy with their terrifying sound (DR181,Caesar); their principal function in Israel was to stress the religious character of the War - "to be remembered before the Lord - and only secondarily for actual signalling." Be that as it may; the explicitness of the use of trumpets in battle is remarkable as revealed in the Scroll of the War of the Sons of Light.[91]

Section 12 ~ When the battle formations are deployed over against the enemy "The one priest shall be walking along in front of all the

[88] Sendrey, 1969, p. 332 ff. Wulstan, 1973, p. 29 ff. Yadin, 1962.
[89] Sendrey, 1969, p. 336.
[90] Yadin, 1962 p. 113.
[91] Yadin, 1962, 292.

men of the line, to strengthen their hands in battle. In the hands of the six other shall be the trumpets of summoning, the trumpets of remembrance, the trumpets of the fanfare, the trumpets of pursuit, and the trumpets of withdrawal. When the priests go forth into the space between the lines, there shall go forth with them seven levites carrying seven ram's horns, and three provosts from among the levites walking in front of the priests and the levites. The priests shall blow the two trumpets of sum(moning when the battle intervals shall open) to a width of fifty shields, and fifty skirmishers shall come forth from the one interval (and fifty from the other interval, and there shall go forth with them) levitical provosts. With every formation they shall go forth according to all (this disposition. The priests shall blow the trumpets and two) skirmishing (battalions shall go forth) from the intervals (and take up positi)on between the two lines, carrying sling and shield ..... and the priests shall blow for them upon the trumpets of the (batt(le array)s (a level note).

COLUMN VIII

The trumpets shall keep blowing to direct the sling-men until they have finished throwing seven times. Then the priests shall blow on the (trumpets of withdrawal, and they shall come to take up position by the side of the first formation to fall in at their proper position. The priests shall blow on the trumpets of summoning, and three skirmishing battalions shall go forth from the intervals and take up position between the lines, with cavalry on their flanks on the right and on the left. The priests shall blow on their trumpets a level note, signal to array for battle, and the columns shall deploy into their proper arrays, each man to his place. When they are drawn up in three arrays, each man to his place. When they are drawn up in three arrays, the priests shall blow for them a second fanfare, a low legato note, signals for advance, until they approach the enemy line and stretch their hands to their weapons; then the priests shall blow on the six trumpets of assault a high-pitched intermittent note to direct the fighting, and the *levites and all the band of the horn-blowers shall blow in unison a great battle fanfare to melt the heart of the enemy. At the sound of the fanfare, the battle darts shall go forth to fell the slain. The sound of the horns shall cease. While on the trumpets the priests shall keep on blowing a high-pitched intermittent note so as to direct, signals for fighting, until the skirmishers have hurled into the line of the enemy seven times. Then the priests shall blow for them the trumpets of withdrawal, a low note alternately level and legato. According to this disposition shall the priests blow for the three battalions. When the first battalion throws, (the priests and the levites and the whole band of horn-blowers) shall blow a great fanfare to direct the fighting (until they have thrown seven times. Then there shall blow) for them the priests on the trumpets (of withdrawal a low note alternately level and legato, and they shall come and take up position) at their proper place in the formation, (and the priests shall blow the trumpets of summoning, and two skirmishing battalions shall go forth from the interval)s and shall take up position (between the two lines within throwing range. The six priests shall blow a fanfare on the trumpets of) assault, (and the levites and the whole band of horn-blowers shall blow a battle fanfare very loudly. And as the sound goes forth,)"*

From this document, the number, length and tone of all the calls can be handed on and the troops, and trumpeters, may learn to co-ordinate the progress of the battle. It does, indeed outline the crucial part played by the priests but is explicit in its definition of all the calls in a purely military sense.

Modern religious observance in Judaism uses the shofar where perhaps once the chatzotzerah was used. The calls used today are traditional and were handed down, possibly from antiquity. These quoted in Figure 5.7[92] may, therefore, give some idea of what ancient calls were sounded.

Figure 2.7: Shofar Calls

[92] Sendrey, 1969, eg. 12.

Later Instrumental Usage in the Middle East

The view of instrumental usage in any area is built up from the evidence available at present. Thus, in the 1000 year period before the Christian era in the Middle East, the very sparce evidence remaining could lead one to suppose that little development and use of instruments took place. However, the Scroll of the war of the Sons of Light, as quoted above, tells of the large numbers of shofarot and hazozerot used in battle and, as far as is known, not one instrument survived to this day. E. v. Nischer, cited in Yadin[93] estimates, from inscriptions of the time of Caracalla that each legion had 37 trumpet-blowers and 35 horn blowers. From the ones remaining today, one could make at most a couple of cohorts![94]

It is only possible to guess, therefore, at the level of activity which took place at that time, while two references give an indication of its nature. IC38 (beginning of lst millenium BC), an illustration on the wall surrounding the Hittite Royal castle at Ujuk, depicts a short trumpet, probably c. 300 mm long, with some bell-like feature at its end. The player is blowing this while holding it in both hands,[95] in some ways reminiscent of the Egyptian iconography. This evidence tells, at the least, that the trumpet was being used in this area, and that some form of bell termination had been devised, possibly indigenously.

One later illustration from Palestine, IC140, depicts a player blowing an instrument which scales at 1.06*m* long. This painting is from a tomb at Marisa, and dates from the second century BC. The instrument appears to have a fairly gentle taper along its length, and opens out at the bell end with a slight flare to a diameter of about 120*mm*. It is being blown by what appears to be an attendant on a hunting trip, who is walking along behind a mounted hunter holding a long spear.

This instrument is very long for this area, but it is exceeded in length by an instrument now at Boston (SD262) This latter instrument has generally been recorded as a Greek salpinx but, being of the same form as IC140, and having an overall length of 1.57*m*, it is clearly not of

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[93] Yadin, 1962, p. 115.
[94] Even that is an over-estimation.
[95] Kinsky 1929, P.4.

salpinx form.[96] According to Caskey[97], it has a tube yard made up of thirteen ivory sections and a 129*mm* bronze bell. These ivory parts appear to be turned[98] are designed to fit one in the other and are strengthened with bronze ferrules. At the tip end a mouthsupport is provided which has a rim of larger diameter than the tube but no throat. With the instrument was purchased a chain said to have been found with it, and on the bronze bell were remnants of what was an applied bronze strip. According to the museum, this instrument was found in an "unknown Greek context" and is normally referred to as a "Greek trumpet" or a "salpinx." However, no references to the presence of an instrument of this type have been found other than IC140. It seems likely, therefore that this instrument came from Asia Minor or the Middle East rather than from the area of what is now modern Greece. Caskey[99] states that the instrument has "a severe beauty which makes one wish to assign it to the second half of the fifth century BC rather than to a later period." Be that as it may, there seems to be absolutely no reason for the assumption of such an early date. Admittedly, the evidence for a later date is itself tenuous but, both the lack of iconography of this type in 5th century BC Greece, and the presence of references to the type in the East, point to an eastern origin. If the Greeks did, as they constantly state in their literature, derive their instruments from the Etruscans, they would probably have obtained no instruments such as these. However, the Greek adventure to the east at the end of the 3rd century BC would take them into what appears to have been fertile country as far as musical instruments were concerned and, no doubt, introduce them to instruments such as SD262 and IC140.

Of greater significance perhaps, is the representation of a tuba player on an Anatolian bronze from Mylasa, Caria, c. 800BC (SR15). On this, a figure is blowing a single-cone type instrument of about 700 mm, length which he holds in his left hand. Coming from the very West of Anatolia, this instrument indicates that tubae of a fairly advanced form had either spread West as far as this, or had evolved here at a period when Greek colonies were becoming established on the Anatolian coast.

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[96] It is now clear that the term 'salpinx' was applied by the Greeks both to the cup-belled form and the coniocal instrument or tuba.
[97] Caskey, 1937, p. 525.
[98] Caskey, 1937, fig. 3 and 5.
[99] Caskey , 1937, p. 527.

Although this tuba (SR15) was present at Mylasa, and was contemporaneous with the Greek presence, it was quite clearly indigenous to the region and not an import from Greece as suggested both by the form of this statue and the fact that the Greeks subsequently adopted the salpinx rather than the tuba.

The Etruscan and Eastern Italian Tuba

With the adoption and development of the tuba, among other instruments, the Etruscans evolved the form that was to remain essentially unchanged for a thousand years or so. The secret of this success may well have been in the adoption of the throat constriction at the mouthpiece end of the instrument. It is not possible to say whether or not the Etruscans developed this feature as it had been in use on the lurs in Scandinavia for some time before the date of the earliest known Etruscan instruments.[100] Similarly in the Middle East, particularly in Israel when producing a shofar, the solid horn tip had to be broken through as part of the process of forming a mouthpiece and, here, the diameter of the drill would determine the diameter of the throat produced. This matter is discussed in more detail in Chapter 3.

The tuba begins to appear on Etruscan carvings in the 5th century BC where it is seen in use as a signalling instrument in battle (IC131, 132, 136) and scales at about 700*mm* long. Shortly after this, it begins to appear in social contexts, such as on IC72, a painting of a player standing with a group of other people blowing a tuba that scales at 890*mm* long with a bell diameter of 110*mm*. Significantly however, the tuba begins to appear in use with other instruments in the 5th century BC. On a stele from Vele Cecina, three tuba players take part in a solemn procession along with a lituus player and several others (IC99). This scene is mirrored many times in later Etruscan and Roman funeral and other processions.

From shortly after this reference comes IC76, an illustration on a vase from the Western coast of Italy.[101] Unfortunately, Behn, in whose book this is illustrated, provides little other information about the

[100] My recent research has shown that the Etruscans did, in fact, use a mouthpiece with a developed throat.
[101] Behn, 1954, Abb. 153 and p. 118.

provenance of this. On this illustration, two players, whose dress and style of portrayal clearly display strong Greek influence, blow a slightly curved tuba and a strongly curved animal horn type of instrument.[102] Interestingly, on this illustration, the animal horn blower is clearly puffing out his cheeks while the tuba player seems to be adopting what looks much like a modern embouchure.

The Roman Tuba

Although musical instruments appear on Roman reliefs from about the 5rd century BC, no tubae are illustrated until about the 1st century BC. The earliest of these is of a single tuba player on a relief in a temple to Apollo (IC127) in a scene from a triumphal procession. His instrument scales at 0.9*m* and appears to taper slowly along its length with a slight flare at the bell, thus being very similar to the Etruscan instrument. On two slightly later representations, IC118 (c. 50BC) and IC124 (8 or 9BC), both of which are in poor condition, players can be seen taking part in processions only in pairs.

However, by about 75AD, the Romans developed the tuba into a variety of different forms. The iconographic material is insufficient to allow dates to be given for these developments and many may have been derived from the Etruscan or Greeks. In fact, the two basic types of tuba in use, from this period on, reflect instruments in use with these two cultures and are illustrated together on IC8 on the Arch of Titus. 0ne's form is very reminiscent of the Etruscan tuba, having a (scaled) length of 900 mm and a bell diameter of 78*mm*. (cf. IC72. 890/110). The other instrument has a similar length (scaled 925*mm*) and a much gentler taper which leads into a cup-shaped bell similar to, but somewhat smaller than the Greek salpinx. This form appears to develop later into the parallel form of instrument well represented in later iconography.

The Single-Cone Tuba

[102] Behn, 1954, Fig. 3.3, p. 82.

From this period onwards, the tuba increases in length with a general decrease in conicity. 0n IC121 (c. 74AD), a tuba player is depicted blowing his instrument downwards, this being one of the few illustrations where the instrument is not pointed into the air in the heroic manner. This instrument still appears to be quite conical, although the bell end is no longer clearly visible and has a scaled length of 1.31*m*. Another illustration, IC119, (C. 50AD) contains tubae and shows them used for the first time in a group of three instruments, a pattern of usage that subsequently became a common Roman one. In addition, this relief shows detail of the instrument mouthpiece for the first time and appears to depict features that push onto the tip end of the instrument having a taper in the opposite direction to the tube. 0n the relief too, the players are depicted using a modern looking embouchure.

This contrasts with IC41 (c. 50AD) where one of the two tuba players taking part in a performance at the gladiatorial contest is blowing and clearly puffing out his cheeks. On this illustration, the tip end of the instrument has a large bulge where one would expect the mouthpiece to be. This is clearly some form of mouthpiece and may well be one made of bone and wedged onto the end of the tube as in DR182, Pollux states that the mouthpieces of tubae are made of bone.

One feature appearing for the first time on this illustration is the cord that runs between a mount on the bell to somewhere near the tip. The instrument is held in the player's right hand only and the cord is pulled down towards the right of the instrument and held between the thumb and fore-finger. (See pl.2.2b). It appears, therefore, that this cord serves no purpose during the playing of the instrument and is probably provided for slinging the instrument over the shoulder in order to transport it safely.

Plate 2.2b: Supporting a Tuba

This feature also appears on IC19 (c. 350AD) where the mounts can be seen which support this cord and here the player again grips the instrument in his right hand but, on this occasion, leaves the cord free. This contrasts with the use of a cord on IC108 (Plate 2.3a, 110AD) where three players appear to be gripping this cord with the left hand as a means of support. Behn[103] shows a reconstruction of a tuba on which the player grips a loop attached to a point near the bell tip. In his text[104] Behn concludes that the loop was to help press the mouthpiece against the lips and to enable the player to support the instrument without gripping the tube. This feature he considers to be of importance in avoiding the hand becoming moist from sweat, leading to corrosion of the tube and an unpleasant grip. His view does appear tenable as an interpretation of IC108 although not of the other references cited here. It seems much more likely in these cases that the cord was a simple carrying device.

[103] Behn, 1954, Abb. 174.
[104] Behn, 1954, op. cit. p. 156.

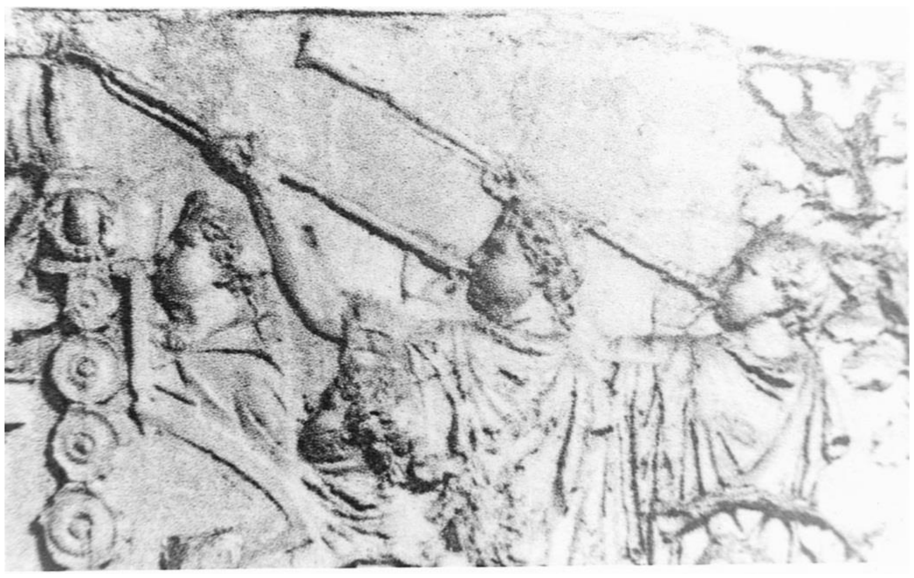

Plate 2.3a: Tubae on Trajan's Column

The Cylindrically-Tubed Tuba

Also appearing about this time was a form of tuba with a cylindrical or very-slightly conical bore with a cup-like bell portion very similar to the Greek salpinx. It is first illustrated on IC12, where it is in use during a gladiatorial battle. This instrument scales at 1.26*m* long and appears to have a cylindrical bore (depiction is on a mosaic) with a cup shaped bell which opens out rapidly to about 110*mm* over about 40*mm* length. The cornua depicted in this scene also have this type of bell. (see plate 2.3b, below) Shortly after this illustration comes one from Trajan's column where three players can be seen blowing similar instruments. On these the very shallow and wide cup of the bell can be seen clearly and on these instruments is in the form of a lightly curved cone. (Scaling difficult on this reference).

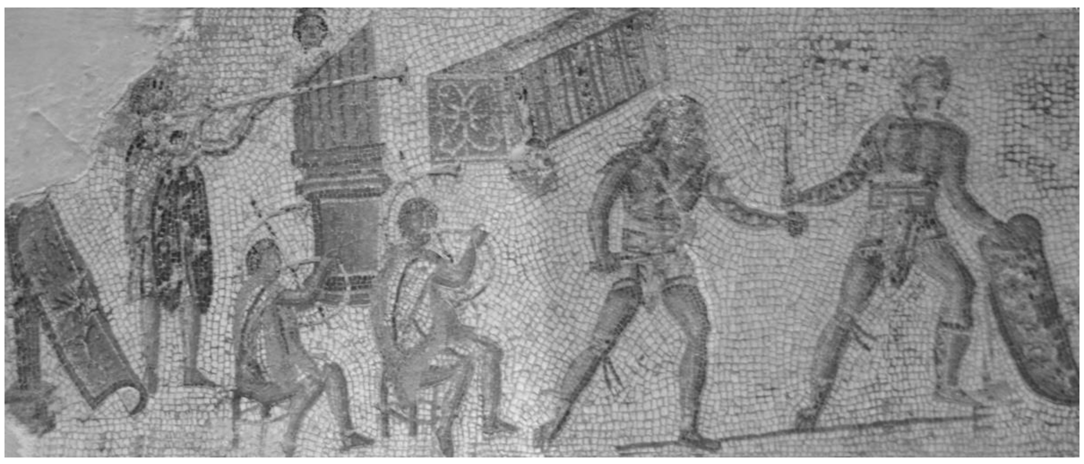

Plate 2.3b: The Zliten Mosaic with Tuba and two Cornua

Later Developments of the Roman Tuba

From the pattern set in the first century AD, the tuba was little changed during the rest of the Roman period. In the case of the single-cone type of instrument, the major development seems to lie in the acquisition of a slight flare or perhaps cup-shaped bell termination as seen on IC144[105] This is confirmed on SD220, a tuba found in the Temple of Mars at Klein-Winternheim which, in view of the material with which it was associated is considered by Behn[106] be a votive offering. It is made of sheet iron 2-3*mm* thick and is 1.37*m* long with a bell opening of 105*mm*. In its present state it weighs 6.5*kg* and even though not complete would be rather heavy for a musical instrument. However, IC121 shows an instrument of 1.31*m* (scaled) length which is being played pointing downwards and there seems no reason why this could not have been used in the same way, prior to deposition.

The only other extant instrument is SD265, a tuba found at Zsambek and now in the Nemzeti Museum in Budapest. According to details supplied by this museum, its length is 1.56*m*, the bell diameter being 95*mm*. This lacked a mouthpiece when found and what remained was made entirely of sheet bronze. (See plate 2.4a) The seam of the instrument was made by cutting vee-shaped notches out of one edge of the sheet and slotting these into the other edge. Thus, a technique similar to that used on the Tutankhamen instruments was still in use when this instrument was made and is, of course, the technique still used today. No information has been forthcoming on the presence of solder or braze on this seam.

Plate 2.4a: The Zsambek Tuba Bell

[105] Behn ,1954 Abb. 172 and p. 136.
[106] Behn, 1912, p. 56.

The other type of tuba developed into an instrument having an apparently-cylindrical bore with a cup-type bell termination, thus reverting to the archaic form originally developed by the Greeks. On IC18 (c. 350AD), this parallel section is clearly visible, terminating in a wedge shaped mouthpiece. Of a similar date (350AD) is the latest representation of the single-cone type of instrument, IC19 from Kaiseraugst, showing that both types survived together and were used to a late date.

THE CELTIC Tuba[107]

The Celtic use of a tuba is attested by the very sparce but nevertheless very firm evidence of two extant instruments (SD205/6,) and three datable iconographic references. (IC78, 88 and 201). Earliest of this iconographic material is that from Trajan's Column (IC88 and 201) and datable to before 110AD. On this is shown the bell of a Celtic tuba which is of a gently flaring form[108] and in a further scene on the base of the column, a cylindrically-bored tuba, with a well-developed mouthpiece.[109]

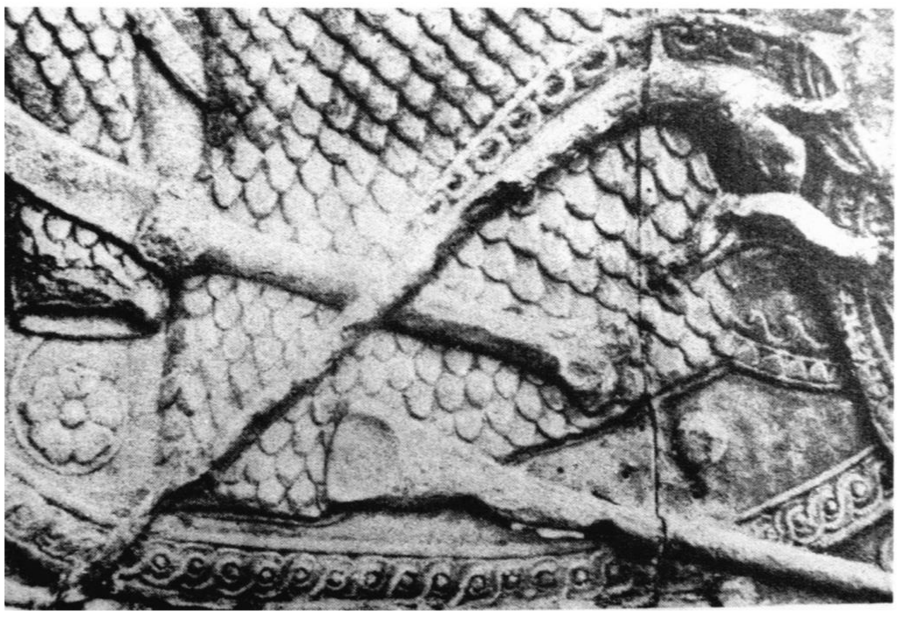

Plate 2.4b: A Celtic Tuba along with a Carnyx

The other reference (IC78) shows Caracalla (211-217AD) subjugating the lands of the Rhein (see pl.2.5). Thus, by this time the Celtic tuba had had a recorded history of over a century and from its appearance

[107] I would now refer to this as a Native Iron-Age Tuba
[108] Behn ,1954, Abb. 187, see plate 2.4.
[109] Lehmann—Hartleben, 1926, Abb. 1.

among the trophies on this battle standard is clearly a local Celtic instrument.

Plate 2.5a: A Celtic Tuba among Trophies

Much more Celtic in appearance, however, are the two tubae found in the Loriet region of France. (SD205/6). These lack the functional simplicity of the Roman instruments, and are elaborately decorated both on the sheet metal and cast parts. The instrument from Neuvy-en-Sullias (SD205) has a total length of 1.44*m* and a tube diameter varying from 10 to 58*mm* (Plate 2.5b). Its mouthpiece is of a simple conical form, with a cone-shaped cup passing into a 2 mm throat. Immediately below this mouthpiece is an elaborate cast (?) boss into which the mouthpiece fits. Made principally from sheet, the individual yards appear to be joined either by sheet-metal or cast ferrules. One of these joints seems to have been formed from a cast-on boss. on the Saumur instrument, the mouthpiece/mouthpipe boss is a large diameter feature with a disc-like front face into which the mouthpiece fits. Undoubtedly, these bosses perform an aesthetic function but their presence is more likely to result from the functional needs of the design.

Plate 2.5b: The Neuvy-en-Sullias Tuba

From the illustration of Mantellier[110], the Neuvy instrument appears to have a mouthpiece with a shank tapered as on modern instruments. Thus, it presses into the tip end of the tuba, effecting a seal. However, while providing a suitably tightly fitting seal, this type of joint is very prone to jamming. This problem is well known with modern instruments, where much of the time of a teacher can be spent removing the jammed-in mouthpieces of their students' instruments. The mouthpipe of a modern trumpet, however, can withstand the jamming-in of a mouthpiece as its rim is normally reinforced by a ring made up of drawn tube and, hence, quite strong. Where tube is produced from seamed strip, however, this seam represents a weakness; the seam is likely to fail if strained by the powerful wedge-action of a gentle taper. Hence, the use of a mouthpiece with a tapered shank would require the provision of reinforcing rim around the end of the mouthpipe and this is, most probably, the reason for the features seen around the mouthpipes of the two Celtic tubae.

Overall, the instruments have the form of a cylindrical or gently tapering tube with a slightly-flared bell at the extreme bell-end. SD205 is said to have a telescopic body[111] although no confirmation can be found of this. Reinach[112] dates it as La Tène, mainly on its decoration, and it is said by Mantellier[113] to date from the end of the 4th century BC. The associated finds are objects from a temple which was sacked at that time, and seems to have been a centre for a college of priests.

[110] Mantellier, 1865, pl. XIII
[111] Bragard, 1968.
[112] Reinach, 1899.
[113] Mantellier, 1865, 227.

Its use, therefore, would be in the ritual of the temple which would account for the elaborate decoration seen on both instruments.

As a musical instrument, it would probably be equally effective, with sufficient conicity to bring its formants into harmonic[114] relationship. Thus with the constricted throat of the mouthpiece an experienced player should be able to sound six or seven notes on this instrument. Also, if the illustration in Mantellier is correct, these notes should be playable with considerable agility as a result of the sharp edge between the mouthpiece cup and back-bore. If the dating is correct, then a direct relationship with the Roman tuba can be ruled out, although a common origin in the Etruscan instrument seems quite likely. Alternatively, with its elaborate and effective mouthpiece suggesting northern influence, it could have been developed from instruments seen in Northern Germany at the northern edge of Celtic cultural area during both La Tène and earlier Hallstatt times.

[114] To a western ear!

CHAPTER 3: ETRUSCAN AND ROMAN INSTRUMENTS

Around 500BC, a great creative explosion of experimentation in instrument morphology took place and a break was made with the old trumpet/horn tradition that had dominated the world of PVAs prior to this date (See Chapter 2)[115]. This wholesale break with the tradition probably resulted from a combination of technological ability to form the instruments, the growth of awareness that powers vested in the old forms did not evaporate when their morphology was varied and that, organologically speaking, they could perform just as well as the old forms. Added to this may well have been the demystification of the instruments used and the separation of roles such as "music producer" and "voice of the gods." Thus, freed from old constraints, the way was open for experimentation in morphological form. With the Etruscans, a whole series of instruments appear and, if the apparent continuity of tradition between their tuba and that of Anatolia and further East is indeed real, then the source of their suite of instruments seems to have been from this area. Whether or not the instruments were actually developed prior to the arrival of population in Northern Italy is a moot point but the inspiration certainly appears to have circumvented the Greek world and to have rejected the narrow Greek instrumental usage of the Salpinx. The possibility of the Carnyx having developed in the area at this time is discussed in Chapter 6.

It is possible, of course, that the great explosion in instrument types is more apparent than real. It could well result from an increase in the practice of representing instruments on paintings, reliefs and bronze-work, thus bringing to light instruments that had previously existed for some considerable period. Perhaps also, taboos had been removed allowing such representations to be made, as the secularisation mentioned above took place. Just as possible too, is the increase in technological ability of the peoples in this area, allowing freer rein to the design and removing constraints formerly placed upon them. Whatever the answer, it seems hard to ignore the increase of knowledge of instruments at the time and reasonable to attribute it to the development of new instrument types.

Last but not least, is the possibility of a great expansion of interest in things musical at this time. Perhaps more specifically, this interest was in PVAs in particular as no corresponding rise in the number of instrument types seems to have occurred with other instrument groups. Such an awakening interest in PVAs could well have arisen from the realisation of the potential of such instruments when a fully-fledged mouthpiece, with cup and throat were applied. Thus, old forms could be rejuvenated and, with the acoustic characteristics of the mouthpiece, impressed upon that of the instrument cavity, become

[115] While this statement might have been a little speculative at the time it was written, I now, wholeheartedly agree with it, following years of further work in this area.

new instruments. Certainly in the 19th century a similar phenomenon occurred with the invention of valves and, for almost a century after this crucial stage, enormous experimentation took place until the modern pattern of instruments emerged.

The Etruscans inhabited North-Western Italy, off the Eastern part of the Tyrrhenian Sea from about 1600BC onwards, while the Southern part of Italy was populated by other Italic peoples. About 760BC a Greek colony of Kyme (Latin Cumae) was established west of present- day Naples, to oscillate over the succeeding years between the Etruscans and the Greeks. By 480BC much of the coastal area of the southern toe of Italy was colonised and fell under Greek influence. It is, thus, impossible to be absolutely certain about the cultural provenance of material that is found along the Southern coast of Italy at this time and the use of the term Etruscan should perhaps be read widely as "West-Coast Italics and Etruscans."

About ten instruments or varieties of instruments are in this area at this time, five of them appearing here for the first time-

i) Ivory horn
ii) Short animal shaped horn
iii) Clay horn
iv) Short conical instrument with upturned bell
v) Tuba
vi) Curved tuba
vii) Side blown salpinx
viii)

Three other instruments either continued to be used by the Romans or led to instruments which the Romans used. With these, the Etruscan and Roman usage is considered as a continuous narrative for each instrument in turn. The instruments are:-

ix) Large highly curved horn
x) Lituus
xi) Cornu

i) THE ETRUSCAN IVORY HORNS

These are known only from two finds SD256 from Populonia, (South of Pisa) and SD275 from Prenestina. Both of these are fragmentary but, according to Ducati[116] they are in the form of a large diameter gently curving horn with gold fittings. These fittings are made of thin gold sheet decorated with chased scenes of animals and form a band around the mouthpiece and bell end along with two similarly decorated ring mounts. The mouthsupport is slightly elliptical with maximum dimensions of 9 and 10 mm. According to Minto[117], (1943, Plate 130), the decoration is of a Graeco-Asiatic school (Greco-asiatico)

[116] Ducati, 1927, 172, Tav. 58.
[117] Minto, 1943, pl. 130.

and contains elements of decoration from Egypt, Assyria and Mycenae along with representations of the flora and fauna from these areas.

There seems little doubt, therefore, about the source of inspiration for the decoration of this instrument and the presence of this on the horn clearly suggests an origin from Asia. No evidence for the use of these instruments exists other than these two extant specimens but the source of the material was most probably eastern. The instruments may, thus, have come directly from Asia with their connection with Greece being one of trading only.

Regardless of how they were used, they were clearly very exotic, the combination of gold and ivory pointing to their having great value to their owner. Their generally-large diameter would limit their playable range to one or, at most, two notes and thus preclude any form of "musical" use.

ii) SHORT ANIMAL HORN FORM

The use of this instrument has been discussed in Chapter 2, IC 145 from Este having been considered. However, a small cast (?) instrument was also found at Populonia, SD257[118]. It is 400*mm* long and in the form of a gently curving animal horn with a taper opening out slowly to a circular bell, diameter 45*mm*. At its tip is a conical mouthpiece with a rim of about 27*mm* (scaled) and immediately below the mouthpiece the tube scales at 12 mm. Thus, the throat of this mouthpiece could be in the range 4-9*mm*, (allowing for a range of wall thicknesses from 2-4*mm*) and it would produce a considerable bore constriction, (Figure 3.1)

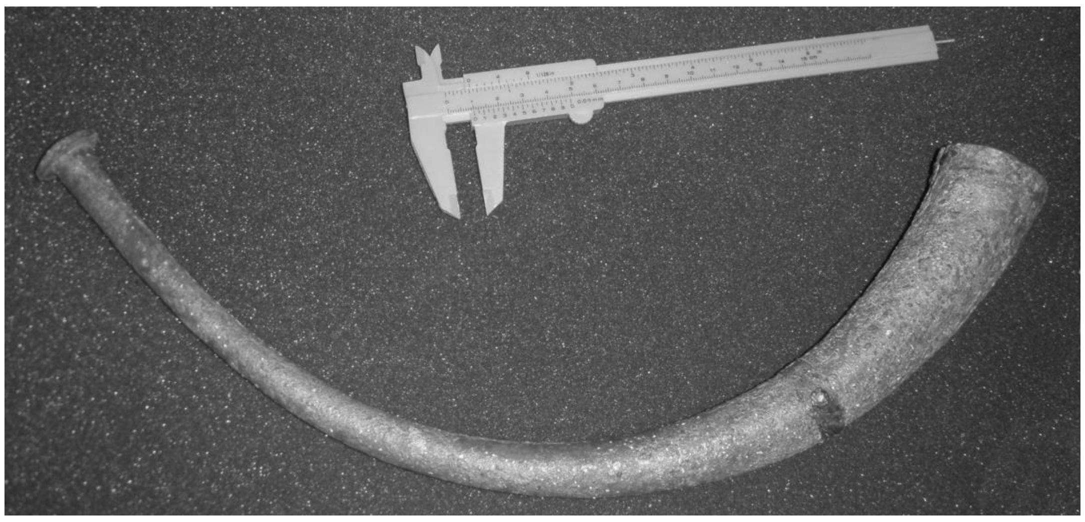

Figure 3.1: The Populonia Horn

This instrument appears to be a well-designed analogue of an animal horn with the manufactured mouthpiece added. No other such instrument has been found in this study and, in this area it represents the first definite proof that the natural animal-horn instrument was refined by being made in metal and also, presumably raised to the status of an instrument proper.[119]

[118] Minto, 1945, 45, Tav. XI.
[119] In recent years, I have had the opportunity to study this horn and the above discrpition is in need of considerable refinement.

iii) CLAY HORNS

The one instrument of this type is also an analogue of an animal horn, although made in clay. It was found in the Po valley area of Italy in deposits of the Terremaren culture[120]. It is 430*mm* long, with a thick wall and lacks a mouthpiece. The tube end is cut off obliquely leaving the instrument difficult to blow. Thus, according to Behn, only the fundamental tone can be played with reasonable ease, the second formant being elicited only with the greatest difficulty.

iv) SHORT CONICAL INSTRUMENTS WITH UPTURNED BELL

Only two references to this instrument occur one of these, (IC24) being on a scene on a situla from North eastern Italy which is dated between the fifth and fourth century BC. It is cited in Behn[121] who gives no further information about its provenance (see plate 3.1a, below).

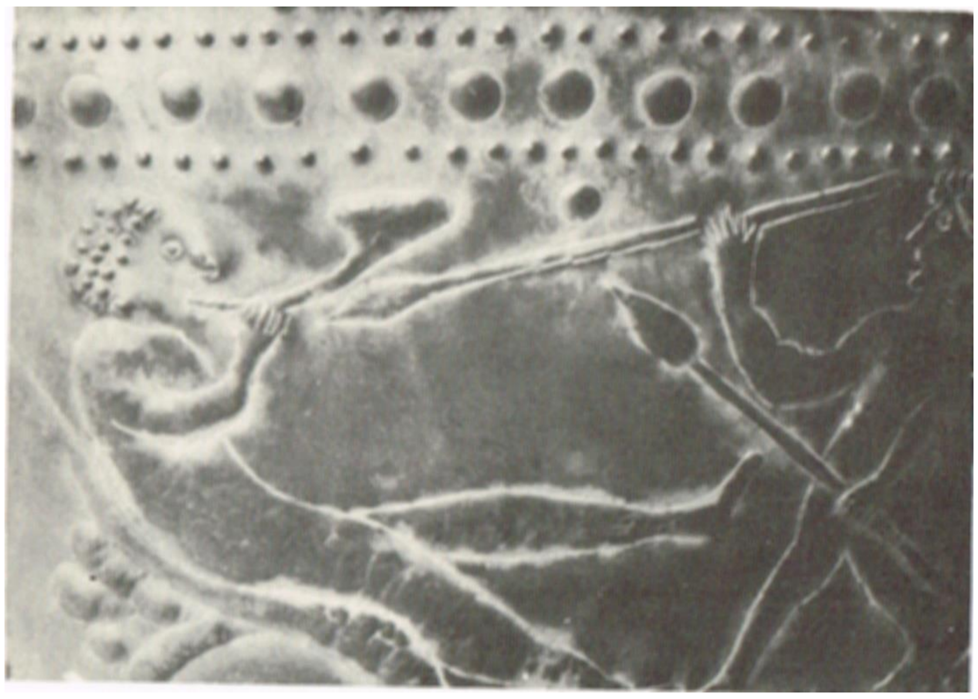

Plate 3.1a: A Short Conical Instrument with Upturned Bell

The representation shows a short tapering instrument with a bell which opens out rapidly into a conical bell end with a certain amount of flare. In form it resembles nothing else from this area, the closest analogy perhaps being with the Egyptian instruments, this being a form of these with a curved tube and bell yard. Similarly it could be said to be related to the Greek salpinx although on the Italian instrument, the tube yard is both shorter and more conical than the salpinx references seen. In addition, this area was not subjected to the Greek influences felt in the Southern part of Italy.

Behn[122] considers this to be an Etruscan Lituus but this seems unlikely as the early form of this instrument used by both Etruscans and Romans had a long parallel tube yard with a sharply recurving bell. (See Chapter 6, Figure 6.3) This instrument may well have been

[120] Behn, 1954, 127.
[121] Behn, 1954, 129, Abb. 160.
[122] Behn, 1954, p. 129.

the result of a low level of design diffusion from another area combined with the local drive to develop the new range of instruments that appear here.

One other representation similar to this exists in the form of a small bronze figure of a trumpeter, dating from the first century BC and found at Hradiste in Moravia. This statue is of a figure holding a conical horn whose bell end turns through a right angle and appears to have a flared end. It is difficult to scale the instrument from the available photograph but it appears to be about 550*mm* long with a bell diameter of about 120 mm. Unlike the instrument discussed above, however, (IC24) its curvature is mainly over the central part of the instrument, whereas IC24 has its curved portion immediately below the bell itself - much like the Celtic Litui. (See Chapter 6, Figure 6.3).

On the uses to which this instrument was put one can say little with confidence. That is, other than either the tonal qualities of the instrument or the performance of the gentleman in IC24 is not too good as he appears about to receive the judgement of a critic!

Several hundred years later, the Sassanians produced a somewhat similar instrument which is illustrated on a relief from Tak-i-Bostan. (IC35)[123]. This instrument too, has a curved, apparently slightly conical tube yard, which is considerably longer than IC24, its conical bell turning through 90°. (Figure 3.2)

Figure 3.2

It is not possible to relate these two instruments with certainty but the Etruscan instrument may, in some way have been a forerunner of the Sassanian one

[123] Behn, 1954, Abb. 107.

v) THE TUBA

This has been discussed in Chapter 2.

vi) THE CURVED TUBA

Instruments of this type are produced by nature in the form of animal horns on species such as the eland and the oryx. It is not possible, therefore, from iconographic material, to tell whether illustrations depict natural or man-made material. Thus, on IC76, where a form of curved horn is being blown, this may be of horn or metal[124]. Behn, who cites this, gives no other information other than it is from "einer unteritalischen Vase" (a lower Italian vase) but the dress of the player is somewhat Greek in appearance suggesting an origin from Southern Italy. (Figure 5.3)

Figure 3.3

No other illustrations of this instrument are found in this area although similar ones do appear somewhat later on Sassanian silverware, eq. IC21.[125]

vii) THE SIDE-BLOWN SALPINX

Only one example of this instrument exists, SR2, now in the British Museum. It is shown on a small statue of a trumpet player, found near Naples and dated to about 470BC. The player holds the instrument to his left, blowing through what must have been an aperture on the tube which appears quite parallel. At the bell end of the instrument the tube opens out to a larger diameter following a short tapered portion.

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[124] Behn, 1954, Abb. 153.
[125] Dalton, 1964, pl. XXXVIII.

This is the earliest representation of a side-blown instrument in the Mediterranean world and it is interesting that it appears in this area where experimentation in mouthpiece design seems to have been carried out. Instruments of the salpinx type have a very slender tube yard and, when lacking a mouthpiece present a small diameter to the lips and create a severe problem of embouchure. One way of overcoming this problem is to terminate the tube obliquely, thus presenting an oval shape to the lips which they can accommodate more easily. (Figure 3.4) However, the obliquely cut instrument end requires the player to hold the instrument at an angle pointing both to his front and to the side. A further method of providing a blowing aperture shown in Figure 3.4b is to cut out a section of tube wall. With such an aperture the tube can be held directly across the mouth, pointing to the right or left, the major axis of the oval mouthpiece lying in the same direction as the axis of the lips. (See Chapter 5, for further discussion of blowing apertures.)

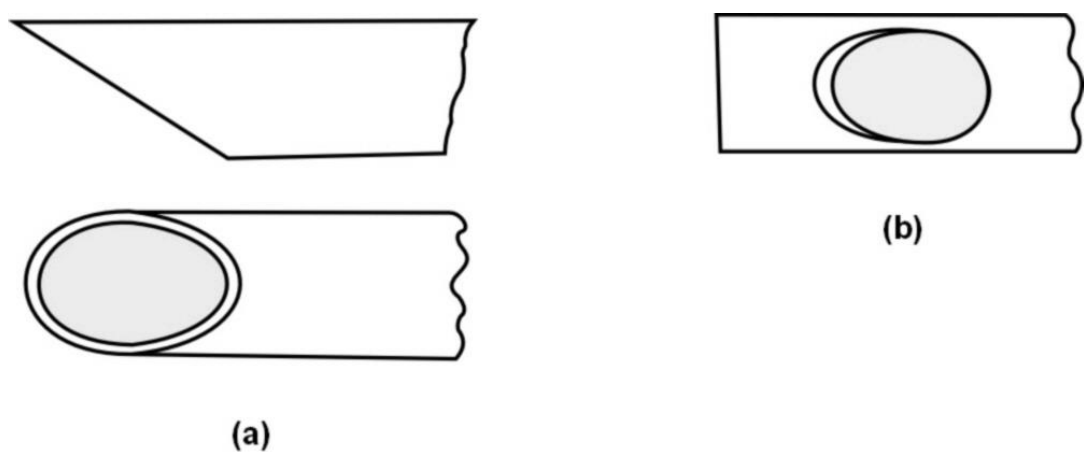

Figure 3.4: Blowing Apertures

Whatever steps are taken to provide a blowing aperture on a thin-walled tube, however, no effective throat can be provided. Thus, this instrument would be severely restricted in its range by this feature and would most likely be superseded by instruments with mouthpieces proper, when they were introduced or developed in this area. This suggests that this area, Campania, awaited the development around 470BC.

The further significance of this particular instrument as a pre-cursor to the carnyx is discussed in Chapter 6.

viii) THE LARGE HIGHLY-CURVED HORN

Only one representation of this instrument exists, IC153, Figure 3.3 and this is separated from (ii) Animal-shaped horn because of its seminal position in the development of both the Lituus and the Cornu. This illustration shows a player blowing a large highly curved horn, It scales at 810*mm*. long with a bell diameter of over 150*mm* and appears to be curved in one plane only. Horns of such a size are rarely found in nature and this representation is, therefore, quite likely to be of a metal horn analogue.

The significant difference between this instrument and SD257 the small horn from Populonia, lies in its curvature and its diameter. Both these tend to suggest manufacture from sheet rather than by casting and in the production of such a sheet metal instrument the maker would have carried out the more difficult of the processes involved in making either a lituus or a cornu. Varro, (DR183) writing in the first century BC wrote that "The cornua now made of bronze ("ex aere") were formerly made from horns of the wild ox."

The Lituus

With several Roman instruments, a difficulty lies in identifying instruments referred to in documentary material. This is no problem in the case of the lituus, however, as several authors have described in terms that are quite unambiguous. Cicero, for instance, (DR8) traces the parallelism of the term "Lituus" as an instrument, with its use to describe the staff of augural office, "a wand which was crooked and at the top slightly curved." This wand, he claimed took its name from the instrument on account of this likeness. Seneca, in DR18, contrasts the "cornu reflexum" (turned about) with the lituus which is "adunco aere" (of bronze bent in the manner of a hook). In addition IC71, a gravestone of Iulius Victor "ex collegio liticinum cornicum" depicts him with both a lituus and a cornu.

Although the lituus is frequently mentioned in contemporary literature, (29 references in this study) it is not as frequently represented as the other instruments. Of these few representations, however, two give a fairly clear idea of the derivation of this instrument. On one of these, IC11, its form is seen to be of a roughly parallel tube with a strongly recurving bell, to which are attached cords or straps. Thus, this instrument appears to be the simplest metal analogue of a reed or similar tube yard plus an animal horn bell. (Figure 6.3) Clearly, the biggest technical problem in constructing such an assembly lies in achieving a joint between the yards that has mechanical integrity and seals sufficiently well to allow the instrument to be blown satisfactorily. This problem is exacerbated on an instrument such as the lituus where a turning moment on the bell can readily cause this joint to fail.

An illustration in Collaer's book[126] shows the solution adopted on these horns from Bolivia, where the same problem of attaching horns to tubes has been tackled. On these instruments, a cord can be seen that feeds through the bell and is, presumably, threaded through a hole in the bell and tube. This cord holds the horn and tube firmly in a fixed relationship, allowing any residual gap to be plugged using wax, resin or clay. A similar such cord is visible on IC11 although it may not feed through the cavity of the bell itself and perhaps simply passes across from bell to tube yard. IC71, a later Roman representation shows cords looped between the bell and tube yards. (Figure 3.5) It is clear from this looping of the cords, that they no longer perform any structural function but remain as purely vestigial features.

Four iconographic references, IC2, 6, 11 and 73 date from the 4th century BC, the oldest of these, IC11 being dated to 490-470BC. The second of these, IC6, from the Tomba dei Relievi at Caere[127] depicts an instrument very similar to the two instruments SD212 and 231 found at Caere which have a possible date of late fourth century BC. These are made up of a parallel tube yard 1.20*m* long and about 20*mm* diameter which is attached to a bell yard of 400*mm* length which opens out to about 80*mm* diameter. This bell yard is

[126] Collaer, 1975, Pl. 5·50(b), p·297.
[127] Giglioli, 1935, Tav. CCXLII/III and Ducati, 1927, 394.

fabricated from sheet and a sleeve is fixed over the joint between the yards. (See Chapter 6, Figure 6.3). According to Fleischhauer[128], this instrument is in G and currently sounds its 2nd to 8th formants when blown.

Measuring over a metre in length and only 20*mm* or so in diameter, this tube yard would be extremely difficult to manufacture. Both forming of the tube into a circular cross-section and its sealing by whatever means were used would be a difficult operation. It is obvious therefore, that the considerable length of the tube yard was a deliberate design feature presumably having been intended to increase the range of useful notes that the instrument could produce. There is, on the extant instrument, no evidence of mouthpieces having been used and the evidence from IC16 tends to re-enforce the view that they were not used on these instruments.[129]

On this reference, a sarcophagus relief from Amiternum, dating to the first century BC, a Lituus player is seen in a funeral procession along with two cornu players and several other musicians. The lituus player, however, while blowing an instrument which scales at 1.45*m* long and is of a typical lituus form, plays it as a side-blown instrument. While, according to Ryberg[130], “the scaling and illusionistic relief of this sculpture lack the sophistication achieved in the Augustan period that followed the Late Republic”, there is little doubt about the way this instrument is being blown. The lituus player is clearly seen full face with the instrument pointing to his left, while the two cornu players who follow him are seen in profile with their instruments angled and resting on their shoulders. Beneath these players is a row of four aulos/tibia players, the rear three of these being seen in profile with the two pipes held before them, only the right arm being clearly seen. However, the fourth player, the one at the front of the procession is quite clearly seen full face, at right-angles to the other players. Both his pipes are seen down across his chest and his arms held out to either side. In addition to this, on the largest photograph of this scene, in Masson[131], the 50*mm* or so protrusion of the tip end of the tube yard past the player's lips can be seen, (Plate 7.1)

Thus, a reasonable conclusion is that the lituus player is accurately portrayed and is, in fact, blowing a side-blown instrument. As discussed above, a lateral blowing aperture provides advantages over a small tube end diameter but not over a conventional mouth-piece. With the appearance of this side-blown instrument of about 100BC, therefore, it would seem that the lituus of this period was not provided with a mouthpiece.[132]

The Roman Lituus

Only one iconographic reference to the Lituus found in this study is clearly of Roman origin, IC71. This is a carving on the gravestone of M. Iulius Victor "ex collegio liticinum cornicinum" and shows the cornicen holding a lituus and a cornu. It was illustrated in 1677 by Casp. Bartholinus, although the illustration is very small. After this,

[128] Fleischhauer, 1960, 501.
[129] This instrument has since been examined by the author and is described in Holmes 2010, 134ff, Figures 46, 47, 48.
[130] Ryberg, 1955, 56.
[131] Masson, 1973, no, 124 on p. 167.
[132] This now appears to be a sweeping over-generalisation as what appears to be an Etruscan lituus with an attached mouthpiece was sold on the open market recently, although only a single photograph of this has been seen by the author.

the stone was lost, and according to Olshausen[133], the next illustration of this, Fabretti (1690) was an enlarged copy of Bartholinus' illustration, as have been all illustrations since. (Figure 3.5)

The cornu seen on this illustration has a relatively large diameter and would seem to date to around 100BC. In the case of the documentary material, references in the first few centuries AD are all in the works of poets or historians. It appears, therefore, that around the turn of the millennium, the lituus went out of favour to be replaced, most probably, by the tuba. To the pragmatic Romans, interested in the acoustic performance of an instrument, and not prepared to accept the more difficult lituus where the tuba would suffice seem to have dropped the instrument quite readily. In some ways the tuba is superior in performance to the lituus, its conicity increases its effective length and, more importantly gives it a range of notes that are better related harmonically. From a manufacturing point of view too, the tuba is preferable to the lituus as its manufacture involves straight tubes only and no curves as on the lituus bell.

Figure 3.5: The Gravestone of M. Iulius Victor

THE ETRUSCAN CORNU

The cornu appears to have developed from an animal horn (DR183) but by the fourth century BC had attained a fairly standard form. This is also seen on plate 3.1b, (IC2) where a conically-bored tube is formed into an oval with major/minor axes (ratio approximately 1.25) and with a structural strut across the major diameter. IC2 appears to be the most primitive of the instruments illustrated and, if it has a mouthpiece at all, has one with a rim of the same diameter as the tube tip. From the illustration, the cross strut across its centre appears to have been simply made from a tube slit at its end and opened out to suit the instrument tube. (Figure 3.6.)

[133] Olshausen, 1891, 846/7.

Plate 3.1b

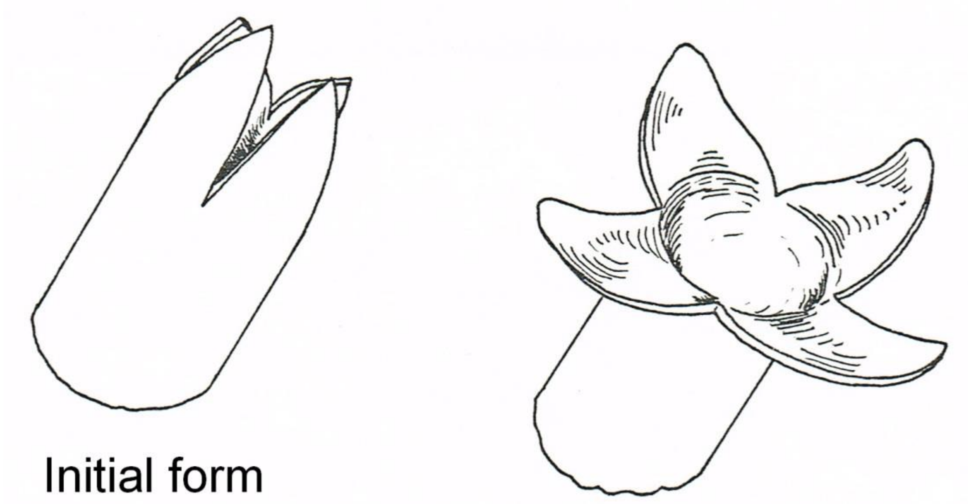

Figure 3.6

Measured along its centre line, the instrument is 2.46*m* long (scaled) and has a cone semivertical angle (α) of 22.7*mrad*. A further instrument from the fourth century BC (IC73) appears to be a much more developed version of the cornu, its length being of the same order as IC2's (2.81*m* scaled) but its conicity being 19.2*mrad* (cf. 22.7). This instrument is shown with a mouthpiece, although the representation is not clear enough to give much detail.

From two centuries later (c. 300BC) comes a further representation (IC135) which has a length of 2.51*m* (Scaled) and a conicity of only 16.3*mrad*. This brings the instrument much closer to figures for modern instruments (12.5 for the oboe to approx. 6.5 for the alphorn)[134] although it is still considerably more conical than these and would, therefore, have retained something of the coarseness of tone of the earlier instruments. A cone-shaped mouthpiece can be seen at the tip of this instrument and this may possibly be taken as evidence for the use of a developed mouthpiece. The instrument retains the cross strut that remains within the limits of the tube itself although it appears to be joined to this tube by three braces attached to the strut. (Figure 3.7)

[134] Smith and Mercer, 1975, Table 21

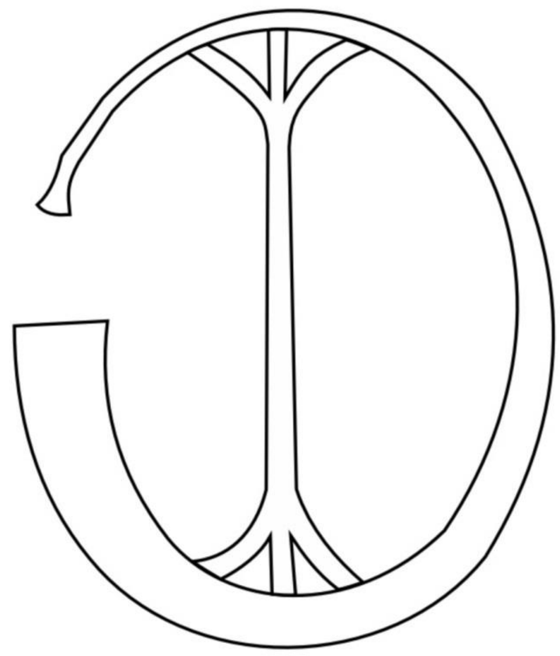

Figure 3.7

One other form which developed was somewhat shorter than the ones described above, an example found at Caere, SD216, being about 1.34*m* long and having a cone semi-vertical angle of 27.9*mrad*.[135] Its cross strut is circular, narrowing out towards each end and fitting into a plate that is riveted into the instrument tube. At the tip end, the instrument has a shallow looking mouthpiece opening out to a rim of about 32*mm* (scaled).

A similar-looking instrument appears on a gravestone of a cornicen from Mantua, IC143.[136] It is remarkably similar in form to SD216 and attests to this type of instrument being used into Roman times, although this gravestone is not datable. This illustration shows the Cornicen holding the instrument mouthpiece in his right hand, i.e. separated from the cornu itself. It would appear, therefore, that this archaic form had continued to be used, although, not without the later Roman innovation of a removable mouthpiece.

Two other iconographic references to Etruscan cornua, IC84 and 115, show instruments roughly the same form as the early ones discussed, suggesting that little further development took place as during the remainder of the Etruscan civilisation.

THE ROMAN CORNU

There is little doubt that the Romans took over the cornu from the Etruscans, the earliest Roman illustration, IC16, first century BC, showing two cornu players blowing instruments of a very clear Etruscan type. The representation is not clear enough to establish a value for the cone angle but the bell diameter of 117*mm* is very similar to the earlier Etruscan instruments (IC73: 111*mm* and IC135: 122*mm*).

About 9 or 8BC, the Arch of Susa was built and on this appears an illustration of two cornu players blowing instruments. (Figure 3.8) These instruments, however, although they still have the large diameter tube of the archaic form, curve over the heads of the players and are formed into a 'G' shape rather than the earlier oval form. All later instruments adopt

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[135] Baines, 1976, pl. II.
[136] Behn, 1954, 139/40, Abb. 176.

this form, with the radius of the curvature of the bell yard being greater than that of the tube yard.

Figure 3.8

As well as this change, later instruments tended to have smaller cone angles achieved either by having smaller bell yard diameters or by increasing the overall length of the instrument. On IC89, for instance, an illustration of a cornu player preparing to play for a gladiatorial contest, the player is holding an instrument with a bell diameter of about 138*mm* (scaled) but an overall length of 2.6*m*. This doubling of the instrument length would halve the cone angle, reducing it to a much more "musical" 13-15*mrad*. (Instrument tip cannot be scaled on IC89). In increasing the length of the instrument in this way its fundamental formant would be lowered in frequency, and the number of formants that could be elicited, increased. Perhaps more significantly, however, its tone colour would change as would the ease with which the tube's formants could be pitched and held. Both these changes are suggestive of a growing desire to use this instrument in much the same way as we use modern instruments; to pitch discrete notes precisely and to hold them at that pitch for given length of time. This view is further strengthened by the development of ensemble playing of PVAs with, for example, the hydraulis (IC12, 22, 40).

However, the change is clearly not all gain as the organological changes taking place here are such that the lips of the player are being increasingly controlled by the formants of the tube. In modern times this is what we desire of an instrument, but in the earlier instruments of the Etruscan period, coarse and unstable as the notes of the instrument may have been, a measure of control over their tone-colour rested with the player. That is not to say that these were in any way variable tone-colour instruments but just that the player's lips still had a greater control over the tone-colour produced.

Nevertheless, from about 50AD onwards developments were towards smaller cone angles and longer instrument lengths. Only one iconographic reference (IC126) shows a large diameter bell later than this period (161-181AD) and this could be taken to show the lingering on of this type of instrument (or could simply be poor artistic representation).

Four extant instruments, (SD239, 243, 260 and 261) were found at Pompeii and thus date to before 79AD. One of these, (SD239) is illustrated on plate 3.2a, from which it can be seen that this, as did the other three, lack mouthpieces[137]. According to Fleischhauer[138]

[137] Klar, 1971, 310, Anm. 24.
[138] Fleischhauer, 1960, 502.

this instrument is 3.33*m* long and the following dimensions are scaled from this. It is made up of a parallel tube yard about 2.5*m* long and 20*mm* diameter. The mouthpipe is about 430*mm* long and tapers down uniformly to 8.4*mm* diameter where the end 47*mm* long section tapers rapidly down to 5.2*mm* diameter. A carrying strut of 1.23*m* length meets the tube at the tube/bell yard intersection being fixed both at this and the other end with a 'T' shaped pipe fitting. From one of these junctions, the bell yard opens up with what appears to be a slow exponential flare to 78*mm* diameter at the bell end. Around the tip of the bell is an annular bell disc of 100*mm* diameter. According to Fleischhauer[139], when provided with an appropriate mouthpiece, 17 notes can be produced on a close copy of this instrument.

Plate 3.2a

Three other fragments of instruments have been found in Austria. (SD238, 273 and 274) and the form and dimensions of these appear to correspond reasonably well with the Pompeii instruments.[140] In Kaff's paper, reference is made to the tube seam of the instrument being soldered (die Lötnaht) and says that this is not of the modern form but is a straight seam. This contrasts with the seam clearly seen on SD263 (Plate 2.4a) where a toothed seam similar to that used today is employed and it would be surprising if a straight seam had been used at a point where the tube was yet to be bent to achieve the instrument's curvature. Kaff[141] also talks of the instrument wall thickness being 1 mm which is rather thick for sheet metal work of this period and would produce a rather heavy instrument.

In use, these instruments are seen on the Arch of Constantine (IC103, c. 80AD) and the column of Marcus Aurelius (IC106, c. 170AD), while similar instruments, apparently lacking the annular bell also are seen on IC23, (109AD) and IC 92 (C. 250AD).

139 Fleischhauer, 1960, 502.
140 Shenk, 1946, 46; Kaff, 1952, 57.
141 Kaff, 1952, 58.

Many other iconographic references show a bell yard terminating in a much-gentler cone and having at the end a cup-shaped disc rather than the straight annular one described above. (Plate 3.2b) On several of these references these instruments are being played alongside tubae and in these cases the tubae themselves also terminate with a similar shaped feature. (Plate 2.3b).

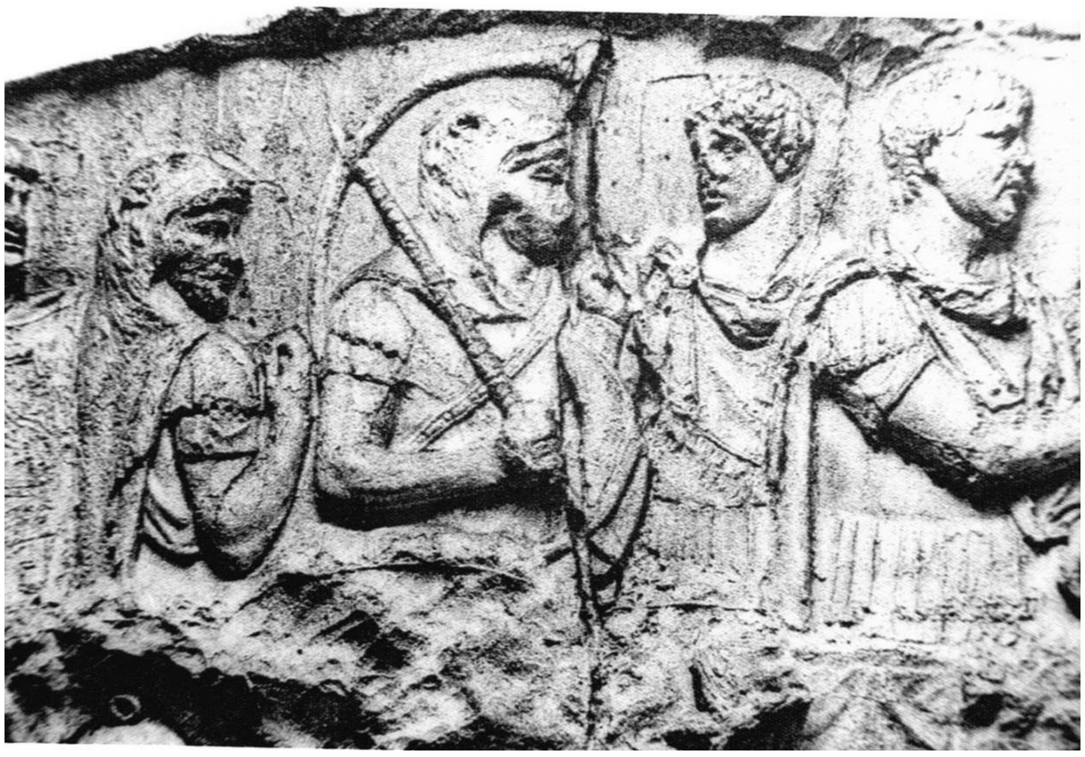

Plate 3.2b

These instruments also have carrying struts which extend beyond the tubes of the instrument and terminate in a decorative way. In most cases they end in a simple spike but on IC22 this is extended somewhat beyond the tube, has a decorative spike at the end of the strut and a curved brace on the tube itself. It appears quite possible, on this instrument, that this strut passes right through the tube yard and is braced hard up to this. (Figure 3.9a) The most elaborate terminal feature seen on these struts is on IC104, on Trajan's column, where a lunate disc is attached to the end of the strut which extends 500 to 600*mm* beyond the tube itself. (Figure 3.9b) In this case, the disc would have a clear function as a visible standard in battle. It would serve as a further rallying point, in addition to the field standards carried, the cornicines always standing near the field standards during a battle.[142]

[142] Fleischhauer, 1960, 502.

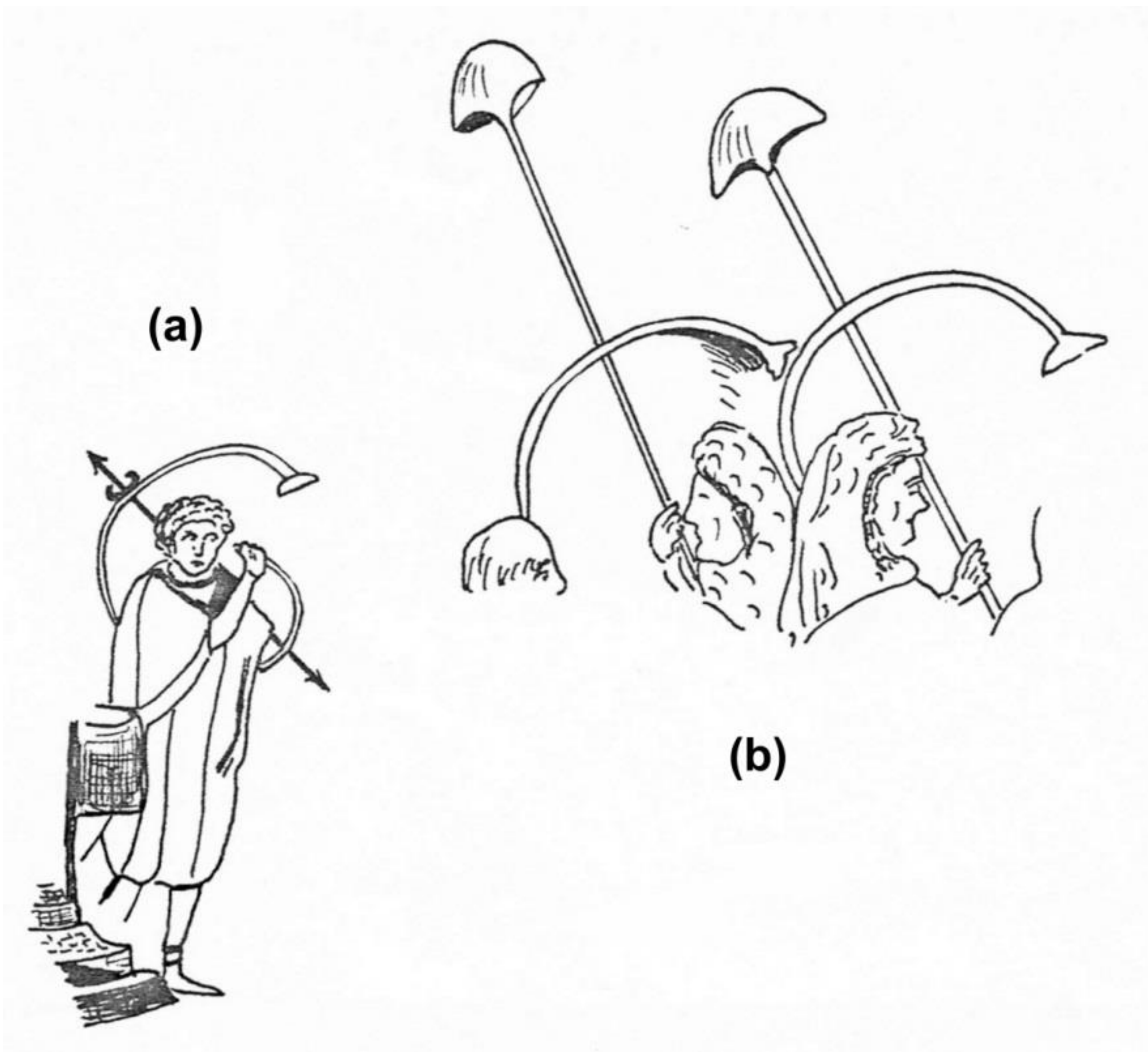

Figure 3.9

Thus the cornu seems to have been taken over from the Etruscans and by about 75 AD had developed into the form that was eventually spread throughout the Empire.

THE BONN/MAINZ INSTRUMENTS

Among the instruments used by the Romans, the only one that seems to have been used by them for the first time is the enigmatic instrument depicted on two tombstones, one at Mainz (IC1) and one at Bonn (IC142). These are parallel bored instruments with a slightly-flared bell, curved back on themselves and looking somewhat like a modern trombone. (Figure 3.10; Plate 3.3a) Unfortunately, neither of these illustrations are integrated with any material that can be scaled and so it is difficult to estimate their sizes. In an attempt to gain some idea of scale the bell diameter of IC142 was equated with the cornua on IC108 (Trajan's column) as the relationship of bell diameter to instrument tube diameter appeared to be about the same on each. This scaling, along with a rough estimate of what the original would look like (based on IC1), gave an instrument length of 1.4 m. In spite of the crudeness of this measure, it gives a length very close to that of the Roman tubae measured viz. 1.3 m, and very much less than those of the Cornua measured. It seems quite likely that this instrument was a development of the tuba having been folded for portability. In carrying out such a process the major difficulty would have been in forming the tight curves in the tube and the representation on IC142 appears to be a very faithful one showing a tube whose curvature is made up of two arcs with a fairly acute angle between. Such a shape is typically formed when a tube is bent without adequate support on the inside of the curve during the bending process. (pl 3.3 (a)).

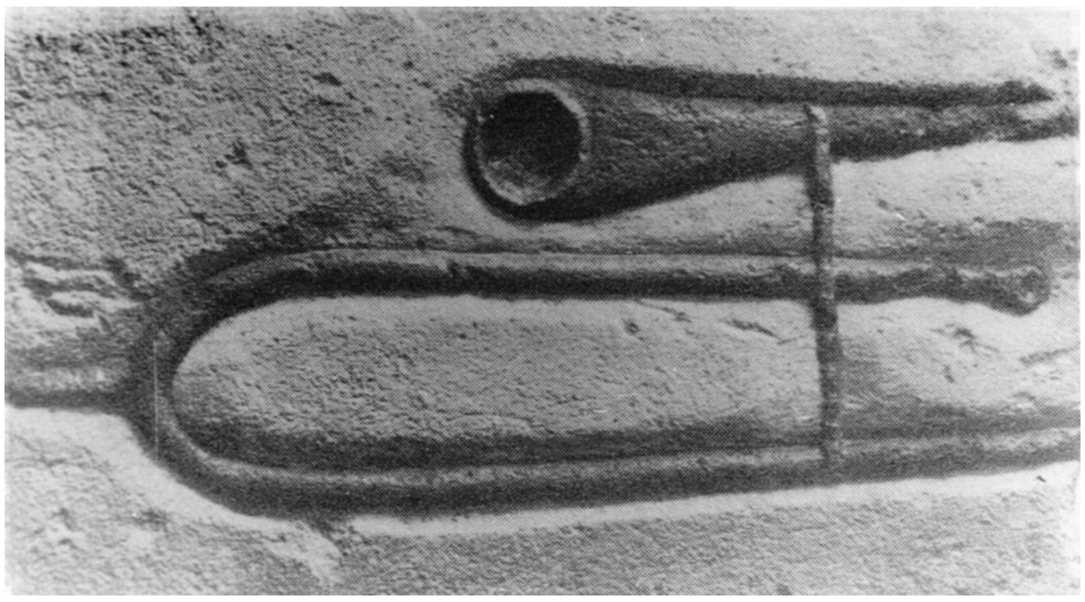

Plate 3.3a

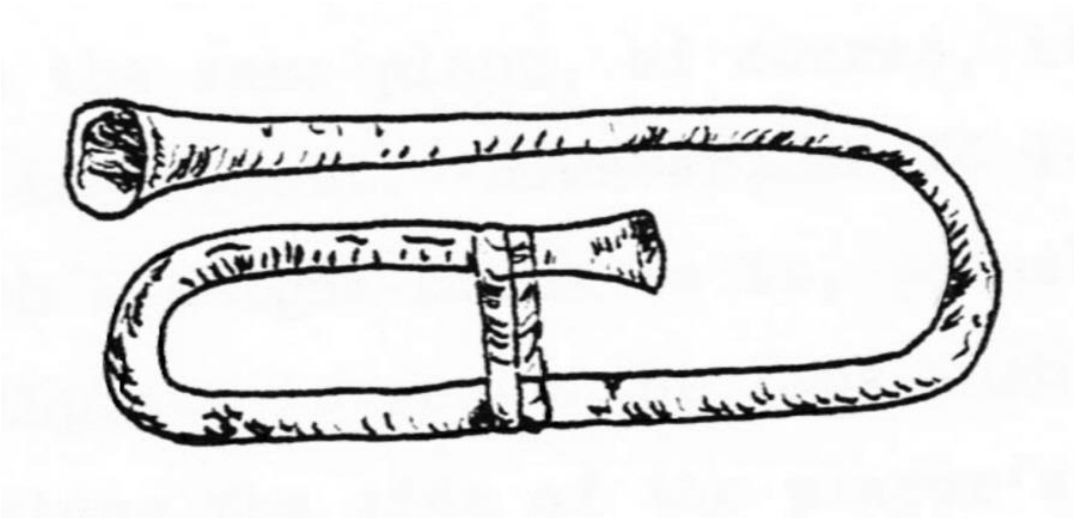

Figure 3.10

The instrument shown on Plate 3.3a (IC142) is clearly a developed form as the spike on the outside of the tube bend is in the right position to absorb shock when the instrument is mistreated and hence protect the tube there. In addition to this, the three tubes are well strapped together by a band passing over all three tubes. This would adequately locate the mouthpipe relative to the bell and tube yards, thus easing the playing of the instrument. On IC1 the mouthpipe is only strapped to the tube yard and this may well represent an earlier form.

Both illustrations are in low relief and this essentially two-dimensional representation does not allow the disposition in space of the various parts of the instrument to be determined. If all the tubes lay in the same plane, of course, it would be impossible to blow the instrument. However, on IC142 the mouth- pipe is illustrated with a slight crank in it, possibly bent just enough to allow the mouthpiece to reach the lips when the rest of the instrument passes along the side of the player's face.

IC1 is depicted on the tomb of Andes who is shown on this relief on horseback. The instrument then, was most probably developed for use of a cavalryman who would be left with one hand free for controlling his steed while blowing.

No other representations of this instrument are seen in the Roman world and no actual examples have been found. It seems particularly significant, therefore, that two instruments have been found in the area of the Rhine and it is reasonable to propose an origin from there. This area was a frontier zone throughout much of the Roman occupation and would, thus have been a point of interchange between the Romans and the indigenous population. It was this population that produced the Celtic Lituus (See Chapter 6) and was, no doubt aware of the carnyx as a cavalry instrument. When confronted with the Roman tuba, therefore, with its unwieldy length it was, no doubt, a local craftsman that set about 'liberating' it from its set military format. As to the problem of bending the tube, he would have already met this if he had at any time been engaged on carnyx production, where the forming of the bell tube is a problem of similar technical complexity.

What the users of these instruments called them is not known although several authors have attached different names to them. Behn[143], for instance, called them Bucinae. With the only location of the existing illustrations being in this frontier area and with their presumed imperial dating, however, this name seems unlikely to refer to these particular instruments. As early as the 2nd Century BC the player of the bucina, the bucinator was referred to by Polybius (DR17) and Jerome (340-420AD) tells that the buccina (a classical period spelling with two c's) is the instrument of the shepherds. ("Buccina pastoralis est." DR177). Jerome then qualifies this by saying that it is made from a curved horn (cornu recurvo efficitur) and here, ambiguity in Latin parallels that of English in that 'horn' does not necessarily imply an animal origin. However, Vegetius (DR21, c. 386AD) uses the term aere curvo (aes, aeris = made of copper or bronze) presumably to distinguish this instrument from one made of animal horn. If, as is suggested here, this instrument is a derivative of the tuba then one might expect it to be called something like a "tuba curva," and for the name to appear sometime after the colonisation of the Rhineland. Vegetius, in the quote above (DR21) comes closest to the use of such a term in "aere curvo" but this appears to refer to the instrument played by the cornicines.

ETRUSCAN AND ROMAN USE OF SHELL TRUMPETS

The use of shell trumpets was not of great significance in the musical life of these peoples, only one reference, IC30, having been found where they are depicted in use. On this, a battle scene from an early Etruscan sarcophagus, a warrior is seen blowing a conch shell.

Other references which occur are to Triton a mythological sea god, half man, half sea creature who blows a shell of Triton tritonis. (IC79, DR28 and 29).[144] This mythology was adopted from Greek legend and incorporated into Roman legend with Triton blowing the concha.

Fleischhauer in a paper in 1960 presents his case for this instrument, the shell trumpet, actually being that referred to by the Romans as the bucina., However, the use of the term bucina is so frequent and the depiction of the concha so infrequent that this case appears a little manufactured.

[143] Behn, 1954, 140.
[144] Otto, 1953, 81.

Although the Romans achieved a satisfactory design of mouthpiece, aesthetic considerations probably played as large a part as acoustic ones when carrying out detailed design. There appears to be little standardisation in the design of mouthpieces, the cups in particular were designed to regular forms such as shallow conical or spherical surfaces.[145] As no mouthpieces have been found with instruments, the assignment of mouthpieces to specific instrument types is somewhat arbitrary and the criteria used are as rule-of-thumb as 'that looks right for a Tuba.'

One mouthpiece that 'looks right for a Cornu' (SD276) is illustrated in Figure 3.11 (a). It has a 35.7*mm* diameter rim and a hemispherical cup leading to an oval throat of 4.25/5.65*mm* diameter. The overall length of the mouthpiece is 133.4*mm* and at its downstream end is terminated by a complete fracture of the shank. Mouthpieces of this type are the commonest to be found in the Roman world.

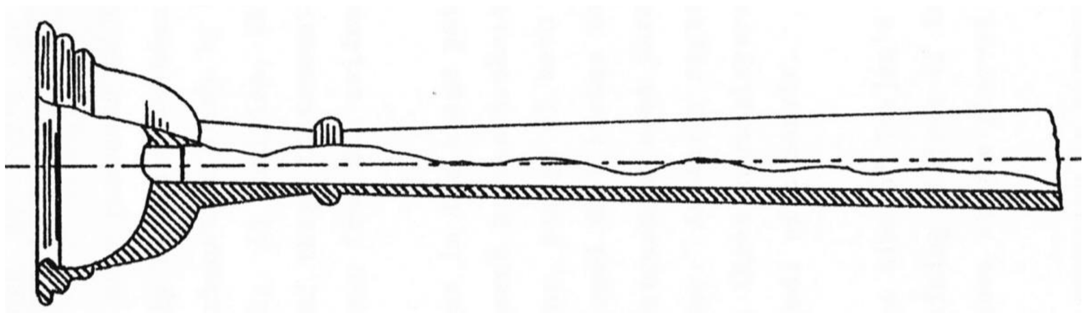

Figure 3.11a

A further mouthpiece of much smaller overall form, SD277, is shown in Figure 3.11b. This has a rim diameter of 21.7*mm* and a cup about 10.5*mm* deep leading into a throat of only 2.5*mm*. It is clearly designed for a much smaller instrument than SD276 and its small throat would favour the production of the higher formants on this. As it seems to be a unique find, and to come from the Rhineland area, it may be correct to associate this with the locally developed instruments discussed under the heading of "Bonn/Mainz instruments."[146]

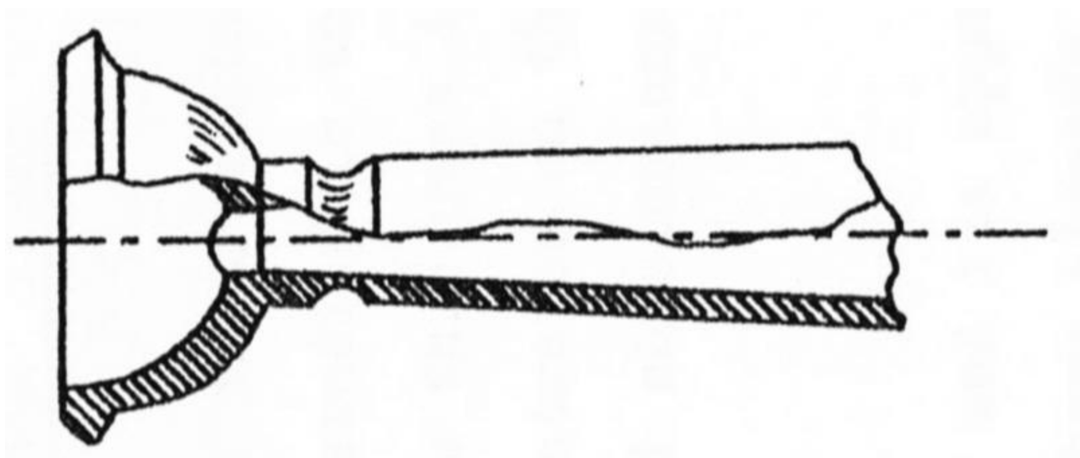

Figure 3.11b

Figure 3.12 (from Behn, 1954, Abb.181), shows some of the variety of Roman mouthpieces that have been found, although he fails to identify any of these.

[145] Klar, 1971, Abb. 24.
[146] Since this was written, another mouthpiece similar to that in Figure 3.11(b) has been examined by the author at St Albans in the UK, Roman Verulamium.

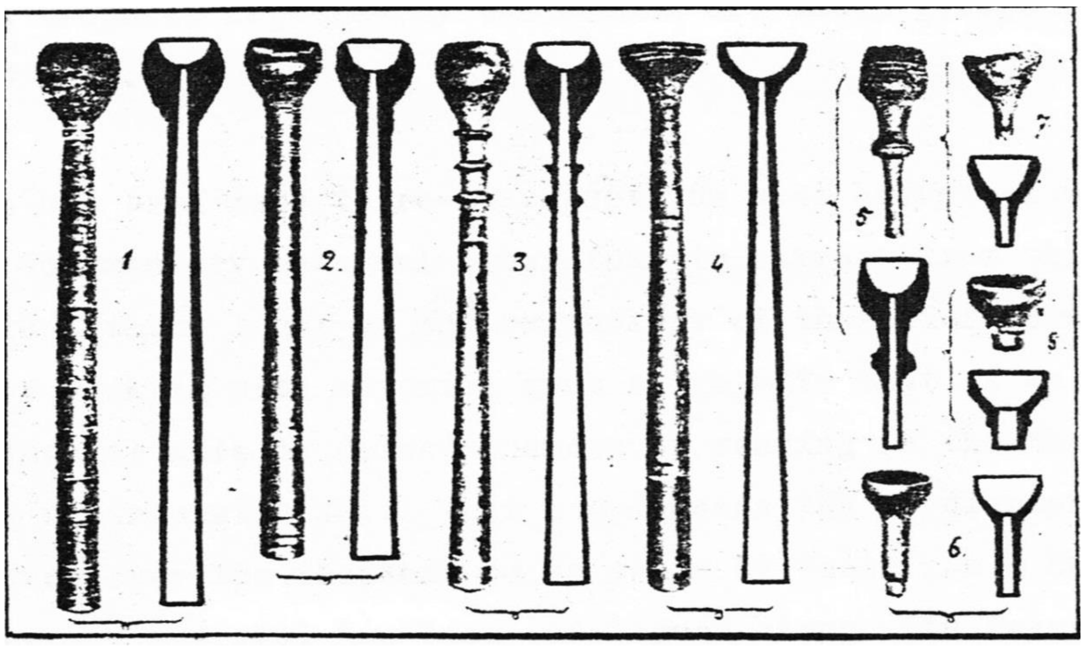

Figure 3.12

Plate 3.3b, Upper, illustrates SD231, the mouthpiece found on the Antonine Wall at Castlecary Fort.

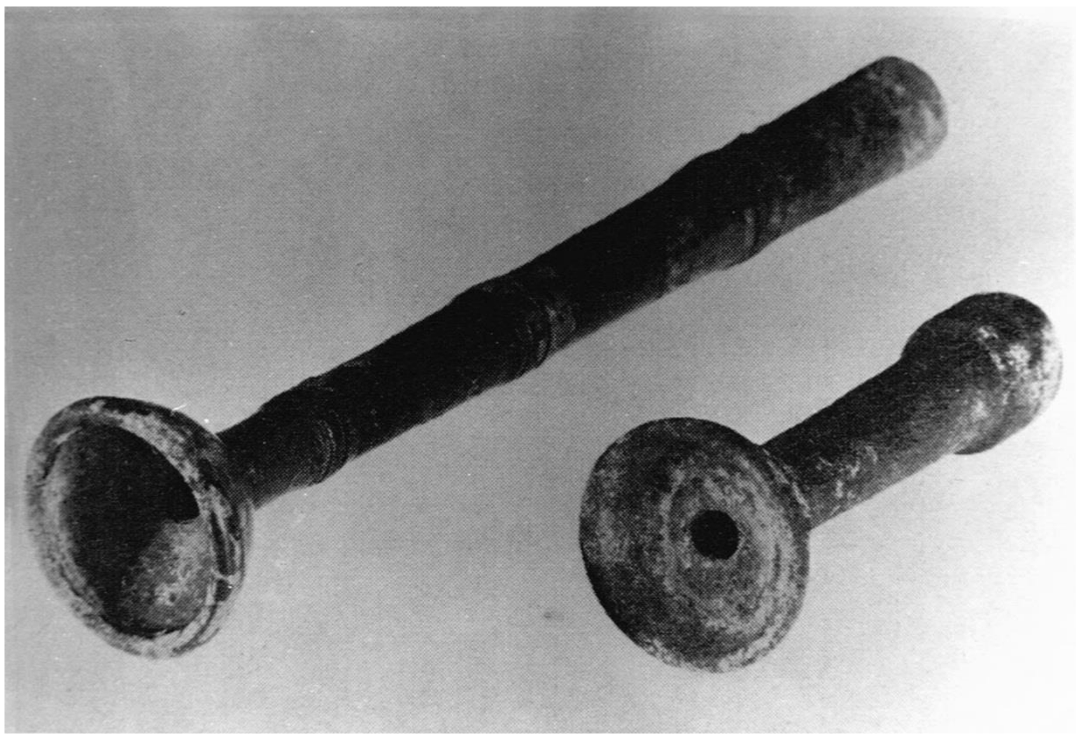

Plate 3.3b: Roman Mouthpieces

THE USE OF PVAS IN ETRUSCAN AND ROMAN TIMES

It is only proposed to discuss this area of instrumental use very briefly as this has been very extensively studied in the past and the exhaustive study by Wille[147] covers this area in great detail. In addition, this study has concentrated on the morphology of these instruments and the technical conclusions that can be drawn from the evidence of their use.

Changes in the usage pattern of the lituus and its apparent replacement by the technically simpler tuba have already been noted.[148] However, a usage of both the tuba and the cornu in groups of three developed which became the common feature, replacing the use of pairs of instruments seen throughout the Etruscan and Republican period of Rome. An early

[147] Wille, 1967.
[148] The term 'Technical' should have been qualified here to refer to the technical aspects of manufacture.

representation of this form (IC120, 50-74 AD) shows three tuba players and three cornu players, playing during the Ludi of a Servir.

By the time of Trajan's column, c. 113AD, the majority of scenes containing players of instruments have them grouped in threes, a few have single players and only one has two cornu players together.

This grouping is mirrored in contemporary Celtic representations where carnyx players are shown in group of three, IC49 (Gundestrup) and Celtic trophies captured by the Romans are shown grouped in threes (IC109).

No attempt has been made to re-interpret the vast amount of Greek and Roman documentary material other than to extract from this those portions that throw light on the organology of these instruments. The task of working with material such as this is that of an accomplished linguist able to detect nuances of meaning in the texts and having a linguistic skill that encompasses the development of these tongues over the thousand or so years of their use. However, the documentary material has been catalogued along with translations and their source. In the case of particularly relevant material where available, these have been made by the author! It is felt that this catalogue provides a basis for a more rational study of the literary references and a preliminary data-source to which the mass of material not yet located can be added when identified as relevant.

CHAPTER 4

THE INSTRUMENTS OF SCANDINAVIA[149]

In the area of Northern Germany, Denmark, Sweden and Norway, between 1600 and 500BC, a culture developed which was distinctive and different from those to the south in Europe and to the West in the U.K and Ireland. Bronze was worked there although no indigenous supplies seem to have been available, the source of raw material being either west or central European. Amber was possibly one exchange material as Baltic amber is quite widespread in both West and central Europe. The conventional sub-division of the culture is into Periods I to IV and a rough comparability of these with conventional dates is given below:-

PERIOD	GENERAL DESCRIPTION	APPROX. DATE	
		Radio Carbon	Conventional
I	Early Bronze-Age	1600B.C.	1900B.C.
II	Middle Bronze-Age	1500-1200B.C.	1800–1500B.C.
III			
IV	Late Bronze Age	900–600B.C.	1100–800B.C.
V			
VI	Late Bronze Age/Early Iron Age		300B.C.

The culture of the area was distinctive both in the artefacts it produced and with the ritual recorded on iconographic sources. The latter included engravings on bronze artefacts, and most important of all the numerous rock carvings in the area. Some of these can be interpreted as representations of ritual practices and show, among other things, the use of what appears to be player-voiced instruments of several forms. (See Map 4.1 for location

149 In recent work, I have described these as of Scandinavian and Baltic origin as the Norwegian instruments such as that from Revheim are found far from the Baltic Sea.

of finds.) Among these instruments, the most distinctive is quite clearly the lur of which 53 specimens or fragments (SD101 to SD154) have been found.

In this study the term "lur" has been reserved exclusively for instruments of the type here designated "standard" lur form. Unfortunately this is not so in Scandinavian usage generally, where all player-voiced instruments are given the title "lur" as in Oldeberg[150] where he consistently refers to non-Scandinavian player-voiced instruments as lurs, in much the same way as Diodorus Siculus writing in the 1st century BC referred to the instruments of the Gauls as "Salpinges" (DR 9). Being the product of a non-literate society the name given to these instruments during their use in the bronze age is not known. However, when cataloguing these instruments at the beginning of the 19th century the term "lur" was used to describe them as the word is mentioned in the Old-Norse literature and this was the period to which they were assigned. In the sagas, the lur is frequently mentioned as the instrument by which the warriors are called to battle[151] and the connection of the name to these instruments must have appeared logical. Although it is now known that the lurs are considerably older than the period of this literature, the name has become attached to the instruments and seems to be as reasonable a title as any other. However, it was applied to these instruments specifically and there seems no reason to apply it to any other with the obvious exception of instruments now shown to belong to the period of the Sagas.

The lur is fairly readily identifiable on several rock carvings and less clearly so on many others. In addition to the recognisable standard form used for the instrument, however, some forms are represented which seem to be clearly identifiable as intermediates between a simple animal-horn instrument and the "standard" lur as represented in the extant specimens.

This "standard" lur, as represented by the 53 finds of instruments and fragments is of a fairly clearly definable form, the major variation from this standard morphology being on the presumed early examples from Gullåkra (SD135), Paårp (SD138) and unprovenanced one in Skåne (SD136). All the lurs are conically-tubed instruments with a tube diameter varying from roughly ten millimetres to between fifty and eighty millimetres. Their lengths vary from 1.46*m* to 2.20*m*, the tip end of this being terminated by a mouthpiece (a mouthsupport in the case of Wismar and Teterow) and the bell end by a decorative bell disc. All the instruments examined have been cast, probably in bronze, and, most probably, using lost-wax technique.

Both tube and bell yards are made up from segments of varying lengths which are joined together either by a "meander" joint in which a protruding portion of one segment interlocks with the next, by use of a ferrule or band or by casting-on directly. See Figure 4.1.

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[150] Oldeberg 1947
[151] Broholm, 1947, pp. 49-51

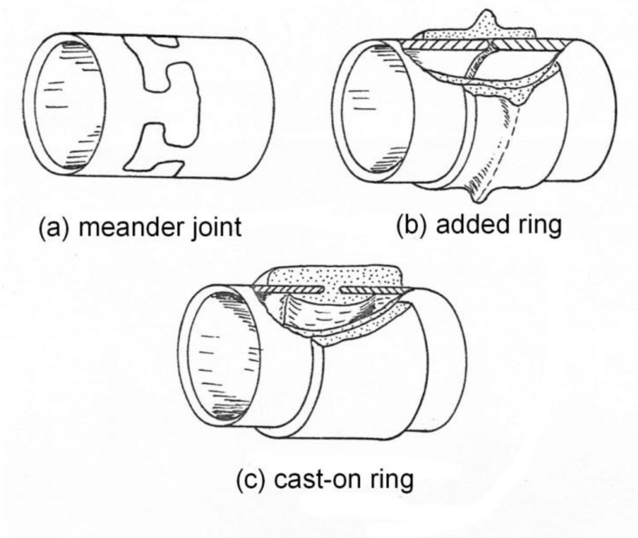

Figure 4.1: Techniques for joining Tube Sections

In some cases, the tube seems to have been cast in sections of one segment at a time in other cases in tube-units made up of several segments.

Visual evidence of the use of chaplets is present on many instruments, from their differential weathering characteristic, their protrusion into the bore of the instrument and from the holes left when these have broken free from the tube material and totally fallen out.

Many instruments have appendages in the form of small (c. 60 mm long) plates attached to various parts of the instrument, mainly on the tube yard and the rear of the bell discs. These rattle or tinkle when the instrument is moved providing a built-in idiophone accompaniment to the music of the instrument itself.

While the early specimens are curved in two planes, somewhat after the fashion of an extended cow horn, the main group of instruments have a very uniform morphology. On these the curvature is almost entirely polarised, that on the tube yard being in a horizontal plane with the bell yard curving in a vertical plane. Some instruments have a transitional segment which curves in both planes while others have a lock which serves to fasten tube to bell yard, where the change from horizontal to vertical planes occurs abruptly. See Figure 4.2.

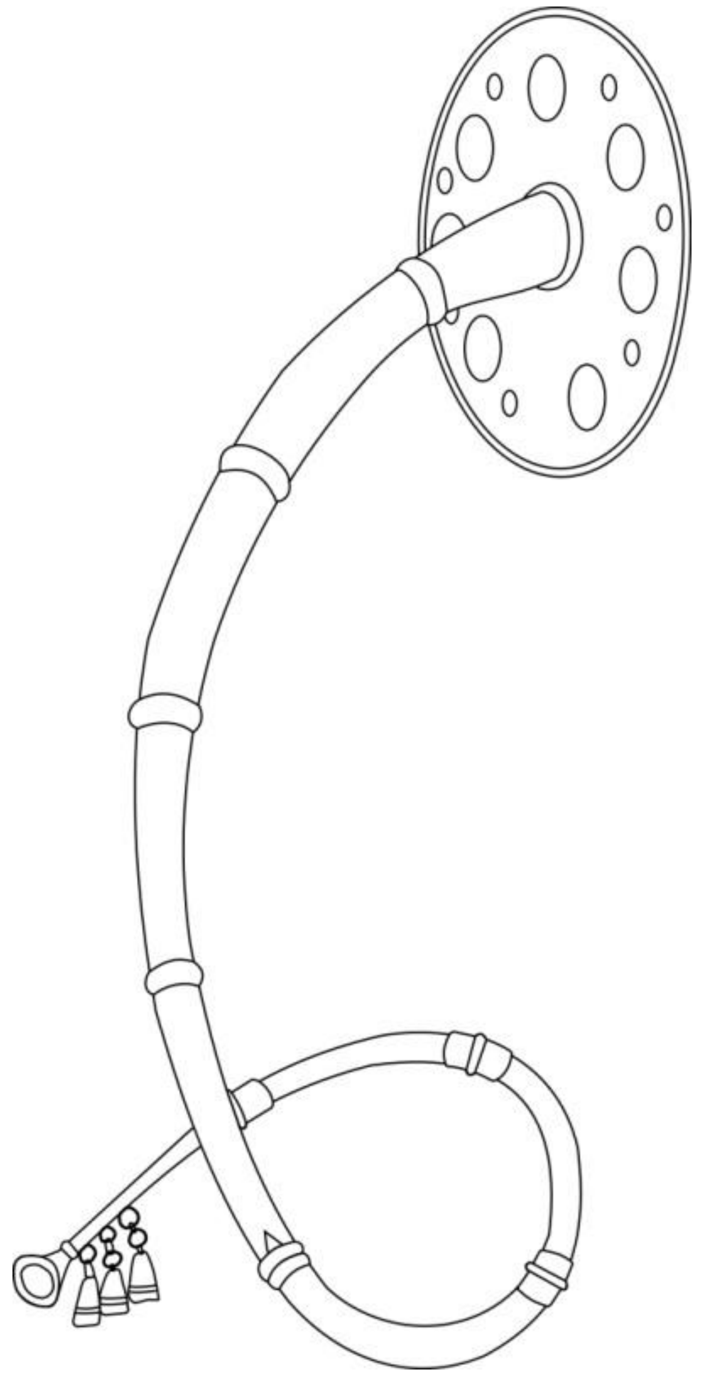

Figure 4.2: A Typical Lur Form

Many instruments have bell discs, and with the exception of the three presumed early instruments, those currently lacking these, have provision for their attachment. Two of the early lurs have an integrally-cast annular disc which meets the bell yard at right angles but the standard bell discs are large annular discs fixed to the bell end so that they fringe the instrument's exit aperture. See Figure 4.3.

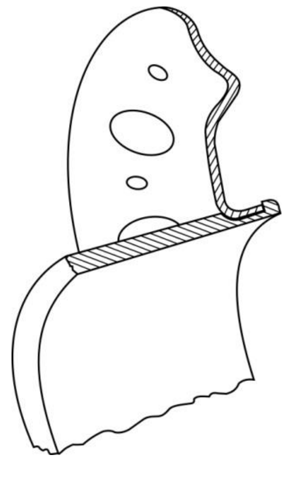

Figure 4.3: Fixing a Bell Disc to a Lur Tube

The lurs generally have been the subject of many papers, their ability to raise interest and spark off controversy perhaps being related to their size and generally spectacular appearance. This has led to considerable speculation and, during the troubled years of the mid-20th century, to their use for purposes of nationalistic propaganda. From the work carried out in the past 200 years, a reasonably stable view of the lurs has emerged, a relative chronology been established and a general picture of the technology involved in the manufacture of these instruments drawn. This study confirms much of the view of the lurs already held but opens up the area of metrology as applied to the lurs in particular and the Bronze Age in general. ln addition it attempts to view the lurs holistically by investigating the evidence of usage and development as presented on the contemporary iconographic material as well as examining the perceptual psychology both of the artists of rock-carvings and the artisan who shaped them.

Three major studies of the lurs have been written previously, by Schmitt[152],Oldeberg[153], and Broholm[154]. Many other references to the lurs are present in earlier literature and these and other specific papers on them are summarised in great detail in Oldeberg[155].

lnexplicably, the iconographic evidence has been largely ignored in previous studies of the lurs. Broholm, discusses two rock carvings briefly on p. 65 of his article and Oldeberg discusses one on p. 81 of his work. This study has located 19 carvings which contain information relevant to the development of the lurs.

THE ESTABLISHMENT OF THE MODERN VIEW OF THE LURS

In works of the early and mid-19th century it had been pointed out that the lurs were cast in several pieces and joined with 'long tenons or rather hooks engaging one segment to the next.' Shortly after this they were generally assigned to the late bronze age. Hammerich[156] discussed the differences between the various lurs and considered that the instruments with integrally cast bell discs were earlier than the others with an added bell disc. He attributed the form of the lur to a development from a prototype cow or ox horn and pointed out that, as with many other instruments, lurs are made, and presumably played, in pairs. By reference to the location of wear on the rattle plates he established that the instruments are played with the bell-disc above the head of the player.

Hammerich's paper was the first to discuss objectively the morphology of the lur in terms of its acoustic performance, coming to the conclusion that the conicity was deliberately designed to achieve a particular acoustic effect.

Writing in criticism of some of Hammerich's ideas, Kroman[157] stated emphatically his belief that the lurs were not played in harmony, being of the opinion that they would have been used as unison pairs.

Curt Sachs[158] considered that the lurs were made by the Etruscans and suggests that the morphology was in some way a derivative of a mammoth tusk form!

A current view that the instruments in the Wismar group of horns were pre-cursers of the lurs was given by Bronsted[159], he suggested a morphological relationship between the

[152] Schmitt 1915.
[153] Oldeberg 1947.
[154] Broholm 1949.
[155] Oldeberg 1947 pp. 1-20
[156] Hammerich 1893.
[157] Kroman 1902.
[158] Curt Sachs 1913.
[159] Bronsted 1938.

Påarp lur and the rock-carvings at Kivik. He continues the old argument that, in lengthening the tubes of the lurs, the manufacturers were trying to attain a diatonic scale, i.e. to break away from the melodic restriction that arises from a "natural" instrument.

Hahne[160] divided the lur material into groups according to age using technological, aesthetic and organological features to establish a gradient of development. Schmidt[161] extended this work and added detailed metallurgical analysis to the tools for research into these instruments.

In his study, Schmidt sub-divides the lurs into Groups A, B and C. Group A, covering the greater part of period III, he considers, includes instruments from Rørlykke (SD119/20), Gullåkra, Påarp and the fragment from Skåne, he characterises them as being of integral construction with several yards joined by meander joints and a bell terminating with an integral flange.

His next group, BI, covering the greater part of the period IV (dated on decoration) are longer instruments made in two parts , the tube and bell yards, these fitting into each other and being held there by the use of eyes cast onto the adjacent tube portions. The instruments he places into this group are: Maltbaek (SD128/9), Lommelev (SD113/114), Lübzin (SD147), Fråap (SD141), and Hindby (SD137).

The next group B2, he characterises as being larger and "more distinctly S-form" i.e. the curvature in the vertical and horizontal planes has become polarised, the former lying mainly in the bell-yard and the latter in the tube yard. These yards are now joined by means of a triangular catch, a protrusion on one yard which fits into a receptacle on the other. The bell discs have cast decorative elements only. He places in this category, the lurs from Folrisdam (SD124/5), Boeslunde (SD111/112) and Radbjerg (SD115/116) and dates them to 'the end of period IV/beginning of period V'.

Group B3 he also dates to the end of period IV/beginning of Period V, assigning the lurs from Tellerup (SD117/118) to this group, these lurs having bell discs with cast bosses and punched decoration.

Group C instruments he dates to period V and characterises as large, "homogeneous" instruments that can always be separated. They are made of segments joined by sleeves and their bell discs are decorated with cast bosses. Their mouthpieces are funnel-shaped with out-turned sides and with an overturned flange. In this group he places instruments from Daberkow (SD144/145), Hof zum Felde (SD146), Brudevaelte (SD101/102, SD103/104, SD105), Långlot (SD142/143) and Broneby (SD139/140)

Oldeberg studied the Swedish, Norwegian and Baltic lurs and published the study of these in his re-interpretation of Schmidt's work in 1947. In this, he re-classified the instruments into groups A, B and C rejecting the earlier sub-division of Schmidt on various grounds.

His criteria for assigning classifications to the various groups are stated as: "the size of the lur; the method of joining the various segments; the connexion between bell and tube and the development of the mouthpiece"[162] .

The group A lurs he characterises as small, cast in four to six segments joined by meander-joints but with yards which are not separable. They generally are of wide bore, have simple

[160] Hahne 1915.
[161] Schmidt 1915.
[162] Oldeberg 1947, p. 45.

flange-like mouthpieces and integrally-cast bell flanges and are decorated by means of cast raised bands.

His group B instruments are larger than the A group. They are separable and each separate yard is generally curved in a single plane. Both yards are made up of segments joined together by casting-on, on occasions a meander joint being utilised. However, some instruments that he considers to be later types were assembled by means of ferrules. The bell discs of this group were somewhat variable, featuring both cast and chased decoration. All instruments in this group have clearly developed mouthpieces and the use of rattle-plates is first seen on the later instruments of this group.

The variability in the B group, which Oldeberg considers to be a typical transitional trait is no longer present in the C group. A further increase in size is seen on the instruments of this group and the curvature has become distinctly polarised. The variability seen in fastening devices in the B group gives way to a uniform use of a triangular tenon and the segments of the tube yards are joined by the use of sleeves. Bell discs on these instruments are the largest seen on any lurs and they are always made separately from the bell yard and secured to this. Their decoration may be punched or cast. The funnel shaped mouthpiece of group B has evolved to a more cup-shaped (trombone-type) mouthpiece with a recurved lip around its edge. Thus, Oldeberg generally retains the classification originally developed by Schmidt, his major change being to group the intermediate instruments together rather than trying to differentiate in finer detail.

Broholm[163], wrote his work after both Schmidt and Oldeberg. ln this work, he dates the lurs by means of their decorative elements and, to a much lesser extent, the techniques employed in their construction. This is necessary as few instruments had been found together with datable material.

The first instruments he considers are those from Lommelev and Maltbaek which have a chased decoration similar to that seen on several objects from.the bronze-age, period III and IV[164] Using these, he dates the Maltbæk lurs to the end of period IV and the Lommelev to the beginning of period V. From these established points, he dates the Nyrup (SD122) fragment by its similarity in tube morphology to Maltbaek and the Dauding (SD123) fragment by its similarity to Nyrup.

Among the earliest lurs, Group A of both Schmidt and Oldeberg had included that from Påarp. However, Broholm discounts this view and assigns this to the end of Period IV on its morphology, decoration and meander-joints. The remainder of this group he assigns to period III on much the same grounds as used by Schmidt and Oldeberg.

On the bell discs of the Folrisdam instruments are two complete circles made up of cast, raised knobs. Broholm dates these by reference to similar decoration on hanging vessels datable to the end of period V and, by means of this date these instruments to the beginning of period VI.

Other instruments too have decorative elements common to other datable material, such as the pips surrounded by raised circles seen on the Brudevaelte (SD103/4, SD105/6) and Daberkow, the spiral lines on the lock of Brudevaelte (SD105/6) and the addition of

[163] Broholm 1949, pp. 51-60
[164] Broholm 1949, Figs. 15 and 16

concentric circles on the large cast bell-disc bosses, Boslunde and Garlstedt (SD148). Again Broholm uses these to date the instruments[165]

The last instruments considered, those from Revheim (SD131/2) in Norway, he dates to period V/V1 and suggests that these are of local manufacture.

ln all, Broholm's survey and dating seem well founded in the dating of comparable archaeological material from this area. Of the three datings discussed here, it accords most nearly with the one derived in this study and has been used for cross-reference to archaeological dates from the Nordic cultural area.

THE PRESENT STUDY

The group of lurs, when studied from archaeological, technological, organological and aesthetic points of view, present spectra of complexity for each of these which do not overlap to provide a simple chronological sequence. However, towards the eastern limit of the cultural area studied, in what is now the DDR[166] three instruments were found (SD221, Wismar, SD222, Teterow, SD227 Bochin). These appear to be very primitive organologically and, consisting as they do of simple fittings for animal horns, could well have had a local source of inspiration for their origin.

Bochin, the earliest of these, dated on its decoration to Bronze Age Early period II by Schmidt[167] is merely a fragment of bronze tube designed to fit over the bell end of an animal horn. It was probably cast by lost-wax technique and, early as it may be, the method of forming wax material over a preformed core which was used on this piece continued to be used on all the lurs examined in this study. The evidence for this is seen on the extant material where the 13 circumferential bands on the bore of the instrument must clearly have been produced by forming over a core while the 20 similar bands on the outside could well have been formed by the removal of wax with a suitable tool. (Figure 4.4).

[165] op. cit., p. 59.
[166] At the time of writing this was the old East Germany, now part of The Federal Republic of Germany.
[167] Schmidt 1915, p. 108.

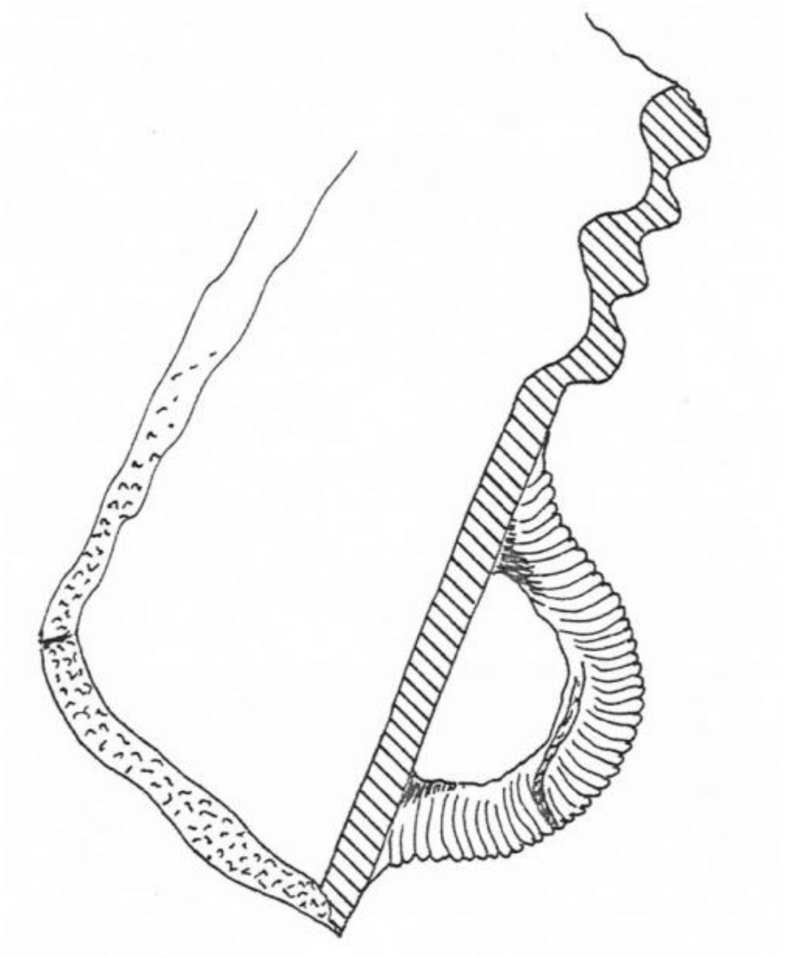

Figure 4.4: The Bochin Fragment

This tube appears to be little more than a simple decorative band, as suggested by the presence of internal decoration. For this to be visible, the bronze tube would need to have been mounted to increase the overall-length of the instrument, thus modifying its organological character.

A similar bell end, along with a central carrying ring and mouth- support tube were found in Wismar.

Prior to Althin's paper in 1945, there was a general agreement as to the dating of this instrument, it being assigned dates to between Periods II and III (Schmidt, 1915) early Period II; Brønsted (1938), Period II; Hahne (1915) Period II - III. However, Althin[168] concludes that much of the decoration of this horn is a forgery carried out, he suggests about 1830. His general conclusion is that the mixture of ornamental elements is inconsistent with that produced in any one object seen until well into Period V. Oldeberg, however, disagrees with this view and cites comparisons for all the decorational elements seen on Wismar that fall in the periods I and II.

From its general construction, Wismar seems quite likely to date from the early periods proposed. Its construction and design in no way resemble the instruments of Period V and, particularly in its provision of a mouthpiece, it lags seriously behind these later instruments. Althin contends that its decoration stems from the 19th century, and Oldeberg contradicts this: There seems little doubt, however, about the body of the instrument itself being from this period. In Period II this, no doubt, represented a considerable technical achievement and the manufacture of such an item in 19th century Prussia would probably still have presented considerable problems. Thus, had it been

[168] Althin 1945, 144.

made as a hoax it would have necessarily involved enough people other than the hoaxer to ensure that the secret did not remain a secret for too long.

The three parts of the instrument together make up the classic trio for an instrument manufactured during the transition from naturally occurring materials to metal.

However, unlike on Bochin, the bell tube is decidedly not round and the wax pattern from which it was made was probably manufactured without a core, again unlike Bochin, ln the bore is a circumferential step of from 1 to 1.5 mm, apparently where one piece of wax was laid over another. Had a core been present prior to forming the wax, the bore of the tube would have taken up the form of this core and this step been smoothed out. (Figure 4.5)

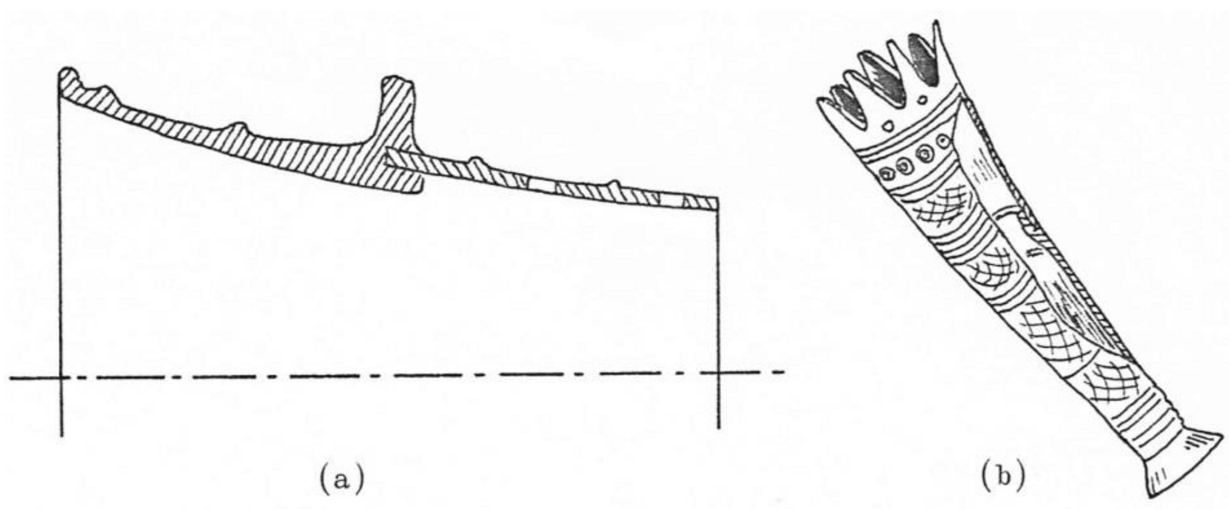

Figure 4.5

Teterow consists of a longer mouthpipe with mouthsupport (0.32mm long), similar in some respects to the Wismar example. On this, however, the central carrying ring is cast integrally; (Plate 4.1 (b).

Plate 4.1(b)

There is little doubt that the three instruments are from the same industrial group, and the decoration on one of these, the Wismar horn, clearly relates the group as a whole to the culture that produced the Scandinavian rock carvings. Several decorative elements present on the Wismar horn are commonly found throughout Scandinavia on the Bronze Age rock carvings.

While it has generally been accepted that these instruments are pre-cursors of the lurs, Broholm[169] suggests that they are simply representatives of a different instrument type from the same culture, He considers that the Gullåkra mouthsupport is inferior to that of Wismar whereas the present study suggests that, organologically speaking, it is identical and indeed, technically- speaking more complex. (Figure 4,6).

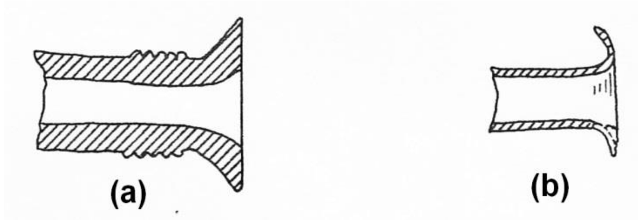

Figure 4.6: (a) Wismar, (b) Gullåkra

The general sectional thickness of the Gullåkra lur is also less than on the Wismar instrument, and the degree of roundness of its tubes higher, both of these features reflecting a higher level of manufacture. Also, as on the rest of the lurs, chaplets were utilised in the casting of the Gullåkra instrument while none are to be seen on any instrument of the Wismar group. Up to a certain length for a given diameter a casting can be made using core-prints to register the core accurately within the mould. However, as the tube length or curvature increases or its diameter decreases either the quality of fit of the core-prints or the diameter of the core itself becomes a limiting factor and chaplets must be employed to retain the core adequately. Significantly, the Wismar group of instruments could all be made without chaplets while the technological step to the Gullåkra (and Påarp) instrument(s) is a quantum step requiring the adoption of chaplets. Thus the critical development that allowed the move to a longer and more curved instrument was probably this technological improvement in the accurate location of the core during the casting operation.

In addition, the evidence from extant instruments and rock carvings provides a fairly complete sequence of morphology from a simple Wismar type of horn to a complex developed lur type.

Ironically, the strongest argument for co-existence of the Wismar type and some developed form of lur comes from the Wismar instrument itself. On this the incised decoration contains a ship motif with passengers one of whom has a feature above his head which is generally interpreted as a lur.

ICONOGRAPHY OF THE LURS: THE ROCK CARVINGS

Throughout the area of the Nordic Bronze-Age many thousands of rock-carvings still exist. In Norway and Sweden these are generally on prominent outcrops of hard metamorphic rock and frequently on the advancing faces of roche moutonnées left by the ice-weathering. In Denmark they are frequently present on much smaller rocks and outcrops (Plate 4.1 (a)).

169 Broholm 1947, 79-80.

Plate. 4.1 (a)

Carved into these rocks are scenes with groups of people, individuals, ships and a great variety of other symbols. As with any form of pictorial representation which has symbolic meaning the representational style developed traditions which resulted in the use of highly abstract forms. Nevertheless these are frequently intermixed with more conventional feature-by-feature representations.

Interpretation of the message left in the rock, carvings and occasional other pictorial representation is aided by the overlap between the iconography and extant material, notably in the case of this study, of the lurs and their pre-cursors. Probably, the simplest pre-lur illustrated on a rock-carving (type I) is that from Gissleggårde in Sweden (IC171), (Figure 4.7). On this a player blows a short horn which scales about 0.5 m long. Its form is difficult to define but it may well be a variety of fairly simple animal-horn instrument. A clearer animal-horn type instrument (type II) is seen on IC174 (Figure 4.7). On this, a slightly longer instrument is being blown with its bell pointing upwards.

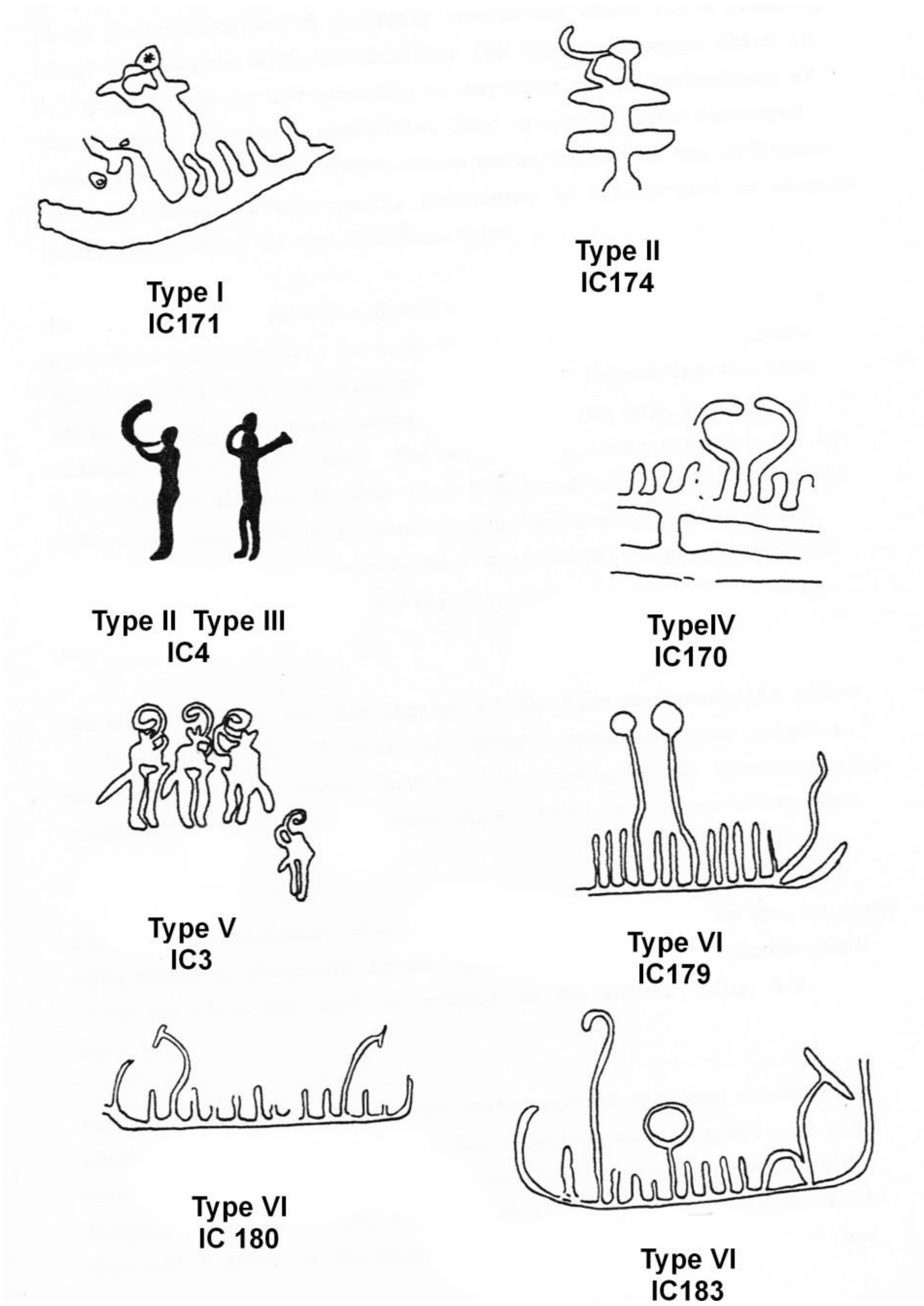

Figure 4.7

A carving from Vitlycke (IC202) shows two players blowing up-curving horns of about 0.9m (scale) length. The size of these must be above that available from animal horn and would point to a metallic instrument being used. Hence, by this period either an organological or aesthetic pressure had led to the increase in length and the technology of manufacture had presumably been able to cope with this demand. Alternatively, the possibility of applying this to lur manufacture have been appreciated and, hence, the longer instrument made. The metrological work carried out on these instruments which is detailed below would tend to favour the former view i.e. organological/aesthetic pressure.

A further example of this type is seen on a carving from Blåholt, Broholm, (IC184). On this, the player appears to be holding a similar single curved horn but on this occasion is standing on a ship

The oft-published carvings from the Bronze Age at Kivik contain an illustration of two players blowing lurs (IC 4 on Figure 4.7). These instruments are very highly curved and about 1.4 m (scaled) long, and compare with the Gullåkra (SD135) instrument which is 1.3 m long. lt is not possible to say from the illustrations of the carvings currently available, (the originals were destroyed some time ago) to what extent these horns curved in two different planes. These carvings could, therefore, be interpreted as players using instruments of the Gullåkra type.

It is interesting that the Kivik carving shows instruments being played in two ways i.e. in both vertical and horizontal planes. This suggests that the problems involved in supporting the lurs while playing were occasioning experimentation into methods of holding them at this time. The weight of a large diameter lur of 1.3 m.length is considerable (2 to 5 kg) and an experiment carried out on the Gullåkra instrument during the course of this study revealed that it was, indeed, most comfortable to play when held as in the right player on Kivik, i.e. in the modern French-horn style.

Unfortunately for the lur players of the time the aesthetic effect of having the lur bell pointing skywards must have been judged a more important criterion than ease of playing as all future developments took place on instruments whose sound source was above the player.

All the illustrations of this next group of instruments are on ships with players, generally in twos, holding curved instruments that stick up above the other passengers on the ships. (Figure 4.7, type IV)

One carving, IC186, shows one instrument of the type described above but in front of it is a lur player standing up. In his hand this man is holding what could be a lur with a double curve. According to Glob[170],the design of the boat on which they stand dates to the transition between Periods II and III and would, thus, point to the presence of the double curvature instrument by this date.

As the lur had increased in length and its playing position had become standardised as vertically above the head of the player, any increase of tube length had tended to increase its visual impact. Thus, when further lengthening of the tube necessitated curving this more acutely in a second plane, the additional curvature was placed where it could be seen, at the top of the bell. At the same time as accommodating additional tube length, this development also allowed the bell exit to be twisted so as to project forward. Such developments are seen on IC 3 and IC187 where 3 and 4 players respectively are depicted. On IC178,the lurs scale at 2.48, 1.81 and 1.78 metres long. (Figure 4.7, type V)

However, the evidence from extant instruments seems to suggest that they were held with the tube yard horizontal and the bell yard curving in a vertical plane. It could be, therefore, that these instruments were played in this way, the current rules of perspective at that time not allowing the differences in plane to be readily depicted.

While the organological significance of accommodating an increase in tube length to about 2m was considerable, so too was the aesthetic effect, Since it is only on representations where this type of instrument is used, that the horned helmet is seen, the visual effect of vertically oriented lurs was obviously held to be significant. The combination of the two features would also suggest that a degree of standardisation of usage had developed i.e. using vertically oriented lurs.

[170] Glob 1969, Fig. 37.

By the time lurs of 2m length were being made, considerable technical developments must have taken place. Not only do the sections of instruments need to be fastened together adequately, but they also need to be manufactured with a wall thickness that would keep their weight down to an acceptable level. It is possible, therefore, that the two remaining stages of development required only organological and aesthetic innovation the necessary level of technology having been developed previously.

In view of the obvious aesthetic impact of the large bell discs of the developed lurs, it is surprising that so few rock carvings depict instruments which have these. This points to the former existence of a whole period of lur history of which nothing is known other than what these rocks tell. When illustrations do occur that carry bell discs they do so over a very limited area of Zeeland and Bohuslan, in much the same area as that occupied by the Zeeland group of instruments. The carvings themselves are quite clear, however, and show an awareness of the problems of depicting such complex three dimensional objects in the two dimensions of a rock surface. These illustrations all show lurs used in pairs suggesting that, by this time, this had become the standard pattern of use.

The straight, frontal depiction of the bell disc is seen on IC179 (Figure 4.7) where two instruments project above the heads of the players on the ship. With the bell disc in this plane, the bell yard is seen as a vertical line and the tube yard as a slight curve in one case to the right and in the other to the left. Any more realistic depiction would have run the line of the tube yard into the next passenger on the ship, thus confusing the whole scene. On IC183 and 187, the whole lur is shortened to a straight line with the former having a relatively large bell disc.

Side views of lurs are shown on IC180 (Figure 4.7) where the curvature of the bell yard is very apparent and the bell disc seen only in profile. A more elaborate representation is seen on IC183 (Plate 4.1 (a) , above) which contains lurs seen both in side and end view. With the side view depiction, the curvature of the bell yard and profile of the bell disc are seen but the artist has also attempted to depict the tube yard. This he has done by showing a humped line which connects with the bell yard and, in order to fit this in, he has omitted several of the ship's passengers. In all this is a very credible representation of the dual polarity instrument in two dimensions. In this review of the rock carvings the evidence cited has been relatively sparce and much more evidence must remain to be described. However, no previous work has recognised either the type I, type IV or many of the type III instruments as lurs and no body of published work exists on these. No doubt, the acceptance of the view expressed here as to their identification will allow many more such illustrations to be brought to light.

METROLOGICAL ANALYSIS OF THE LURS

In addition to general observations on the manufacturing techniques employed in the production of the lurs, a fairly detailed metrological examination was made of those lurs that were both suitable and available for this.

Dimensions were obtained from the axial features of the lurs - ("x" values) by measuring the length of each segment and each decorative band or ferrule. An accurate tape measure was used for this where the curvature of the instrument necessitated it, the straight or relatively short features being measured by means of vernier calipers. The respective outer diameters ("y" values) were measured at the beginning and end of each segment by means of either a vernier caliper or micrometer, depending on the specific nature of the measuring point.

Figures for x were obtained by the accumulation of values of 'x' for individual segments and ferrules/joining bands, and the errors in these are thus likely to increase as the station distance from the tip increases. However, where a group of segments is analysed separately the accumulation of errors prior to the lowest x value utilised is not significant.

The reading of the tape measure is considered to be subject to an error of ±0.3 mm and that of the vernier calipers to ±0.03 mm. Thus each segment length being made up of a length of plain tube plus a ferrule is subject to an error of ±0.33 mm and the cumulative length x for the end of segment n to an error of ±0.33n mm. Values for y, the diameter of the instrument tube at a given point were obtained by use of the vernier calipers. The possibility of an unquantifiable error existing from the skew of the calipers across the tube cannot be ruled out, the problem being greater on the larger diameters of the tube, However, repeat checks, where carried out, showed this error to be of negligible magnitude.

The most striking features of the lurs which has been discussed in practically every paper ever written on these instruments is the similarity between right and left-hand instruments.

It is clearly an important factor as, not only are the pairs of instruments found to be superficially similar; they have the same number of segments, of the same diameter, virtually identical bell discs and appendages, but the detailed metrological work carried out in this study failed to find significant differences between the individuals of a pair. The absolute values to which this statement is true are discussed later in this chapter. While the manufacturer clearly produced instruments that are found as identical right and left hand pairs, it seems quite possible that these have resulted from the policy of making instruments to a given fixed standard but of different windings. Thus, the pairs found probably represent right and left-hand output made to this standard rather than deliberately matched instrument pairs. One dimensionally similar pair of instruments are of the same winding, those from Rørlykke which are both right-wound, their dimensional similarity being discussed below.

It is difficult to express the degree to which instruments resemble each other in a clear mathematical way and, as this similarity between pairs may also be expressed as the result of each instrument in the pair being similar to a theoretical (abstract or concrete) model, discussion of the feature of pairing is integrated into the general study of morphology.

In the pre-lur stage of the Wismar group of instruments, bronze tubes were formed which increased the length of the instrument, both at its tip and bell ends. The shape of these additions extended the form of the material to which they were attached and could, broadly speaking, be described as "round" with their enclosed air-space varying from "cylindrical" (parallel tube) to "conical" (tapering tube). Early varieties of this type of instrument would probably have the bronze extension pieces tailored to suit the individual shape of the horn for which they were made and these pieces would presumably be shaped to blend in with this horn in an aesthetically pleasing way. Thus, the requirement for dimensional accuracy arose from the need of the bronze addition to fit the horn and to look reasonable, i.e., it was only a moderate requirement. However, as the length of the horn increased in later, all-metal, instruments, the tendency to extend by continuing the horn taper in both directions would result in a very small diameter at the tip and an excessively large one at the bell.

On the Gullåkra instrument, for instance, the development of an excessively small mouthsupport is avoided by providing the instrument with an almost parallel mouthpipe (semi-vertical angle = 7.3 mrad) whose smallest diameter is only 2.6 mm smaller than the centre section entry diameter. (Figure 4.8, p. 129).

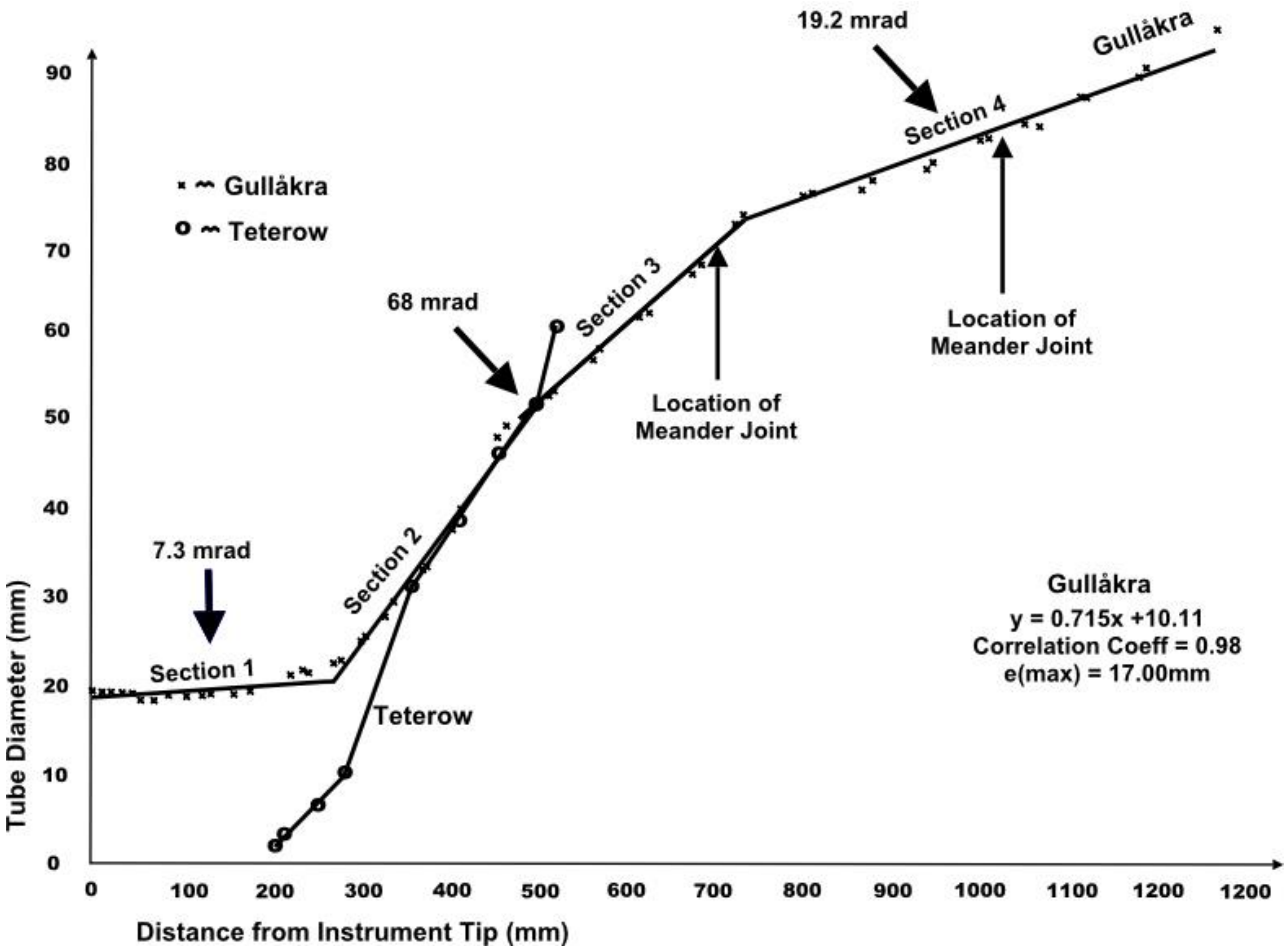

Figure 4.8: The Tube Dimensions of the Teterow Horn and the Gullåkra Lur

Similarly at the bell end, the bell yard expands but at a much slower rate than this centre section (α = 19.2 mrad compared with 68 mrad) thus avoiding the development of an excessively large bell diameter.

This instrument, thus gives the appearance of having originated from a central section similar in form to the Teterow instrument. (Section 2 on Figure 4.8) Two other sections were then added,(1 and 3 on Figure 4.8) and finally, the addition of section 4, the longest yard with the gentlest slope, created an instrument of 1.3m length.

From the data obtained by measuring these instruments, the nature of the relationship between the tube diameter (y) and the distance of the measuring point from the instrument tip (X) can be determined. (See Appendix II for details of the statistical analysis applied). In the case of the Gullåkra instrument the relationship between the x and y measurements (taken as a whole) is $y = 0.0715x + 0.11524$ with r = 0.9800 and E (max.): the maximum deviation from the "best" straight-line = 17.0mm.

However, the second yard of this instrument, from $x = 0.27$ m to $x = 0.464$m has slope approximately twice as steep as the overall figure at $\alpha = 68mrad$, this being roughly comparable with the $\alpha = 81mrad$ of the mouthpipe on Teterow. 1

While most other instruments retain the 4-yard structure that the Gullåkra instrument displays, they tend to have a more uniform overall slope and the E (max.) for these overall figures is generally much less. Put in more general terms, the instruments tend towards the development of a uniform slope from tip to bell such that the relationship $y = mx + c$ holds very closely throughout the whole length of the instrument.

On Maltbaek for instance, although the correlation coefficient for the overall instrument form is less than for the Gullåkra $r = 0.9534$ cf. 0.9800, the value E (max.) is reduced to 8.*6mm*. Moreover, as a pair of instruments were found at Maltbaek, the difference in morphology between these can be determined. From the plot of these dimensions, (Figure 4.9) this difference can be seen to be very small, its maximum value of 2 mm occurring at the junction of the tube and bell yards while, overall the four slope construction is retained on this instrument.

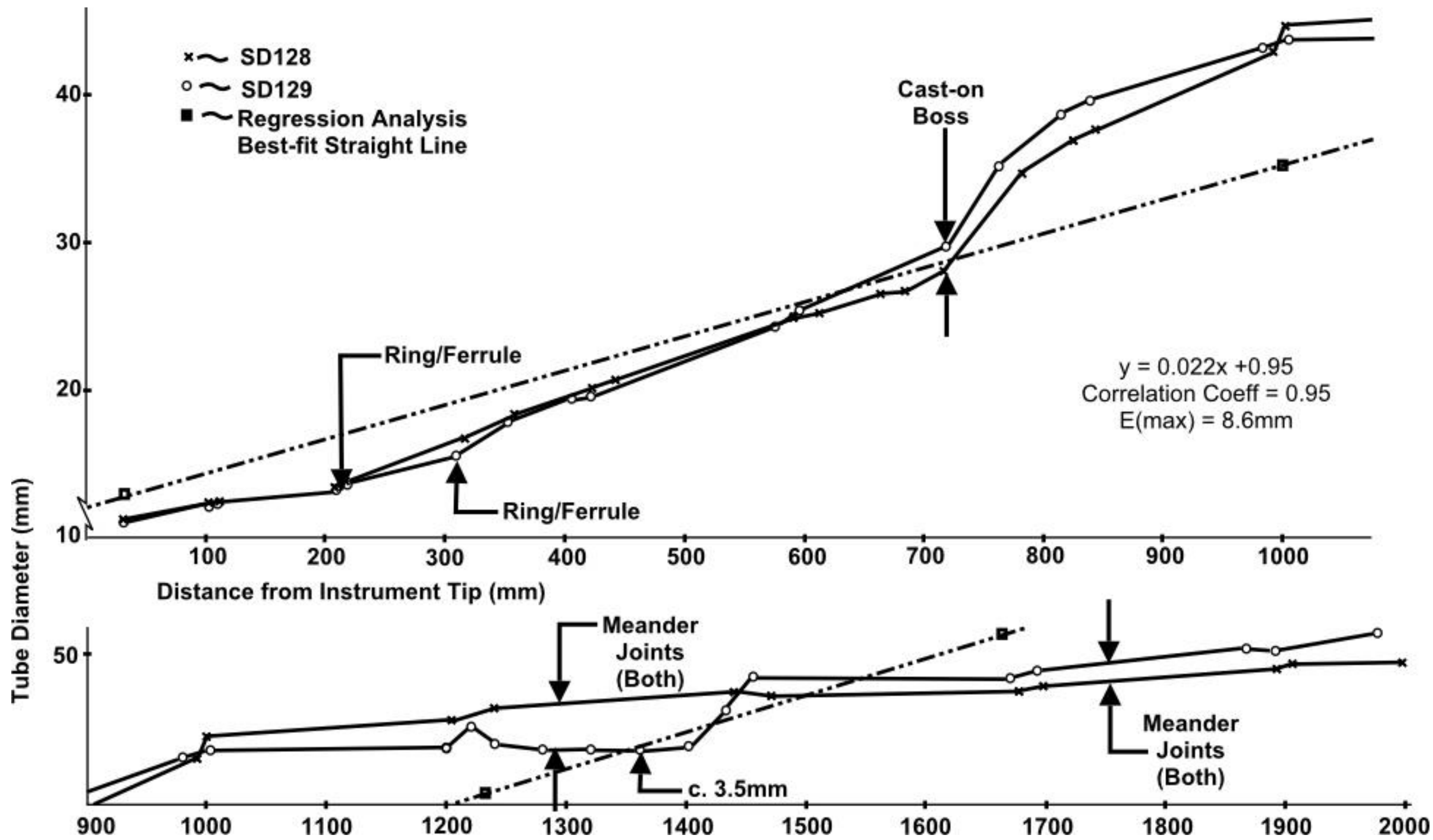

Figure 4.9: The Tube Dimensions of the Maltbaek Lurs

Another group of instruments from Brudevaelte consists of 6 lurs made up of 3 pairs. on the second pair of these, SD103/4, the structure of the slopes has been virtually reduced to a 3-unit pattern, (Figure 4.10). However, the units of slope differ very little from the best straight line equation for the dimensions as a whole r = 0.9951. The maximum "error" from this line is about 2.5 mm and values very close to this exist at both intersections of slopes and at the bell exit diameter. This suggests that this instrument is built to a design; i.e. a set slope of the order of this best line slope. Figure 4.10 also shows the remarkable similarity in dimensions of these two instruments, the largest difference at any point being of the order of 1 mm, while the average difference is almost zero! As a group, the Brudevaelte instruments are generally very similar and this can be seen on Figure 4.10, where the dimensions of the five instruments that were studied are plotted.

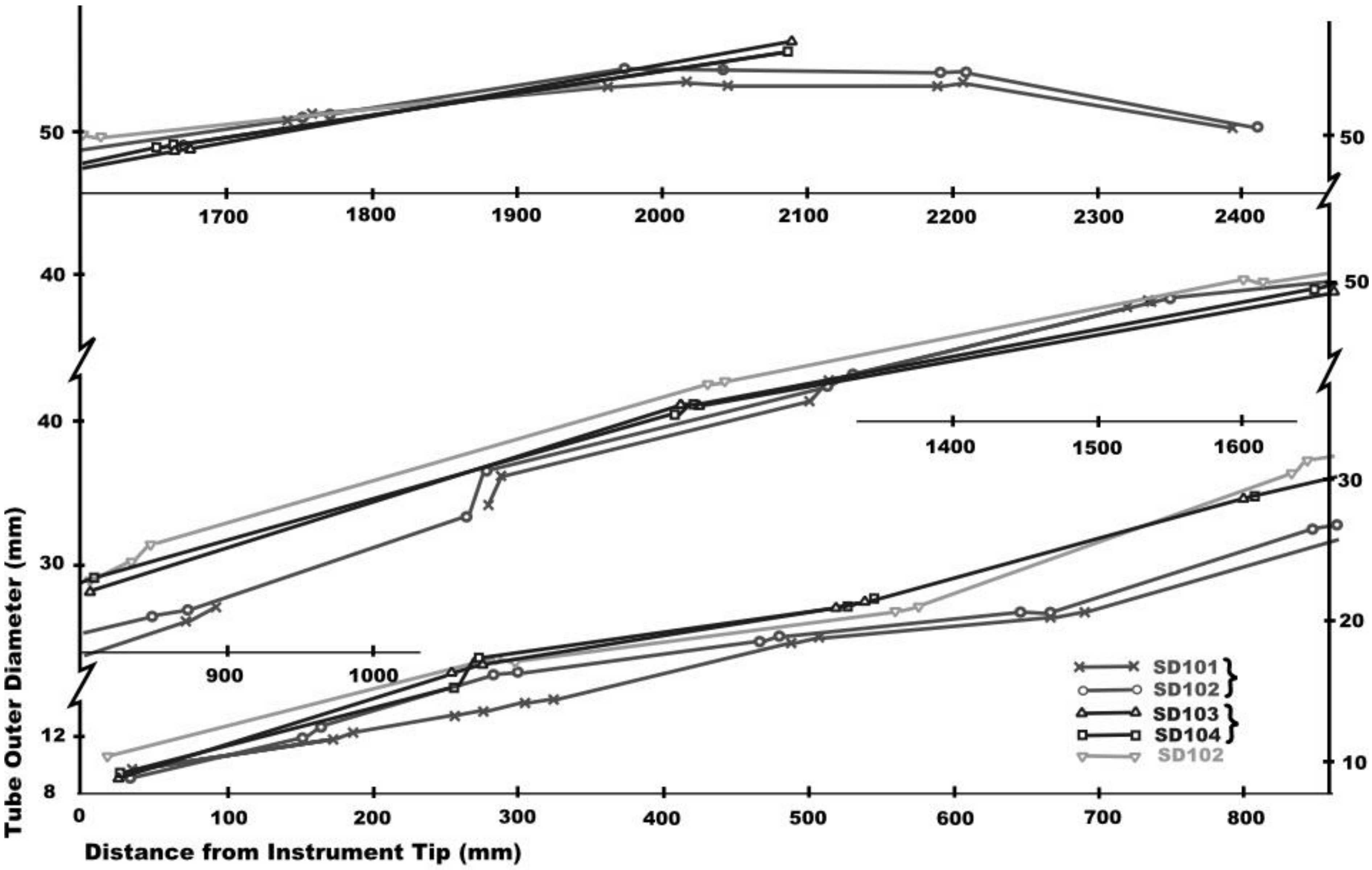

Figure 4.10: The Tube Dimensions of the Brudevaelte Lurs

In its most highly developed form, the uniformity of tube slope is seen on the Folrisdam instruments where the relationship between x and y is described by the equations:

Instrument 1: $y = 0.0275\,x + 6.964$, $r\,(1) = 0.9930$, $Syx = 1.327$mm

Instrument 2: $y = 0.0277\,x + 6.653$ $r\,(2) = 0.9943$, $Syx = 1.411$mm

These figures show a very close approximation to a straight-line relationship between x and y. However, the crude expression of error in terms of Syx values hides the fact that the error is very systematic, and that even on this instrument the (x, y) relationship is best described by three separate equations with standard errors of:

Instrument 1 S_{yx} = *0.277, 0.332, 0.245 (mm)*

Instrument 2 S_{yx} = *0.700, 0.332, 0.200 (mm)*

However, the nature of the variation of these equations from the overall equations, (Figure 4.11) is quite different from that on earlier instruments, in that the slopes of all three intermediate lines are similar and lack the clear steeper central section of the earlier examples. This suggests that an overall concept of the complete instrument had emerged and that the maker was succeeding in matching the three segments to an overall specification very accurately.

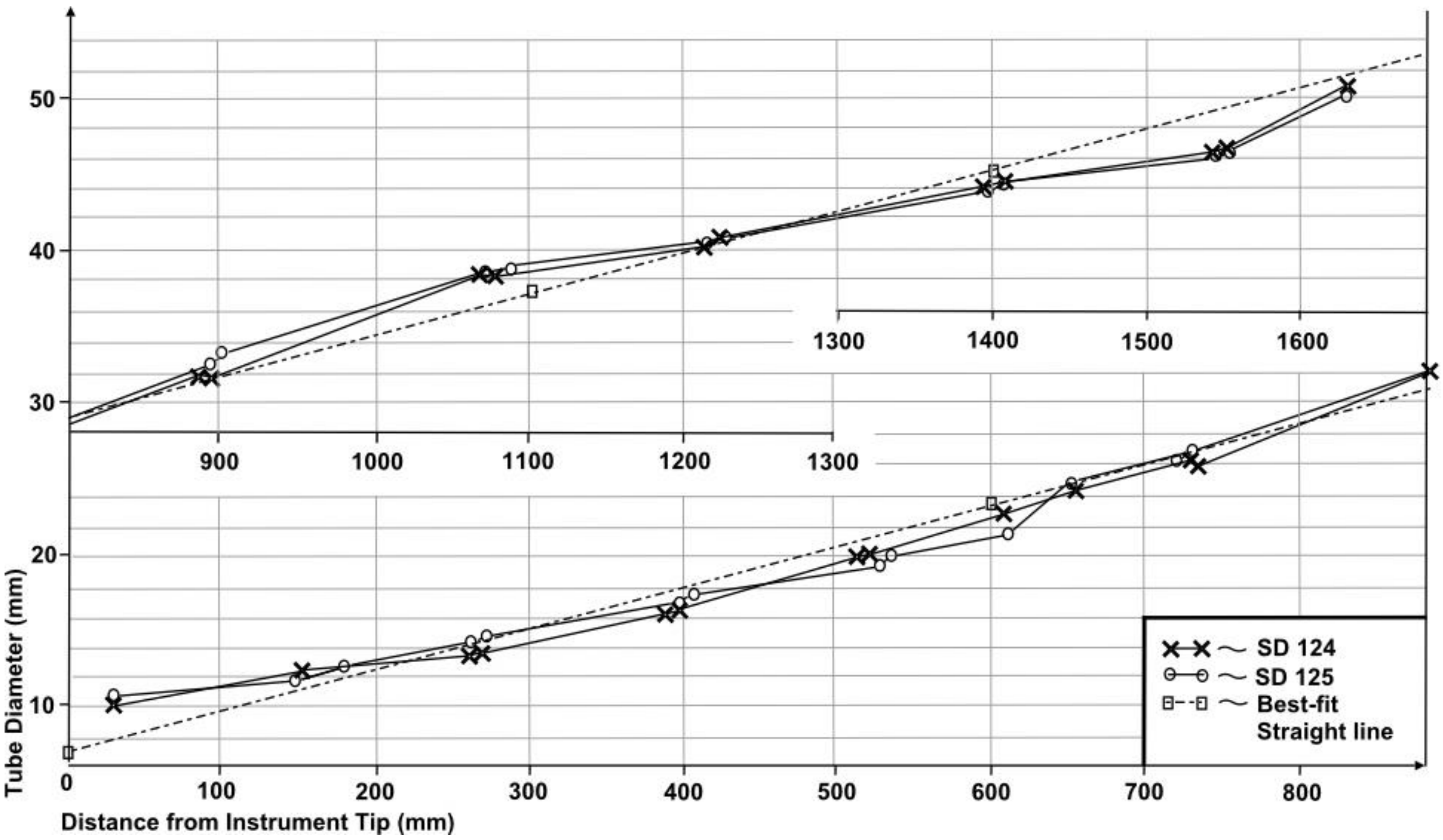

Figure 4.11: The Tube Dimensions of the Folrisdam Lurs

Not only are the diameters of instruments as a whole related by a straight-line relationship but the tube units too follow such a relationship closely. In the case of the Folrisdam instruments, the section from the tip to $x = 0.61m$ is manufactured with standard errors of 0.*2mm*/0.*6mm*. Thus, were the 610 mm of this instrument to be straightened out to produce a straight conical tube, then it would open out uniformly, with a slope of 0.27 in such a way that the diameters at all points are within 0.3/0.9 mm (actual values) of the best straight line values.

Even on these instruments whose overall form is less uniform than the Folrisdam ones, the individual segments are manufactured in such a way that their own slope conforms very closely to a straight-line relationship. On Gullåkra, for instance, although E(max.) is high at 17*mm*, its third unit of slope has a straight-line correlation coefficient of $r = 0.9947$. (13 values) On Maltbaek, slope 2 has a value of $r = 0.9976$ with a mean tube diameter variation from the best-fit line of 0.26 mm.

Only one tube was available for detailed analysis of the tube diameters at 10*mm* stations, this being the Rossum bell yard fragment (SD133). This was measured over 230*mm* of tube, the plot of these figures being on Figure 4.12. From the figures, a regression line was calculated giving a correlation coefficient r = 0.9958, this line is shown on Figure 4.12. Measured values show a maximum deviation from this straight line of about 0.35 mm with this error having a periodic reversal of 60 to 90 mm. Such a variation suggests the use of form of a paring tool to remove the material, with a cutting surface length of 50 or so millimetres.

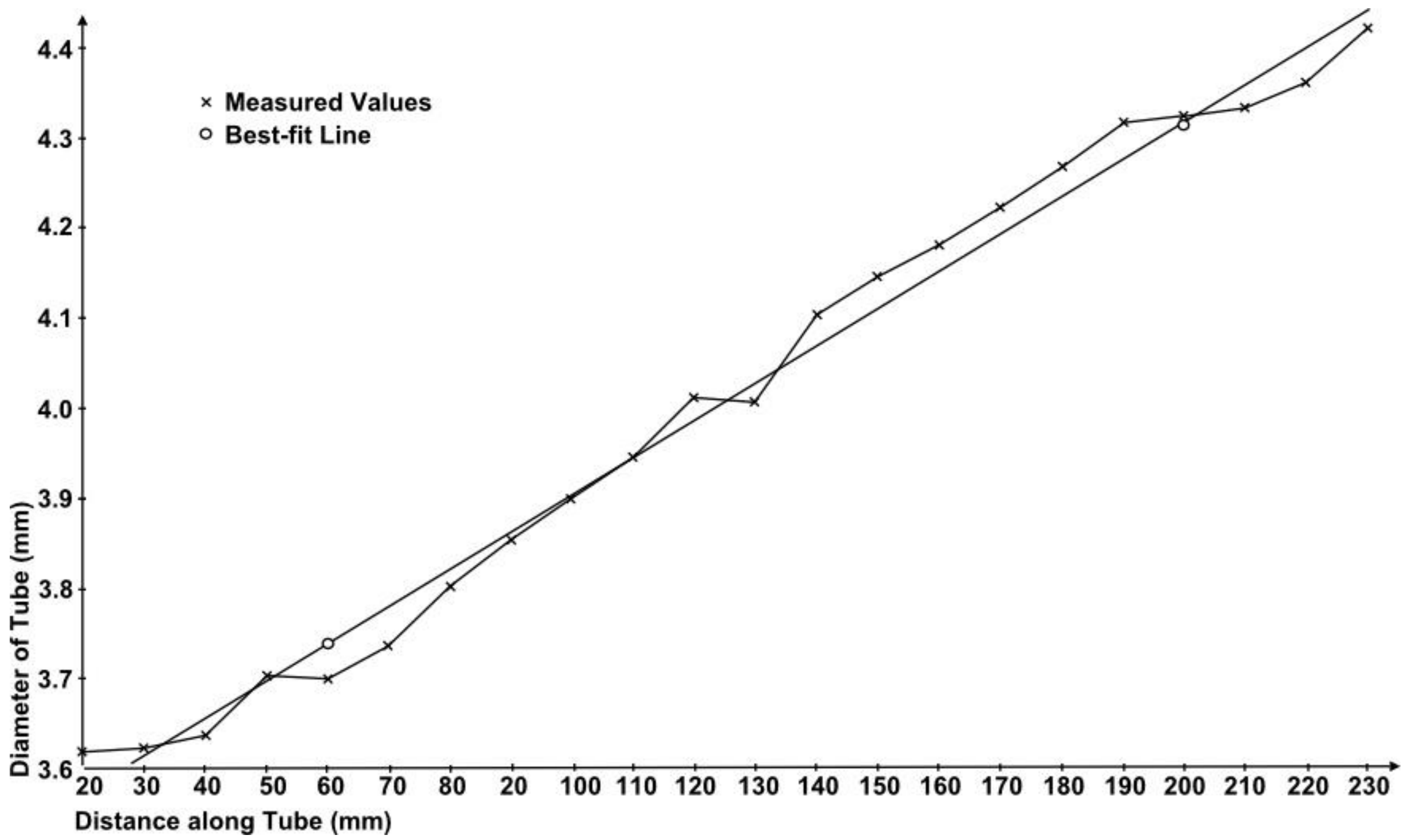

Figure 4.12: The Rossum Lur Tube Fragment Dimensions

THE ROUNDNESS OF TUBES

Along with increasing ability to control conicity of the tube the maker had also developed techniques for producing round cross-sections. The earliest instruments from this area are quite clearly not very round at all. This is most noticeable on the Wismar instrument, the bell part of which is a rather complicated "roundish" shape. Unfortunately measurements were not taken at the time of examination of this so its roundness cannot be expressed with the accuracy that can be applied to instruments studied later, the other instruments having been specifically measured to obtain a "roundness" value.

Unfortunately, many instruments have suffered damage since manufacture and hence, where deformed, the tube can give no indication of the level of accuracy to which it was originally manufactured. Where damage is obvious these areas have been avoided when taking measurements but more superficial damage may not be detected as such, and readings taken at this point. Hence, where several sections of tube are found of a high roundness, this is taken as an indication of a generalised ability to manufacture round material.

The Gullåkra instrument is considerably more round than the Wismar group but its out-of roundness can still be detected both by eye and by feel. Running along the axis of this instrument can be felt decidedly flatter areas, suggesting the cross-section to be a form of polygonally deformed circle. (See appendix III). From the five stations measured, a mean roundness of 1.32*mm* was found. Two stations of the five were round to within 0.90*mm* although, even here the out-of-roundness was visibly detectable.

While human perception includes the generalised conception of roundness, various factors, both tactile and visual limit an individual's ability to discriminate between objects varying only slightly in their level of roundness. Thus for a given individual, a minimum increment of roundness, or at least a range of values of this, may be defined, above which differences can be detected and below which the individual perceives the object as "round". Having developed the technique or skill to manufacture objects to this maximum degree of roundness that can perceived, no improvement on roundness can be expected unless the manufacturing technique adopted, itself produces inherently round objects.

The roundness values (based on OD's) of the other instruments, along with the number of stations measured are listed below (in mm) in order of increasing roundness.

Instrument		Roundness (mm)	No. of Stations
Name	Reference		
Rørlykke	SD120	2.3	4
Rørlykke	SD119	1.9	4
Gullåkra	SD135	1.32	4
Brudevaelte	SD102	0.74	4
Maltbaek	SD128	0.65	8
Brudevaelte	SD101	0.62	24
Brudevaelte	SD104	0.61	11
Revheim	SD131	0.59	13
Revheim	SD132	0.54	15
Rossum	SD133	0.47	7
Brudevaelte	103	0.38	6
Maltbaek	129	0.36	7
Folrisdam	125	0.28	5
Garlstedt	148	0.24	10
Folrisdam	124	0.10	4

This list shows a wide range of values for roundness and, from the close grouping of the pairs of instruments in this list, it appears that the sequence listed above gives some crude ranking in terms of level of manufacturing technology. Whether or not instruments in the above list are manufactured by a technique which produces round objects, it is not possible to state categorically, lacking experimental data on this subject. The only data that seems to be available is an old engineering rule-of-thumb which says that the smallest detectable difference in measurement using what nature provides is $^{1}/_{64}$" i.e. 0.015" or 0.397*mm*. However, a large gap is seen on the above list between the 1.32 and 0.74*mm* figures and may suggest a point of difference between manufacturing processes. Certainly when considering the 0.10*mm* roundness figure for Folrisdam (SD124), it seems perfectly

safe to state that this was manufactured by a process that produced inherently round objects.

If the assertion is true that the roundness error on several instruments is less than the human eye can perceive, then the cross-sectional form must have been produced by a generating process, i.e. the tube or its pattern was rotated on a form of bearing while a tool, point or flat surface, was worked onto the rotating element to generate the circular object. In such an operation the bearings would have to constrain the motion to within 0.10*mm* to attain the degree of roundness found on these instruments.

Even to the limit of 0.10*mm* it is not adequate to state baldly that the tube is out-of-round to this degree, it being necessary to define much more accurately the actual morphology of the cross-section if more detailed comments are to be made on this subject. Such measurements, however, were outside the scope of this study as more sophisticated measuring instruments would be needed along with much greater access to the instruments than is currently available.

THE DESIGN OF THE LURS

The high degree of similarity of pairs of instruments provides no guide as to whether these instruments are similar to each other or to a common standard. Another type of information must be sought, therefore, and this seems to be provided by the group of six instruments found at Brudevaelte and the two instruments from Rørlykke.

These latter instruments are not a pair, being both right-wound, but are clearly from the same workshop. Their overall form is very similar, (Figure 4.13) the shape and type of the decoration bands is identical and the level of technology displayed in the casting of each instrument is clearly similar.

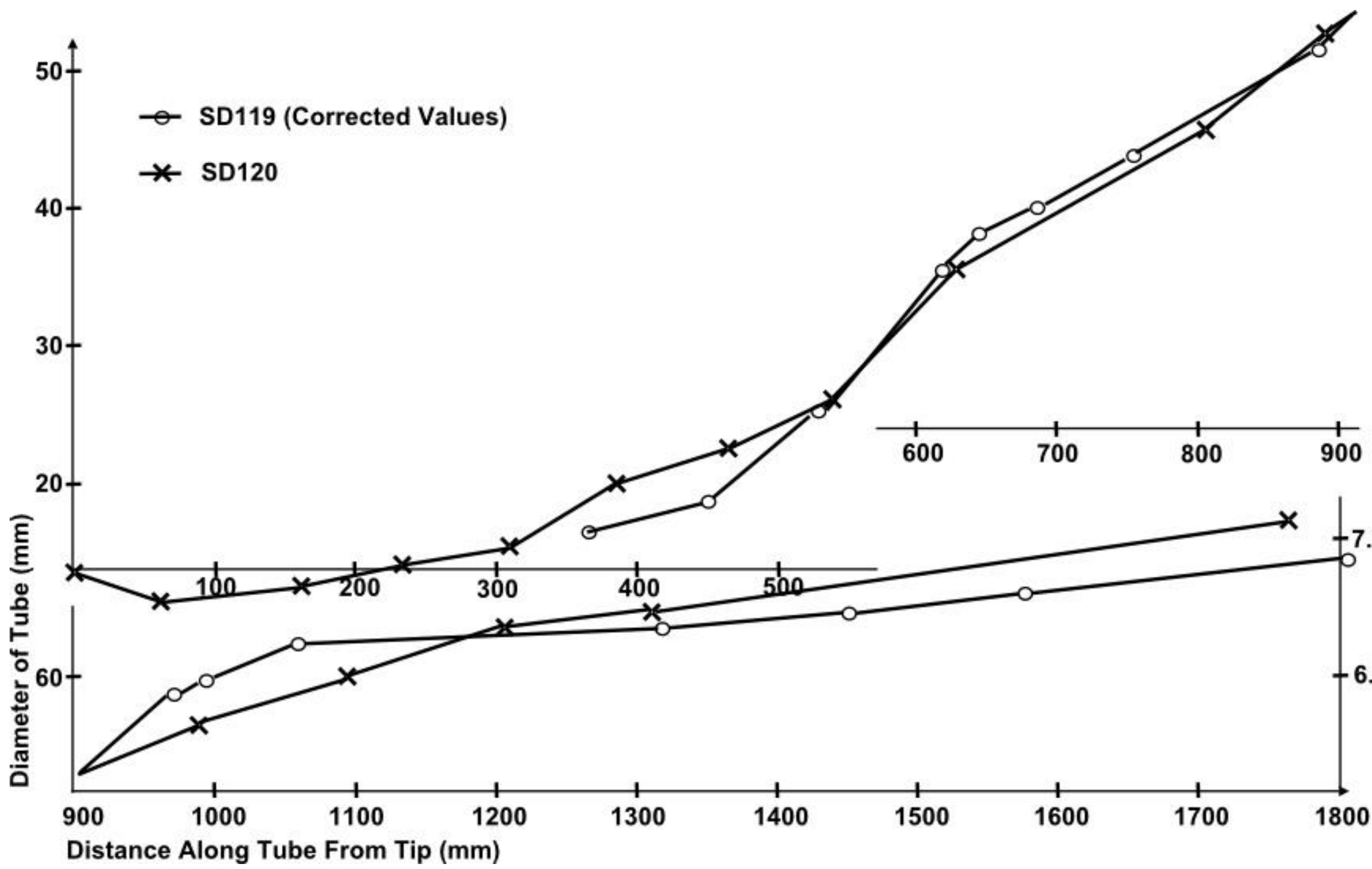

Figure 4.13

One of these instruments was in several pieces when found and has been reconstructed but appears to lack about 29.6 cm of mouthpipe. This figure is estimated from the x-shift necessary on Figure 4.13 to allow the maximum coincidence of the two *x-y* plots. Such a move appears to be justified by the very close coincidence of the two lines when this correction has been applied. Over much of their length they are within a millimetre or so of the same diameter and at the points of maximum divergence differ by under 4*mm*. What is striking is the close similarity throughout the instrument. Indeed, over the section between $x = 525$ and $x = 880mm$, the tubes are virtually identical. Although the tube's morphology does diverge over certain sections it still seems to be produced to an overall design, such that the divergence is "corrected" and the tube dimensions again coincide down- stream.

The decoration applied to the tubes of these instruments is made up of a series of parallel circumferential bands and it is the number of individual bands in these that suggest strongly that the instruments were not made at the same time. Nowhere on the two instruments do the number of bands coincide and on SD119, the average number of bands per group is 11 compared with 9 on SD120. In addition, the segment lengths demarcated by these bands are also quite different and the meander-joints between adjacent yards are in different places on the tube. (Figure 4.14) Such a divergence between instruments of a "pair" is unique among the lurs, there generally being an extremely close similarity between the individual elements of such instruments. Thus although Figure 4.13 suggests that the instruments are to the same design/pattern, these differences in individual elements suggests that one instrument was made without direct reference to the other but to some form of overall design.

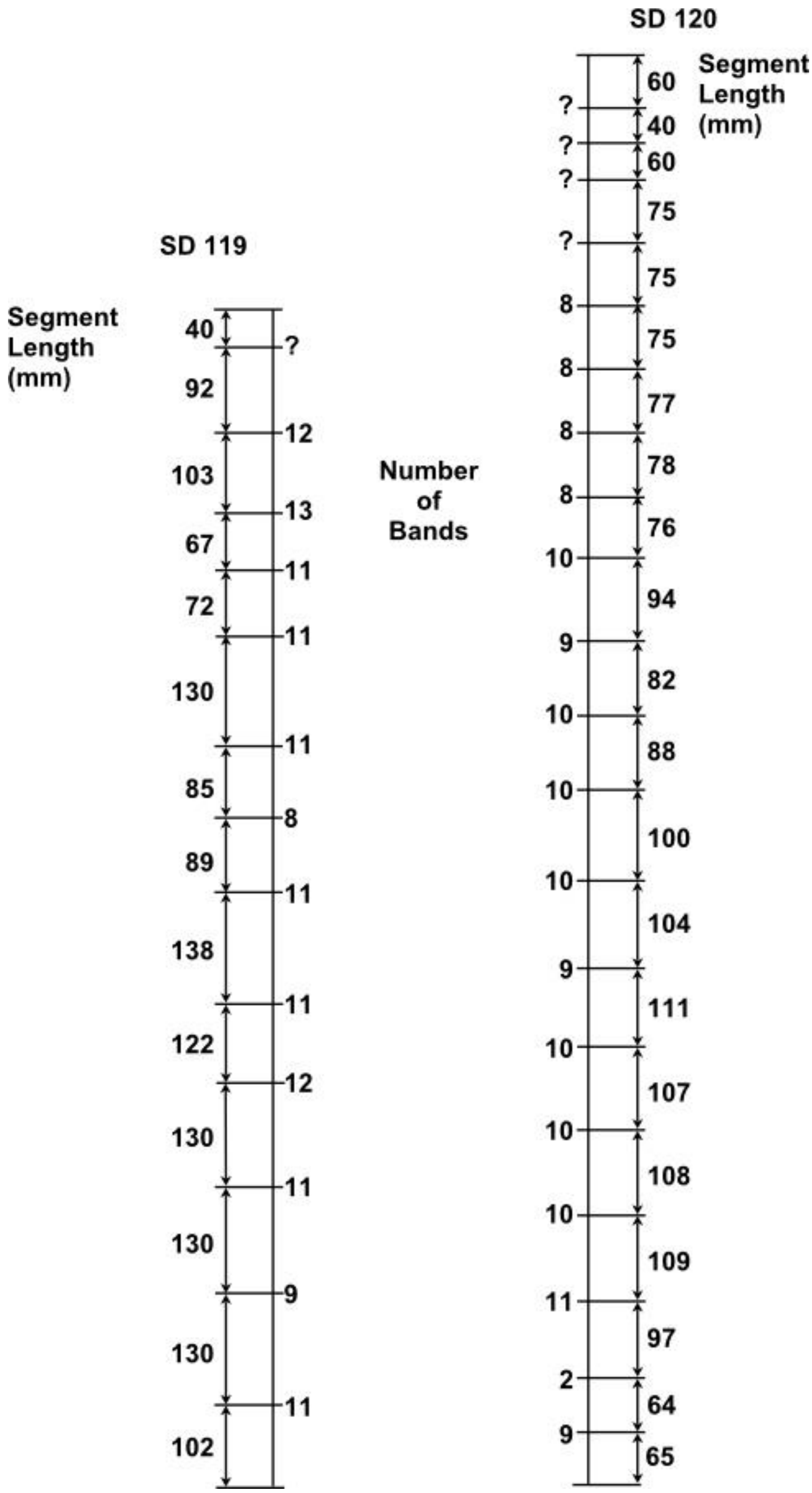

Figure 4.14: Segment and Decoration Details on the Rørlykke Lur Pair

The other group of instruments is that from Brudevaelte where three pairs of instruments (SD101/2, SD103/4, SD105/6) were found. One of these, SD106, was not currently available for study.

Like the Rørlykke instruments, the Brudevaelte group are all clearly from the same school of manufacture, having similar tube morphology, all instruments being of roughly the same roundness and having similar bell discs. However, one pair, SD101/2, is sufficiently different from the two other pairs to suggest that it was either manufactured earlier than the other instruments or was made by a less accomplished craftsman. The features which illustrate this difference are:-

Segment length: the mean lengths for instruments SD101/2 are 180.2/180.8 mm while those for the other instruments are

SD103/104 332.7/331.9*mm*

SD105 526.5*mm*

Conicity: The x/y data for instruments SD103/4 and SD105 follows a straight line relationship with

E (max.) = 3*mm* (103/4)
E (max.) = 4.5*mm* (105)

while that for instrument SD101/102, although following a very similar relationship shows a much greater variation from this, *E (max.)* : 6.6 mm

Mouthpipe Morphology: The mouthpipes on SD101/102 are roughly semi-circular as on the majority of other lurs while those on SD103/104 and SD105 have a straight portion immediately downstream of the mouthpiece. (Figure 4.15)

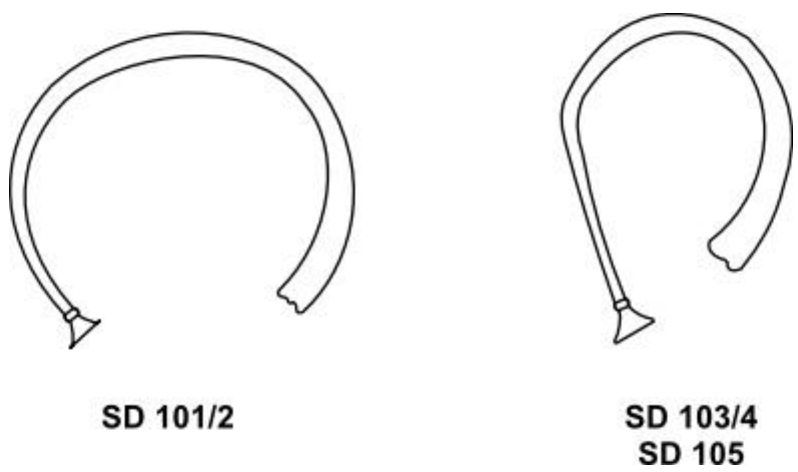

Figure 4.15: Brudevaelte Mouthpipe Morphology

Bell-disc Design: The bell discs of SD103/104 and 105 are larger and contain a greater number of decorative elements than SD101/102 for, while these latter instruments are decorated with six bosses and six equally-spaced sets of concentric circles the other instruments have both a completely circular set of these circles and other patterns made up from them. (Figure 4.31)

Junction Pieces: The bell yards of SD103/4 are cast with only a thin band, possibly as on Rossum while SD101/2 have a much thicker feature here.

Although these instruments were probably made at different times the overall tube morphology is very similar (Figure 4.10) Their overall slopes are 0.022/0.021, 0.024/0,025 and 0.026 and at a point 1.67 m from their tips, all 5 (6?) are within one millimetre of the same diameter. Thus, if these instruments were made at different times but to a similar design, the information to define this design must have been stored in some way.

THE DESIGN AND MANUFACTURING PHILOSOPHY OF THE LURS

The Folrisdam instruments, SD124/125, are the ones whose design appears to be most deliberate. As shown above, the entire instrument can be defined by a straight-line equation to within about 3 mm, i.e. at all points along the 1.7 m of the instrument's length, the diameter is within 3 mm of that predicted by the appropriate straight-line equation.

Two possible patterns of manufacture could be suggested for the instrument as a whole

i) progressive development of the instrument form, either from the tip-end to the bell-end or vice-versa, or
ii) consecutive construction of the three yard sections, starting each yard at its tip or bell-end and building that up progressively.

It could be argued that the presence of a large cast-on boss at the end of the mouthpipe yard suggests that at least the first and second yards were subsequently joined together. However, as the change in polarity of curvature occurs at the junction of these two yards, it could similarly be argued that the material added here serves only to strengthen the instrument tube at this highly stressed point.

Assuming that the instrument/yard manufacture was started at the mouthpiece end of the mouthpipe yard, the maker produced a tube of increasing diameter from about 10*mm* to about 22*mm*. (Figures from SD125). Then, 610 mm from the instrument tip, having manufactured a length of tube that opened out with a slope of 0.0208 to within about 0.4*mm* of the best-fit straight-line value at each point, he increased the slope on yard 2 to 0.0350. Again this yard was manufactured closely to this slope the mean variation from it being 0.2*mm*. Thus, at this point 610*mm* from the instrument tip, he was clearly aware of the change in slope, i.e. he had made it deliberately. It seems likely therefore that he was clearing the cumulative error that had built up at that point, where, presumably it had reached a detectable value. His change of slope produced a second yard that crossed back over the "best-fit" line, correcting this "error."

As a further indication of the degree of fit of the data to a presumed theoretical model, the equations of the two best-fit straight lines may be treated as simultaneous equations. Their solution gives an intersection of (689.0, 22.59) which compares well with the actual measured intersection of (606.9, 22.6)

Yard 2 was then manufactured with a consistent slope up to 1.075 m from the tip where the slope was changed from 0.0350 to 0.0181, On yard 3 this slope was again closely followed, the mean error here being 0.17 mm. In yard 2, as with yard 1, a variation from the overall best-fit line appears to have accumulated during its manufacture, being at its greatest value of 2*mm* at the intersection of yards 1 and 2. However, these yards do run smoothly into each other suggesting that the variation from the overall best-fit line that now exists was designed into the specification and was not a measuring error.

Considering the possible manufacturing process where the whole instrument was made in one piece, a break in slope could similarly be interpreted as indicating that, at the intersection point, an error of detectable size had built up and that the slope of the next yard was adjusted in order to compensate for this.

ln the case where the instrument is made in individual yards, the dimensional requirement to enable adjacent yards to fit accurately is that the exit diameter of yard 1 would match the entry diameter of yard 2. This places a tight requirement for accuracy on the manufacturer particularly when manufacturing adjacent yards simultaneously, as the required exit diameter for a particular yard is established as soon as the entry diameter to the next yard is made.

The clear implication arising from the Rørlykke and Brudevaelte data is that these instruments were made to a defined design. Obviously this had to be stored in some way but, resulting as they do from the activities of a pre-literate society which has left no definite evidence of the mode of storage of data, the lurs themselves are the sole source of data on overall design philosophy.

IMPLICATIONS OF DIMENSIONAL ANALYSIS ON PRODUCTION

There seems little reason to doubt the generally-held belief that the lurs were made by casting using lost-wax technique. The material used for forming the pattern was, most probably, beeswax, which given the conditions believed to have existed during the bronze age, may well have been readily available within the Nordic cultural area. To produce a 3.3*kg* instrument (a typical instrument weight) about 0.4*kg* of wax would be required, this being the amount produced in association with about 3*kg* of honey.

At an ambient temperature of 20°C, beeswax is moderately hard but, when warmed only 10°C or so above this, is malleable and readily formed by the hands or with simple tools. However, when making tubes of 60 to 80*mm* diameter with wall thicknesses of only a millimetre or so it would be difficult to obtain a reasonably round object and to maintain its roundness using wax alone. Added to this difficulty, is that of obtaining a well-fitting core as the shrinkage of clay is generally about 10%. This would mean that a clay core moulded green inside a 60*mm* diameter wax pattern would shrink some 6*mm* on drying. When reduced in this way, it would give rise to a tube of considerable wall-thickness, i.e. always at least 5% of the tube bore and chaplets, put in while wet, would be pulled loose by the differential movement between the wax and the core,

None of the Wismar group of instruments have wall thicknesses which approach this figure, 1 to 2% being a more common figure. Were a clay of much lower shrinkage to be used such as a fire clay with an admixture of sand or grog (previously fired clay) the overall shrinkage figure might be brought down to around a 1 to 2% figure. This would still give an overall wall thickness in excess of that seen on these instruments possibly twice the value, and raises doubts about its practicability as a viable technique.

However, the bore of the Wismar horn clearly shows a step, (Fig.4.5) and such a feature would clearly not be deliberately constructed on a core prior to forming wax over it. The manufacturing process then, must have followed the sequence: wax pattern - infill and this infill material would need to have a negligible shrinkage rate upon drying. It is possible that this area provided a suitable material such as a fine-grained sand with a 1 - 2% clay admixture. The clay would be sufficient to bind the sand while wet and, on drying the overall shrinkage of the core would be negligible. Although the dry green core would not be particularly strong, it would be sufficiently so to hold together during handling of the pattern and core together. Of the suitability of this material as a core there is no question as it is used to this day as a core and mould material in small-scale casting operations. For its appearance, the technique depends upon the existence of deposits of suitable argillaceous sands, or knowledge of the technique of mixing the two materials. Other than on this Wismar instrument, however, there is little suggestion of its use. elsewhere. Other tubes of lurs are too long to have had sufficient structural integrity when made in wax alone and remain too round to have been handled while in that condition.

Chaplets are present on the later lurs and their use, while necessitated by the increasing length of tubes used, probably coincides with the introduction of cores as the basic generator of instrument shape. Used in this way, a clay core provides, while dry and green, an ideal form which is dimensionally stable, strong, and yet can be worked by the use of stone or metal tools. It is probably the development of the core that is the key to the high level of dimensional uniformity of the lurs. If the core is round and of the required form, then the overlaying of a uniform thickness of wax over this will produce a round pattern to that form.

Moulding of clay materials by hand has been carried out since the Neolithic and would have been nothing new to the maker of the early lurs and their pre-cursors. When moulded green and wet and finished abrasively when green and dry, close dimensional control can be exercised over the form produced. However, when breaking away from the morphological constraints imposed by animal horns i.e. a lack of uniformity both in their cross-section and their conicity the maker began to construct instruments to a model, abstract or otherwise that was rounder and more uniformly conical than natural material.

THE GENERATION OF ROUND CORES

Early instruments are recognisably round in form but have visible variation from perfect circularity, the Gullåkra instrument, for instance having clearly definable flattish areas along its length. The degree of roundness, 1.32 mm, is, thus, clearly of an order that could be formed by hand using a generalised concept of roundness to judge when the required degree had been attained. This is not so with other instruments, one of these having a roundness of 0.10 mm. This is more round than could be achieved by hand-forming and suggests that a generating process was used.

Processes for producing round objects are known from the Mediterranean and the Middle East where the earliest depictions of about 600BC on Greek pottery shows the potter seated at a large turntable which he himself or a helper turned by hand. Two Egyptian reliefs from about 300BC show the use of more sophisticated rotating machinery. One of these depicts the god Khum using a potters kick-wheel and the other shows two workmen using a lathe. On this latter machine one provides the power by pulling a band across the work-piece. The general literature of this period assigns the invention of the lathe to Theodorus of Samos, the truth perhaps being that he refined some equipment of the day to take the whole credit for the invention.

In North-West Europe, however, no documentary or iconographic evidence exists for the use of the lathe although in Mordant et Prampart[171], it is demonstrated that a lathe was used in Late Bronze Age II N. Burgundy to polish up the heads of bronze pins (Fig, 4.16).

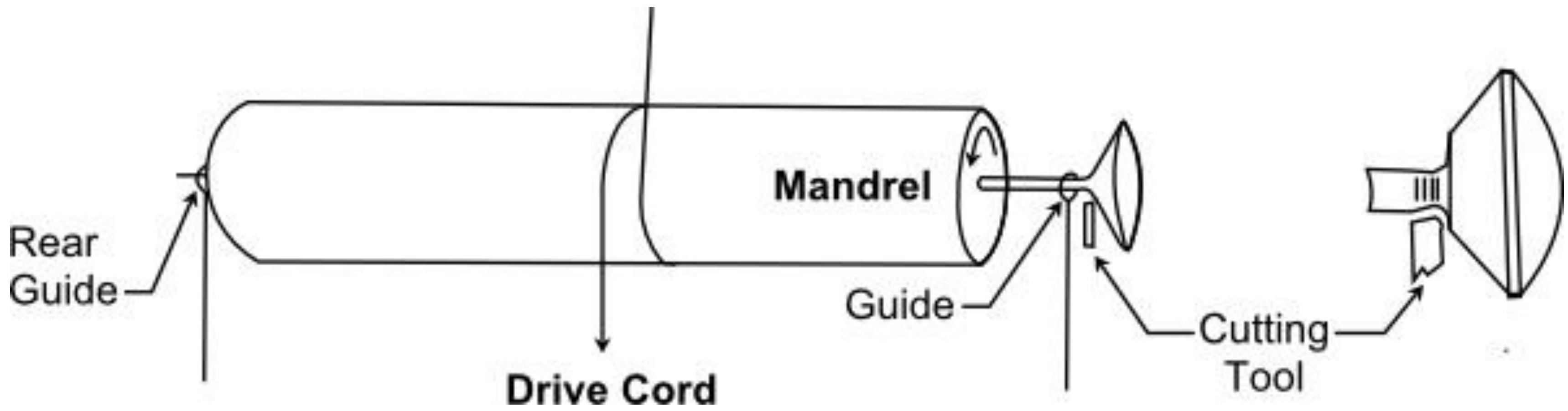

Figure 4.16: Decorating Bronze Pin Heads

However, irrespective of how these instruments were made in terms of the detailed production sequence a rotary generating process was clearly used, i.e. a lathe-type device.

While a lur may be round and of conical form, its axis curves in two planes, (Plate 4.2 (b), Plate 4.3 (a)) It would not, thus, be possible to generate a finished instrument between centres as the generating process involves rotation about a straight line connecting the effective centres. Thus the roundness of the lurs must have been produced on the core before it was curved i.e. while its axis was still straight. For such an operation to have been possible, the core must have been malleable, i.e. in a green and wet state. However, a core in this state lacks the strength to support itself between centres for the turning operation to be carried out. Part of it would have to act as a pulley, to allow the rotational energy to be fed into the system, while the bulk of the core would need to be strong enough to transmit the torque necessary to overcome bearing friction and the load applied by the cutting surface.

[171] Mordant et Prampart, 1976, 139, fig. 126

Plate 4.2 (b): One of the Folrisdam Lurs

One possible manufacturing sequence could be: rough manufacture of the core in a green/wet condition; drying of the core; turning to achieve the round conical form; re-wetting the core; bending the core to the required curvature; insertion of the chaplets; final drying of the core prior to forming the pattern over it. The difficulty in this proposal lies in the re-wetting of the core as the major core shrinkage occurs during the green core drying process. As this process is slow and continuous, the clay is capable of shrinking in three dimensions at this rate without cracking. It is not easy to re-wet the core at this rate and when the outer surface is wet too rapidly it expands and breaks away at the sharp wet/dry interface. However, it seems reasonable to assume that the Bronze-Age worker, as has the present-day potter, had several techniques that enable him to re-wet a piece of clay which has dried before he has I finished working on it. In the present-day application of this technique the dry clay is wrapped in newspaper and then placed in a sealed polythene bag which is packed with wet newspaper. This is then left overnight or, if necessary longer until the moisture soaks throughout the clay. Presumably, during the Bronze-Age the same effect could be achieved by wrapping the clay in a piece of cloth and then covering this with wet leaves and, if necessary, pouring water over this.

A further solution might be found by the provision of a temporary support during the turning operation. To do this a piece of wood could be fed through the centre of the core which was then turned in the green/wet state. If the wood could then be removed without deforming the core, the requisite curvature could be generated and the core allowed to dry. In order to maintain the dimensional regularity seen on these instruments, the wooden insert would need to be reasonably round, straight and smooth to facilitate its removal from the wet core. This process of stiffening moulds with wood is known from mould fragments found in Northern Ireland where a longitudinal hole down the length of sword moulds attests to the use of wood or other such material as a central backbone to support the mould in its green state. Hodges[172] considers that the supporting stick was generally left in the mould right throughout the casting process and cites a mould fragment from Lough Eskragh which still contained a charred fragment of wood when found.

It is, of course, possible that a technique other than lost-wax had been utilised to produce the instruments or the patterns from which they were derived. As with the Irish Bronze-Age material, some stage of the manufacture could have utilised a two part mould the most likely piece to have been made like this being the core. However, the two-part mould technique suffers from a limitation in dimensional stability across the mould joint-faces. Thus, cores made by such a process, while reproducing the curvature of the mould form over much of their circumference, tend to show a greater divergence from the presumed design dimension when measured across the normal to the joint-line, i.e. tend to be oval. (Figure 4.17) Further evidence of the use of two-part moulds is generally provided by the presence of joint line evidence, where the two parts of the mould fail to fit together tightly and allow material to flow into the space provided. (Figure 4.18)

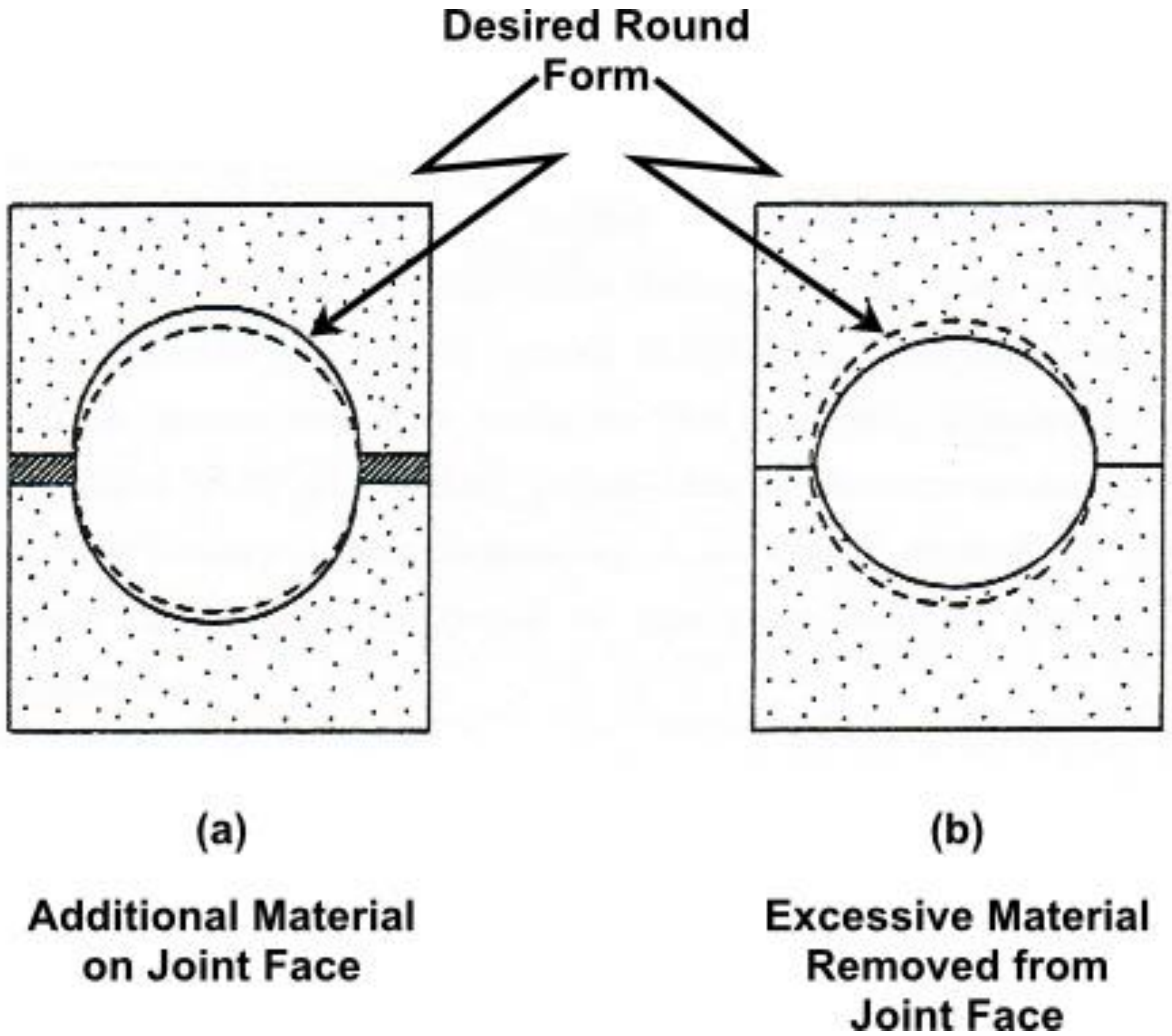

Figure 4.17: Problems arising from the Use of Two-part Moulds

[172] Hodges 1954, 64.

No instrument bores show any evidence of joint-lines, although these could have been fairly readily removed. (Some core markings are present on Gullåkra's bore but these are not joint-line evidence and probably result from the build-up of the core using sheets of clay.)

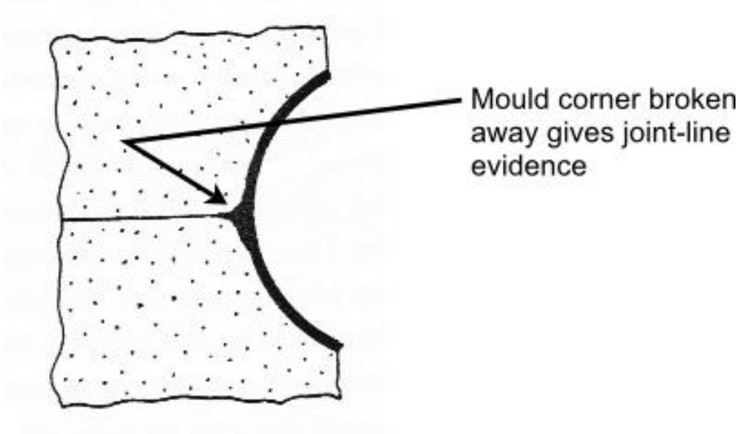

Figure 4.18: Flash Lines from Two-Part Moulds

While all the lurs have curvature of their axes in two planes, this became markedly more polarised in the later instruments. (Plate 4.2 (b), above) In these one segment only remains curved in both the horizontal and vertical planes whereas the dual curvature is seen in several segments in earlier instruments. The split mould technique is able to handle an item with a non-planar joint-line only with great difficulty and it seems unlikely that cores could be made to the accuracy observed using a split-mould with a complex joint-line. Measurements of roundness of the transitional segments, i.e. those curved in two planes show these to be just as round as the remainder of the single-plane segments. Thus, overall, the evidence outlined suggests that these instruments or their cores were not made by forming in a split mould.

THE MANUFACTURE OF PATTERNS

So far the discussion has centred on the manufacture of the instrument core, but the pattern wax must be laid over the clay core, allowing the chaplets in the core to penetrate it. The thickness of the sheet of wax is, therefore, a further determinant of the final dimension of the tube outer diameter. Hence, it is also tightly constrained to be uniform if manufacture is to a be carried out to within the limits measured. To examine one particular case, the Folrisdam instruments are considered, their mean figure for roundness being 0.19*mm*. Assume that, as a first step, a core was formed and that this was manufactured perfectly round i.e., say, to within 0.001*mm*. Thus, in order, to manufacture the overall pattern to within ±0.095*mm* of this figure the wax sheet would need to·be made uniform to within 0.095mm (say 0.1mm). Sheet could be made to such a constant thickness by rolling the material with two distance pieces to set the working gap and hence the thickness. (Figure 4.19)

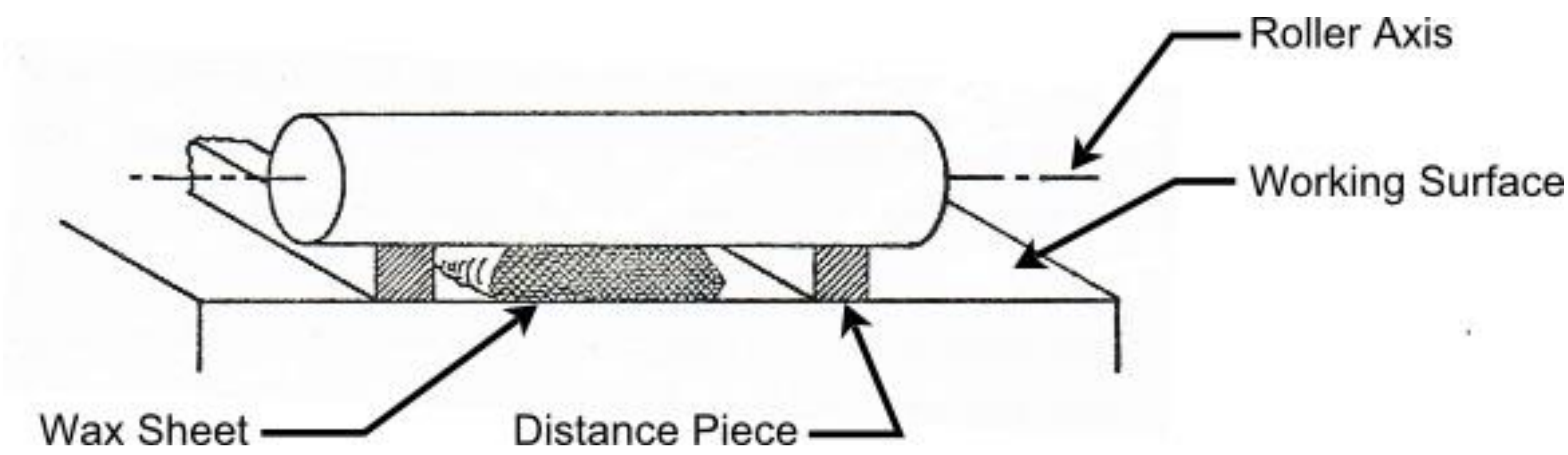

Figure 4.19: Creating Wax Sheet

However, the figure of 0.1*mm* for maximum permitted thickness error would be made up from cumulative errors in: the thickness difference between the two distance pieces; the planeness of the working surface and the trueness of the axis of the roller.

As the thickness of the wax sheet used in manufacture is replicated in the tube material itself, measurement of the instrument wall thickness would give an indication of the degree of uniformity of the sheet used in manufacture. However, it was not possible to do this during this present study as suitable instruments did not exist. Several are under development at the time of writing and the possibility of their use in a further study is discussed in Chapter 5.

THE ASSEMBLY OF COMPLETE INSTRUMENTS

Not only was considerable attention paid to dimensions such as diameters and lengths but the production of curvature on these and their assembly into complete instruments was also carried out very carefully. Figs. 4.20 and 4.21 show the dimensions of instruments SD101/2 and SD103/4, illustrating dimensions formed both by the curvature of individual tube units and by their assembly together.

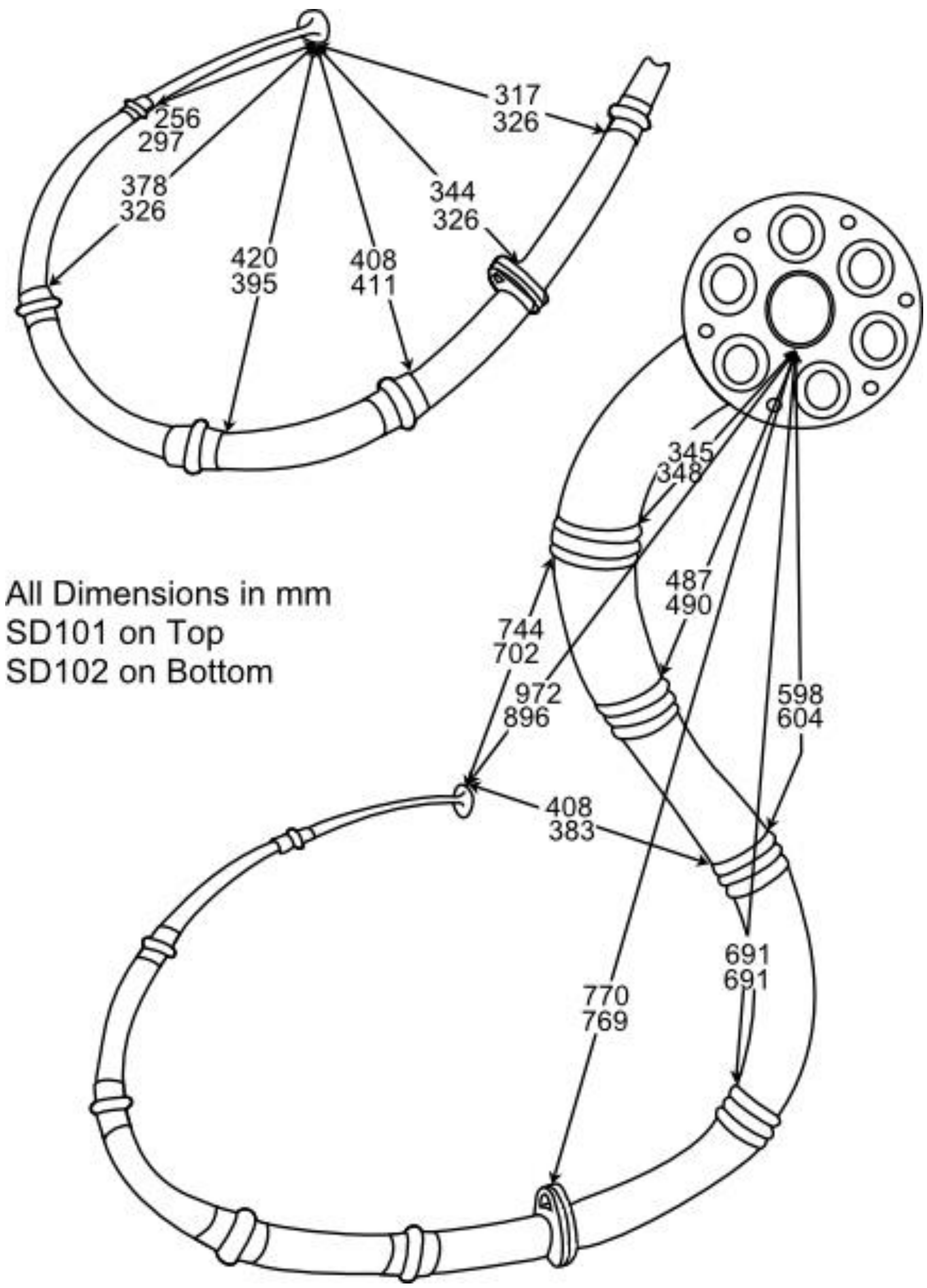

Figure 4.20: Assembled Dimensions of the Brudevaelte SD101/2Lur Pair

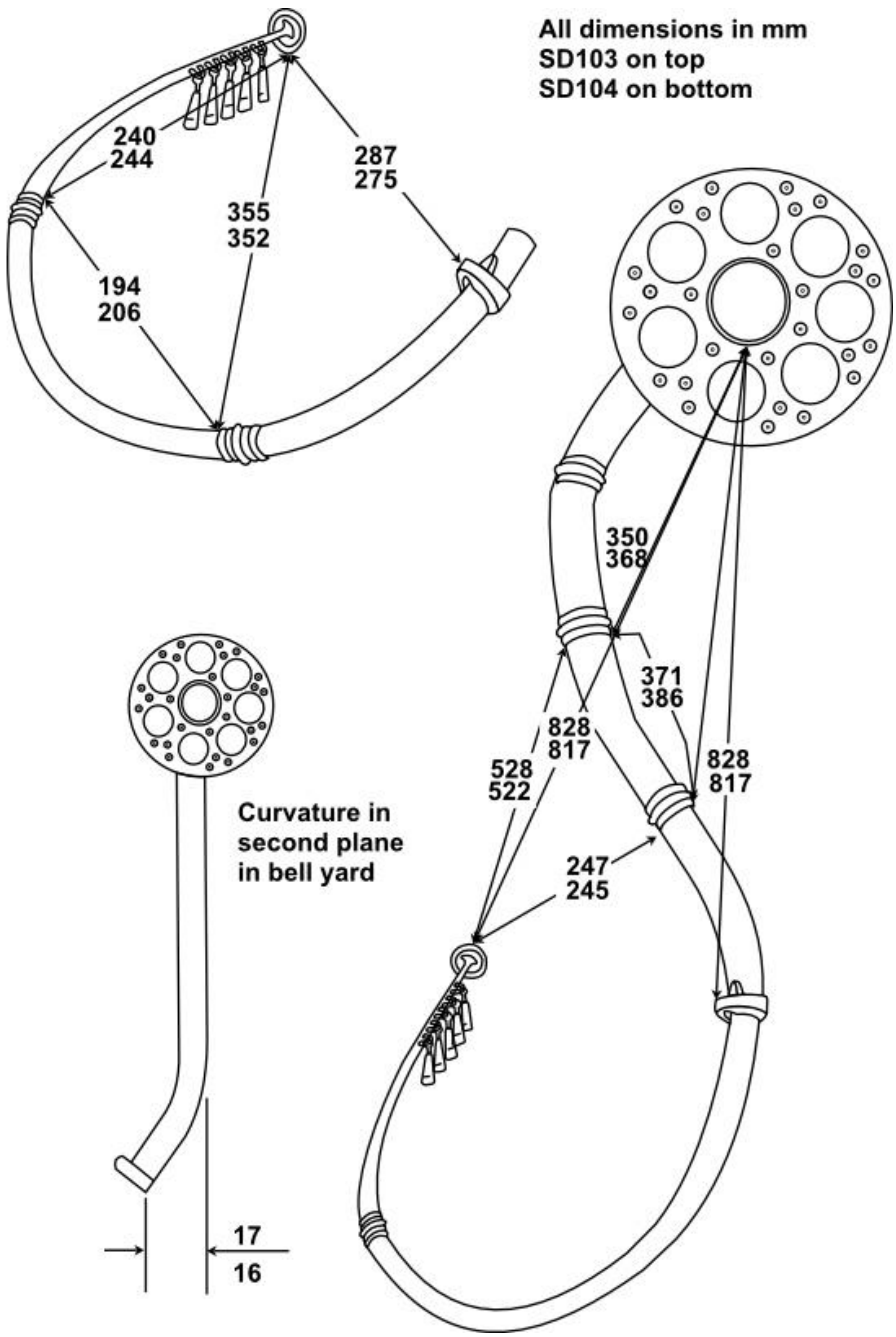

Figure 4.20: Assembled Dimensions of the Brudevaelte SD103/4Lur Pair

On Figure 4.21, for instance, the difference between the four tube yard dimensions are 12, 12, 4 and 3*mm*. In the case of the closest of these dimensions, 355/352mm, this is derived from two individual curvatures of tube units and one joint, between the mouthpipe and the second tube unit. It is clearly a closer fit than can be achieved by visual assessment alone, suggesting that some form of measure was used in its construction.

This effect is even more noticeable on the bell yard of SD101/2, (Figure 4.20). on this, the dimensions from the tip of the bell mouth to the segment bands are:

SD101	SD102	Difference	
		Percent	Absolute (mm)
345	348	3	0.86
487	490	3	0.61
598	604	6	0.99
770	769	1	0.13

These are most impressive figures for repeatability between items and the uniformity of this repeatability over the four readings leaves no doubt as to the deliberateness of the dimensions. Their achievement must derive from careful assembly of the segments when casting these together. Undoubtedly, the chords measured here were used as check measures on assembly, presumably to achieve identical forms on instrument pairs.

The amount of work of a metrological nature such as that above, is strictly limited by the fact that these instruments are now mounted on display as permanent fixtures. Thus, in order to obtain the dimensions shown on figs. 4.20 and 4.21 it was necessary to work inside the display case and accept such limitations as this imposed.

THE GENERATION OF CONES

When turning the cones that subsequently form the core, the maker could either use a single point tool traversed across the cutting surface or a straight-edge to pare off material across the whole edge. In the former case the locus of the tool determines the straightness of the line cut. Thus, the maker has to manipulate the tool to traverse in a straight line against the tendency of the hand to traverse a radius defined by the length of the forearm. This can be overcome to some extent by use of a guide to work the tool against but any irregularity in this guide is reproduced on the finished item. Using a straight-edge to generate the form also requires an accurately made edge as any irregularity on this will again be reproduced on the finished work, albeit to a slightly lesser extent. Hence, in the case of an instrument with a yard manufactured to within 1 *mm* of a defined straight form, the straight-edge would similarly have to be straight within about 1 *mm*. The manufacture of an edge straight to this limit is a considerable technical feat involving a certain amount of motor skill and, more importantly, a good conceptual grasp of the idea of a straight-edge.

CONCEPTUAL GRASP OF THE PROCESS OF MANUFACTURE

Perhaps the most difficult of all aspects of the lur manufacture to evaluate is that of the level of conceptualisation of the manufacturing process. On the one hand, it could be argued that manufacture was to a previously developed pattern that was copied, while on the other, the design could have been stored in some way to be retrieved when making another instrument.

If a physical standard were used, to which new instruments were made then the limit of reproducibility is defined by the ability to copy a dimension or form from this standard.

Thus, if perception alone is used to carry out this process, the limit of reproducibility is defined by the perceptual ability of the maker, the possibility of arriving at some figure for reproducibility using perception alone being discussed in Appendix III.

However, the figure calculated for the minimum perceptual increment is by no means the absolute figure to which matched diameters can be produced. Clearly the tube seen as larger than the standard will need to be modified and in doing this both the skill of the maker and the actual technical process involved are significant. Generally speaking, the simpler technical processes are less controllable, for example the use of a coarse abrasive material to reduce a core diameter. (If a finer abrasive is used this readily clogs and thereafter fails to cut until cleaned.) With this coarse material, by the time contact with the workpiece is established, a considerable amount of material would already have been removed. Following this initial contact, the amount removed would be dependent both on the pressure applied and the length of time for which this was applied. It is in judging the time of application where the skill lies as, when progressively working down a dimension to a requisite value, the tendency is, after several attempts to match, to overdwell with the tool and to remove excessive material. Thus, not only is the minimum perceptual increment a determinant of repeatability but to this must be added the minimum quantity that can be removed in one machining pass.

Development of instrument form under these conditions could arise either from deliberate design or by dimensional drift, as the dimensions of the standard form are likely to vary by up to the minimum perceptual increment each time this standard is replaced. This drift although almost imperceptible would, nevertheless, be consistently towards a more aesthetically-pleasing design.

Several different types of physical patterns could be used to store dimensional information and in increasingly abstract order these are:

l. An actual instrument (or a pair) kept as a copy

2. The yards of a dismembered instrument (i.e. following prime manufacture)

3. The cores of an instrument for use as generators of form

4. The cores of an instrument in the form of a straight cone

5. Station markers or gauges storing dimensional information specific to set locations on the tube

6, Dimensional data stored in the form of units by some means. In the case of 1 to 5, all these techniques could be used in association with information transfer using;

a) perception alone

b) gauging of some form

No physical evidence exists for the use of any of the techniques above and one must rely on interpreting the instruments themselves for a guide to the practices employed.

If perception alone cannot account for the uniformity between instruments in a pair or group, the second level of abstraction (b), that of gauging may have been employed. This would enable a dimension on the instrument being made to be matched to one on a standard, the gauge allowing a close assessment of size to be made.

The concept of taper in a tube or bar is fairly readily understood but the expression of taper as a uniform incremental change in diameter per unit length is more restricted in usage to mathematical work. The use of gauging in the production of a taper may be seen as a first stage in the abstraction of the concept, allowing the user to note that equal increments in length of tube require equal increases in diameter to achieve true conicity. There is, of course, no reason to connect the size of the two units, that of length and that of diameter quite possibly being seen as totally different types of things. Given time for development, they might well be conceptually united to give rise to a unified system of measurement. Thus a diameter gauge could be used with provision for inserting spacers to step down its aperture progressively, producing intermediate points on the taper. Such spacers could, of course, eventually become the new minor units of the total aperture gap or units of measure.

Suggestion 6, the use of dimensions, the most abstract form of storing and transferring dimensional information would free the maker from restrictions imposed by physical models and their imperfections and leave the problem of defining the unit of measurement as the major problem. It could also lead the maker towards a geometrical analysis of his product, significantly different from that of earlier instrument makers who simply copied a shape.

THE USE OF STANDARD UNITS OF MEASURE

Although this cultural region provides no evidence of the use of units of length, much evidence exists from other areas for the use of units from much earlier periods. In Egypt and Mesopotamia, for example, as early as 3000BC, standard lengths were used, being kept in temples and royal palaces[173].However, such units as are known have the finger-width as the major sub-division and, being defined on a very variable anthropometric feature, such a unit would appear to be far too coarse for use in defining the tube morphology of a lur.

One caveat that must be entered here when speaking of dimensions is that, as the major medium for recording and interpreting the morphology of the lurs, in this study, has been dimensional it is .easy to begin to think of this entirely in terms of values of 'x' and 'y' and their mathematical inter-relationships. This obviously influences the view taken and is in danger of precluding the holistic view that needs to be taken, encompassing organology, perception and production processes. The key feature of the results that allow or deny

[173] Hodges, 1970, 110, Wilder, 1973, 94.

mathematical analysis as a valid procedure is that of the uniformity of the dimensional information and its repeatability from one instrument to another. From the data already mentioned it seems clear that the dimensional information is quite valid and, indeed, would justify even more rigorous analysis of these instruments in a further study.

Evidence of a finer unit of measure was reported in 1970 by Butler and Sarfarij. This was in the form of a dimensional analysis of a ceremonial bronze sword deposited as a votive offering in Jutphaas in the province of Utrecht. No dating was possible with this find but, the authors believe, it can be related stratigraphically to three finds in this area that are dated to the Middle Bronze Age. (Here about 1200 - 1000BC, based on C14). Table 4.2 below shows their analysis of the dimensions and appears to confirm their view that a unit of 26.5 mm was used to construct this sword - a unit that they entitled the Jutphaas inch or J-inch.

	Jutphaas			Ommerschans			Factor
	measured mm	constr. mm	J-in	measured mm	Constr. mm	J-in	Increase
length	423	424	16	685		25.85	1.62
max. thickness	7		c.¼	9			
height hilt-plate	48	48			62.2		1.31
blade length (minus hilt-pl)·	375	376			622.8		1.66
radius of constr. circle		106	4	113	171.25	6+	1.62
chord across butt	77.8	80.2	3	113		4¼+	1.42
length side hilt-pl.		48.3			64.4		
width	129	131	5	186	187 to189	7¼	1.41
height trapeze		40	½		52.4	2	1.33
angle of side hilt-plate	57¾°			55°			
angle enclosing butt	45°			39°			
weight	0.705kg						

TABLE 4.2: Comparative Dimensions of the Jutphaas and Ommerschans Swords

All the lurs available for study have been measured as accurately as possible using hand methods of measurement and this data has been extensively analysed in order to find what dimensional standards might lie buried in it. The key to such standards as the smith may have used, however, lies not in mathematical analysis alone but primarily in the understanding of the processes by which the smith designed and made his product.

The basic unit of construction of a tube appears to be a segment, whether on the tube yard, assembled by means of ferrules or on a bell yard, assembled by means of meander joints, cast-on bands or whatever. Thus, the ends of these units are covered over to deny access for assessing both true segment lengths and their terminal diameters and these dimensions must be reconstructed. (Figure 4.22)

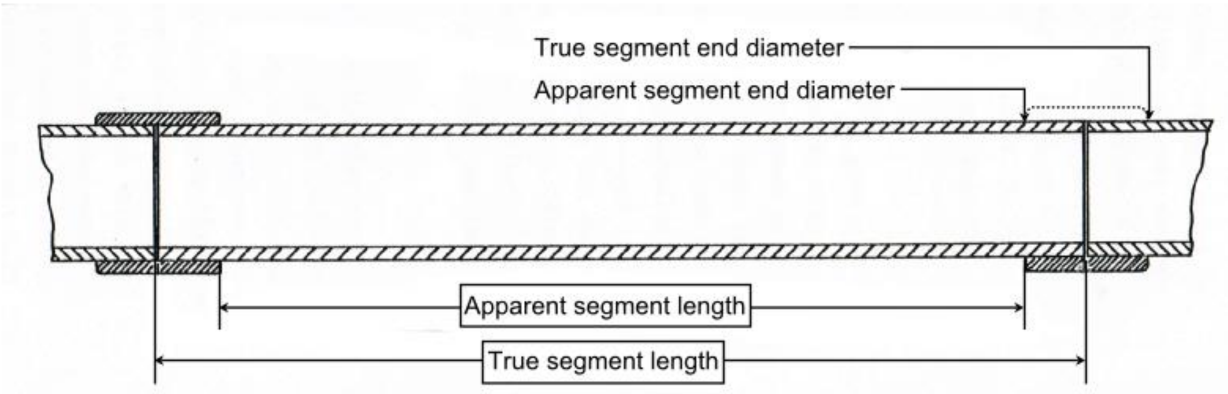

Figure 4.22: Establishing the Smith's Segment Length

True segment lengths and end diameters were calculated for Brudevaelte, SD102, as a fairly complete set of data was available for this instrument. Segment end-diameters were estimated by taking the mean of the tube diameters either side of the joining piece, i.e. assuming that the slope between these diameters was uniform and that the segment ended in the middle of the band or ferrule. The first of these assumptions appears to be justified by the detailed analysis of Rossum which showed a close approximation to a straight-line within the segment itself, although Schmidt's butchery of a cast-on ferrule on Daberkow[174] shown on Plate 4.3 (b), p. 167) suggests that the second assumption may be only approximate.

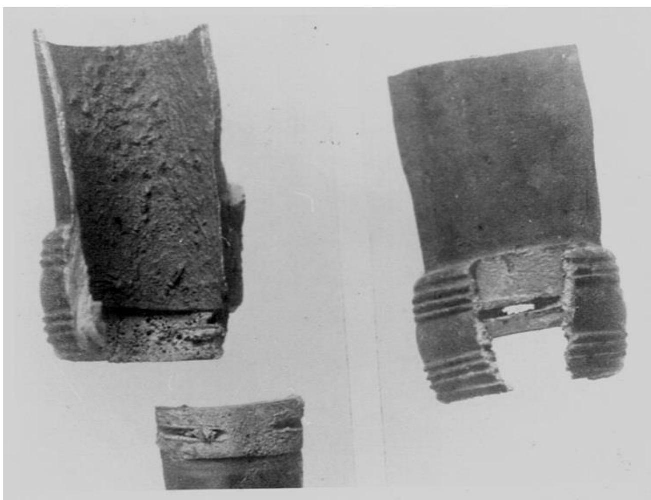

Plate 4.3(b): A Section through a Ferrule of the Daberkow Lur

On Brudevaelte (102) a unit of 4.5 mm was found to give a series of multiples which coincided quite accurately with the calculated segment end diameters these being shown on Table 4.3. For purpose of shorthand notation this unit is referred to as a (Bronze-Age inch) or "brin" in the case of Brudevaelte (102) the value of 4.5 mm being a Brudevaelte

[174] Schmidt, 1905, 99, Abb. 5, 39 and Taf. 8.

brin. Table 4,3 expresses the nearness of the measured lengths to multiples of brins in two ways: Column 1 shows the number of brins needed to generate the measured value while Column 4 shows the value obtained from an integer number of brins and Column 5 the difference between the integer number and the actual measured value.

Column 5 on Table 4.3 seems to substantiate the view that 4.5 mm is a relevant unit of measure as most of the difference values are very low. In addition, each of the 2nd to 5th segments seems to be one brin longer than the preceding one while the diameters of segments 7, 8 and 9 increase at only half that rate. This may account for the large variation from an integral number of brins seen on line 7 of Table 4.3 as this may result from the desire to increase the tube diameter more slowly. Were the application of a unit of measure to these figures false, then a range of error values from 0 to ±2.25 would be obtained with a numerical mean of 1.125. The mean error of the figures in Table 4.3 is 0.85, counting the two large figures and 0.55 omitting these.

No. of brins to obtain corrected value	corrected value of tube dia. (mm)	nearest integer no. of brins	value of integer number (mm)	difference columns 2 and 3(mm)
2.02	9.1	2	9.0	-0.1
3.16	14.2	3	13.5	-0.7
4.16	18.7	4	18.0	-0.7
4.53	20.4	5	22.5	+2.1
5.89	26.5	6	27.0	+0.5
10.78	48.5	11	49.5	+1.0
11.44	51.5	11	49.5	-2.0
12.07	54.3	12	54.0	-0.3
12.02	54.1	12	54.0	-0.1
11.24	50.6	11	49.5	-1.1

Table 4.3: Estimation of Standard Measurement Units for Brudevaelte 102

The fourth of these listed values, 20.4*mm* (Table 4.3) which occurs 666.5*mm* from the tip, could equally well be approximated by 4*brins* (18.0*mm*) or 5*brins*, (22.5*mm*) and thus does not conform well to the theory. However, if the "theoretical" value of tube diameter is calculated by extrapolating the best-fit line obtained from the tip to 479.5*mm* then a value of 22.96*mm* diameter is obtained. It could be, then that this was the diameter that the smith had determined would terminate yard 1 but, in order to make this mate with yard 2, he had to reduce this by some 2*mm* . When compared with the other lurs from Brudevaelte (Figure 4.10) the shape of SD101 and SD102 is decidedly hollow at this point,

and this feature could also represent a stage in the evolution of the overall straight line form as is seen in SD102, 103 and 105.

Segment lengths, being of larger dimension that tube diameters would probably have been dealt with in a different way from tube diameters. However, there is no doubt that in many cases, the dimensions of segment lengths were conserved and frequently used in the multiple form. This suggests that, at the very least, the concept of length and its use was understood.

Tests were carried out on the segment length data to check for uniformity based on the brin defined above and in the case of the corrected segment lengths of Brudevaelte (102), using a brin of 4.5*mm* ,gave a mean error of 0.88*mm* which seems significant in terms of the random error value of 1.25*mm*. However, 4.5*mm* is a very small unit for measuring lengths of segments which vary from 1530 to 210*mm* and it would be possible to reduce this "error" to any desired level, simply by choosing a small enough unit!

In view of the size of segment lengths several tests were carried out using multiples of 4.5*mm* as it seems likely that if the brin were used then it would have been in multiple form for measuring x lengths of 100*mm* or so. When using a value of 10*brin*, the mean numerical error from integer values on SD102 (i.e. as column 5 on Table 4.3) is 7.75*mm* or c. 17% of the multiple, this compares with the random error of 11.25*mm* (25%). A further test was carried out using the J-inch (which approximates to 6*brins*, i.e. 27.0 *mm* cf 26.5) and with this a mean numerical error value is 4.96*mm* (19%).

In neither of the cases does the evidence appear overwhelmingly positive but neither is it clearly negative and much the same can be said for the results of much work carried out on other instruments. In nearly all of these some degree of uniformity can be seen in the dimensions but the key to this has not yet been found. The approach taken here may be too simplistic and the data points used not be coincident with those taken as references by the maker. On Brudevaelte, SD105, for instance, the first three measured segment lengths of 263, 261 and 259 mm are all very close to a value of 10 *J-inches* (265 mm) whereas the "corrected" values of these segment lengths are 281, 278 and 270mm which are nearer to 10.5, 10.5 and 10.0 *J-inches* respectively. On the Maltbaek instrument tube diameters measured at certain segment ends coincide very closely with integer *brin* values but, as the taper of the tube itself is slow, the possibility of this being a chance occurrence is clearly in need of investigation.

Much more work would need to be carried out on a range of instruments before a sample large enough to be statistically valid could be assembled. In addition, a number of re-iterative programmes would need to run to establish values for the "best-fit" lowest common factors and the overall summed errors when using these. Unfortunately such programmes could not be run on the calculator available during this study as it lacked a conditional step. Future work could better be run on a computer but would require as a firm prerequisite, a solid statistical base. However, the major problem would still remain that of gaining reasonable access to the lurs themselves.

Whenever standards are stored in a concrete form, some dimensional drift is inevitable when transferring these and using them in manufacture. Hence, units in use that are

separated both in time and distance can be expected to show the level of variation outlined above. It is no more than remotely possible that some connection between these units and that of Butler and Sarfatij[175] exists. Their value of 26.5*mm* for the J-inch could be

[175] Butler and Sarfatij 1970.

interpreted as a coarser unit than that seen on the lurs, being made up of 6 units of 4.42 mm length.

Obviously much more valuable information is locked away in the lurs themselves. It is unfortunate that at this moment it is also locked away behind glass in Copenhagen!

THE DEVELOPMENTAL SEQUENCE OF THE LUR

In his work in 1915, Schmidt developed sequences of lurs, grouping these in groups A, B1, B2, B3, and C, this being varied somewhat by Oldeberg in 1947 when he eliminated the sub-division of the 'B' group. Later, in 1949 Broholm re-classified the instruments in terms of standard dating sub-divisions of the Nordic Bronze-Age, i.e. periods I - VI. (See above).

Two separate stages have been applied to the problem in this study firstly that of defining the sequence of the instruments using whatever information is available and secondly inter-relating this where possible with established archaeological periods.

Several general trends in design and manufacture can be distinguished which, given a culture with increasing technological capability could define a chronological series of instruments. Such trends are expressed in a positive direction in the following sequences:

A. TECHNOLOGICAL

i) Increasing lengths of segment. This sequence is difficult to express as all lurs have segments of different lengths. Thus, this sequence is sub-divided into

a) Increasing value of mean segment length

b) Increasing value of maximum segment length

ii) Tendency to separate prime manufacture from final assembly.

iii) Increasing roundness of tube diameters

B. ORGANOLOGICAL

i. Increasing sophistication of mouthpiece design
ii. Increasing conicity of instrument tubes
iii. Change in tube morphology to facilitate handling
iv. Increasing sophistication in lock provision

C. AESTHETIC

i. Increasing complexity of tube decoration
ii. Increasing complexity of bell-disc decoration
iii. Increasing complexity of chain decoration

iv. Decrease in number of segments
v. Increasing polarity of tube curvatures
vi. Morphological development of mouthpipe

However, this analysis fails to produce a single sequence, this failure leading to the conclusion that the sample of instruments available for study is only a minute fraction of those that have existed, and that developments took place at several localities producing a whole series of individual sequences, the various features typical of these becoming mixed through trade. Nevertheless, groups of features do produce clusters that have a definable geographic spread.

THE SCANIA GROUP

The first of these groups - here called the Scania group - are the presumed early instruments. These, although presumed early are nevertheless, variable in form and individual instruments display some of the following features: integrally cast bell discs of undecorated annuli; (Plate 4.10 (a)) integrally-cast tube structure; individual elements being joined by means of meander joints, (Plate 4.4 (b), below) highly conical tube morphology and an overall shape roughly like an enlarged animal horn.

Plate 4.10(a): The Gulåkra Bell Disc

Plate 4.4(b): A typical Meander Joint

Some features which are, or could have been, common to all the instruments are simple mouth-supports of the Gullåkra type (Figure 4.6(b)) and decorative elements made up of groups of raised bands. Broholm dates the instruments of this group from Scania on the basis of the simple band ornamentation which is also seen on wide arm-rings datable to period III. However, there are technical differences in manufacture between the two sets of bands, that on the arm rings being partially pressed through from inside while the Gullåkra bands are produced by addition to the existing band. Nevertheless this dating allows what appears to be a reasonable relationship between both earlier and later material.

One of the instruments of the group, that from Påarp, has a markedly less conical tube than the other group members, its semi-vertical angle being 10.8 mrad compared with 35.2 for the Gullåkra instrument. It thus appears to be a later indigenous development on Scania towards a less conical form. A further feature on this instrument is the decoration of linking concentric circles on the bell yard[176] which has counterparts on the Maltbaek instruments and other material that dates it to the close of the 4th period.

The most advanced members of this group, the instruments from Rørlykke, share many of the group characteristics but have an overall morphology which is clearly polarised, with the tube-yard horizontal and the bell vertical. This polarisation is then seen on almost all later instruments. It is possible, therefore, that these instruments developed from the Scania type, probably on the island of Langeland. From here the industry that produced them appears to have formed the basis of industries that developed to the North-East and North-West.

The bell discs of the Rørlykke instruments are integrally cast but differ slightly from the rest of the group. Around their exit diameters are portions of cast metal which turn at right angles to the tube axis and serve to anchor the bell-discs. It is thus possible that the bell disc was cast separately and moulded onto the bell-yard or that it was made in wax and thence moulded onto the bell yard prior to investment.

One other instrument, that from Lübzin in Northern Germany, seems to have a close affinity with the Scania group. While this instrument is of the general animal horn-form and has a simple four-ring decoration, it has a two-piece construction with a simple lock.

[176] Oldeberg, 1947, Fig. 29 and Schmidt, 1915, Abb. 7.

This suggests a derivation direct from Scania indicating that at least two lines of development were present, one leading to this instrument and one to the Rørlykke types. Schmidt dates this Lübzin instrument to period IV, mainly on account of its bell decoration. This dating allows the presumed close affinity to the Scania group to appear reasonable.

POLARISATION OF TUBE AND BELL YARDS

All the Scania group instruments are of integral construction i.e. the instruments are in one piece, all joints between segments are of the same form, and several segments are curved in two planes. However, all later instruments have a joint which separates the bell yard from the tube yard and is either in the form of a large cast boss or a lock. The development of such a feature became necessary when the two instrument yards became polarised to such a degree that the torque on the instrument tube resulting from the mass of the bell yard overloaded this, causing potential failure in torsion. This is illustrated in Figure 4.23 where C is the effective centre of mass, through which the mass M of the tube yard acts, at a distance of d, from the critical cross-section.

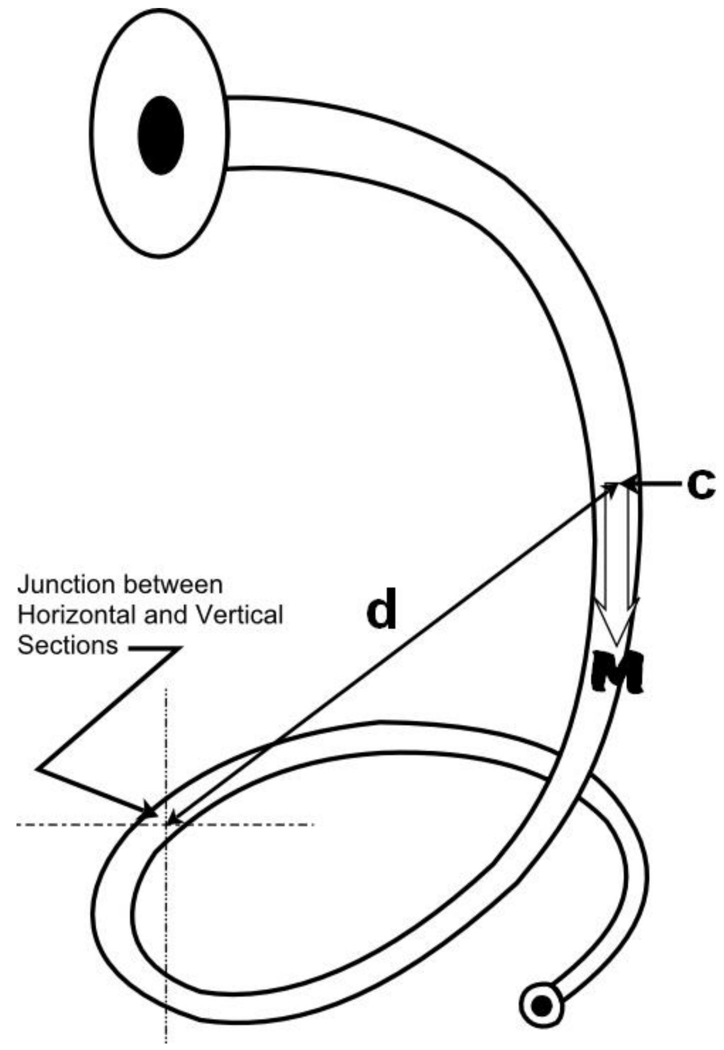

Figure 4.23: The Torque on the Junction piece between the Horizontal and Vertical Lur Elements

In a homogeneous tube of uniform cross-section, the torsional failure would occur at a predictable point. However, when the tube is made up by means of meander joints it would be most likely to fail at one of these. Thus the problem would come to be seen as one of providing a suitable strong joint rather than one of designing a strong enough tube.

Even on instruments of only moderate polarisation such as that from Froarp, the centre joint was obviously a problem as on this instrument the central meander joint differs from the rest (Plate 4,5 (a)) On this holes had been drilled in the tube wall and were then infilled with molten bronze. These, being connected internally to a thick annular band around the bore, serve to anchor together the two tubes. As failure was most likely to occur at meander joints a further solution, that of casting-on a heavy boss, probably over a meander-joint, in order to hold the two parts together, developed. This is seen on instruments such as that from Maltbaek where the boss was clearly cast-on onto the existing tube.

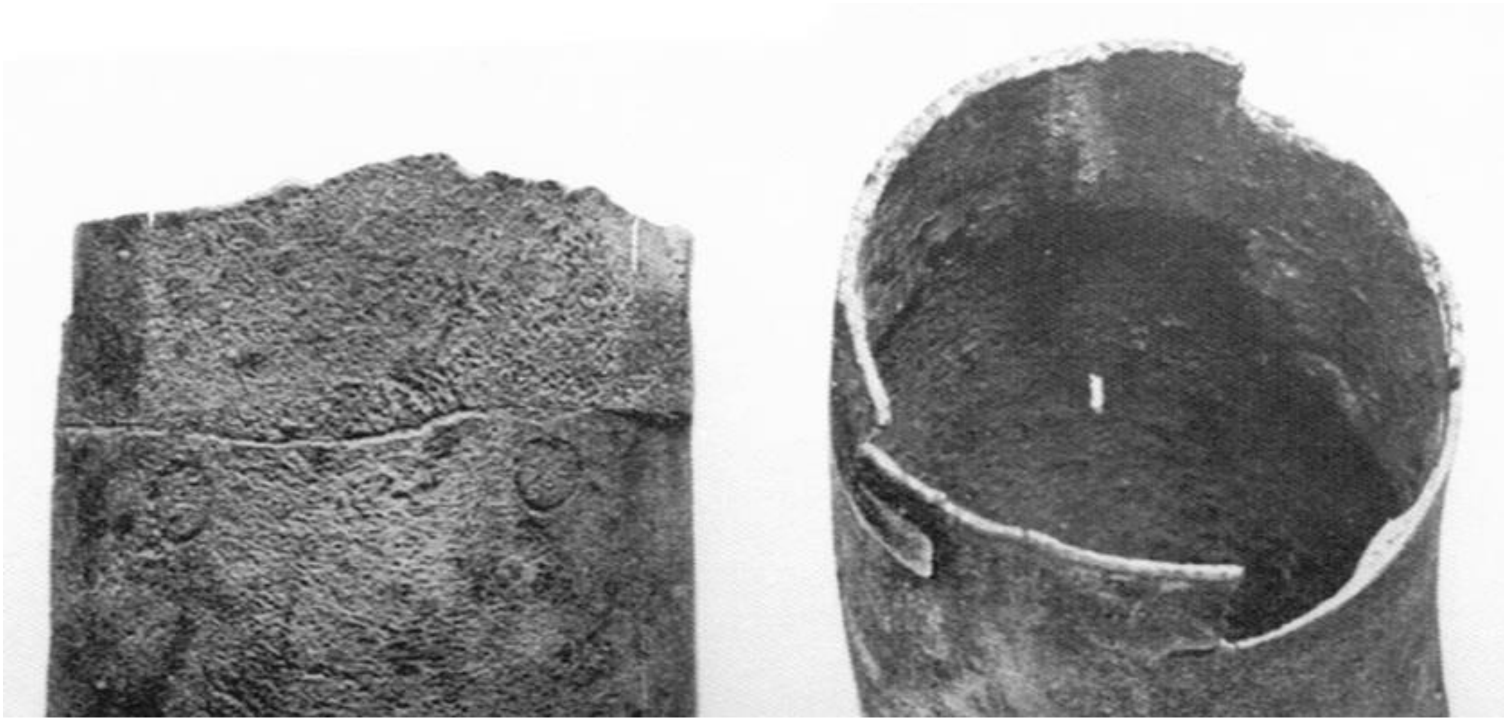

Figure 4.5(a): The Centre Joint on the Froarp Lur

DEVELOPMENT OF THE LOCK

The other solution adopted, was to provide a joint which could be disassembled - the lock - although it was quite likely that this joint was, in fact seen as a semi-permanent feature that was only rarely taken to pieces. Such a lock had to fulfil the basic requirements of providing a male/female junction that was tight enough to hold together, remained air-tight, and was capable of preventing rotation of the bell yard on the tube. The Lübzin instrument achieves this by means of a simple male/female junction and a pair of eyes, normal to the tube axis, (Figure 4.24) through which a peg could be inserted for purposes of location or to hold the two yards together. At the present time one link of the instruments chain is threaded through this ring.

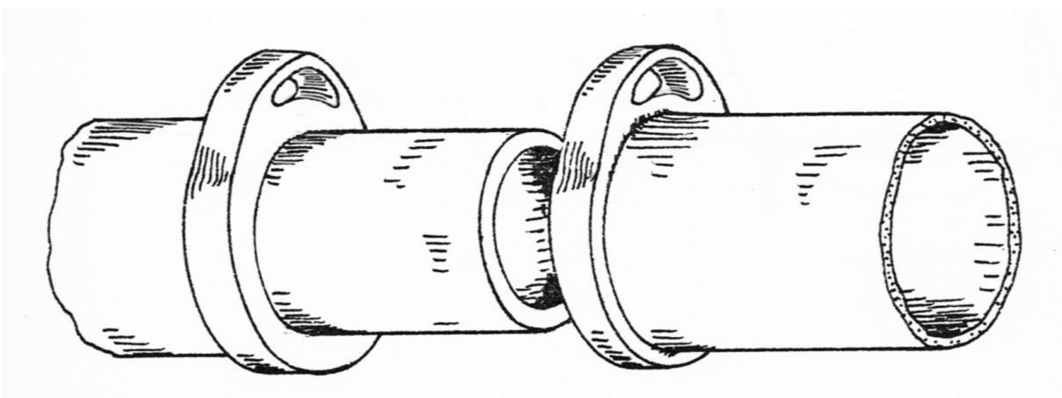

Figure 4.24: The Lübzin Lur Lock

This device clearly represents an early attempt to provide a locking mechanism between the two yards and is undoubtedly effective as a tie between the two yards when either a cord or wire is used to hold the two eyes together. However, it is less effective as an anti-rotation device and an instrument having only this simple two ring lock would still suffer from rotation of the bell. In seeing this as a remaining problem, therefore, attempts made to solve it would be quite likely to accept the eyes as a stop to lateral movement and to provide a totally separate anti-rotation feature. This is, indeed seen on the Lommelev instrument where the lock provision consists of a pair of eyes at 180° to a triangular tongue which penetrated from the tube yard into the bell yard. (Figure 4.25).

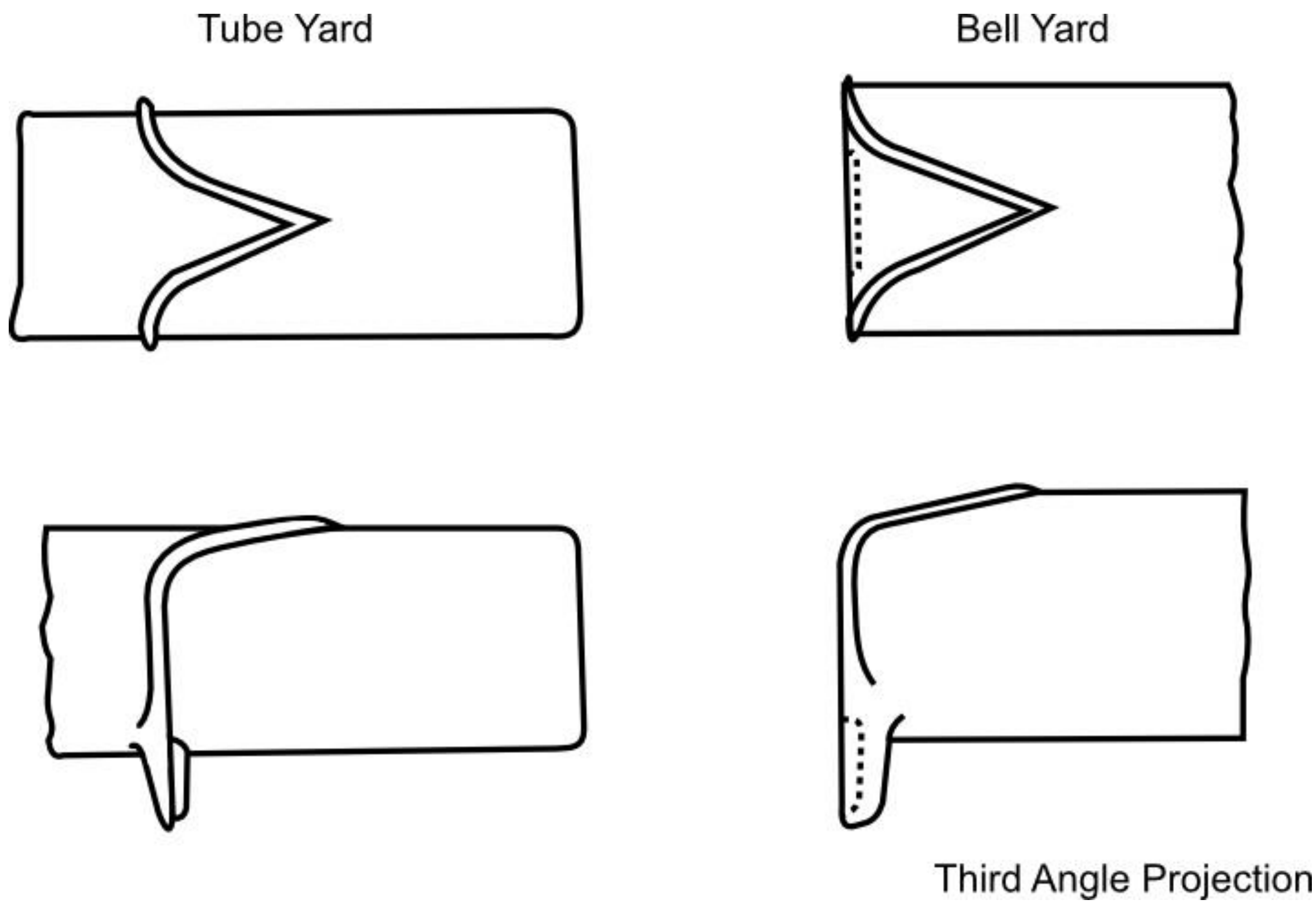

Figure 4.25: the Lommelev Lock

The tubes of these instruments are decorated by pairs of double bands which delineate the individual segments and, in many ways, resemble the bands on the Gullåkra instrument. As with the rest of the Scania group, the instruments are assembled by means of meander-joints but are generally not so well cast as these.

With the development of polarised instruments of greater length and with almost semi-circular tube yards, the weight of the instrument came to be supported more by this tube yard than the case on earlier instruments. (Figure 4,26).

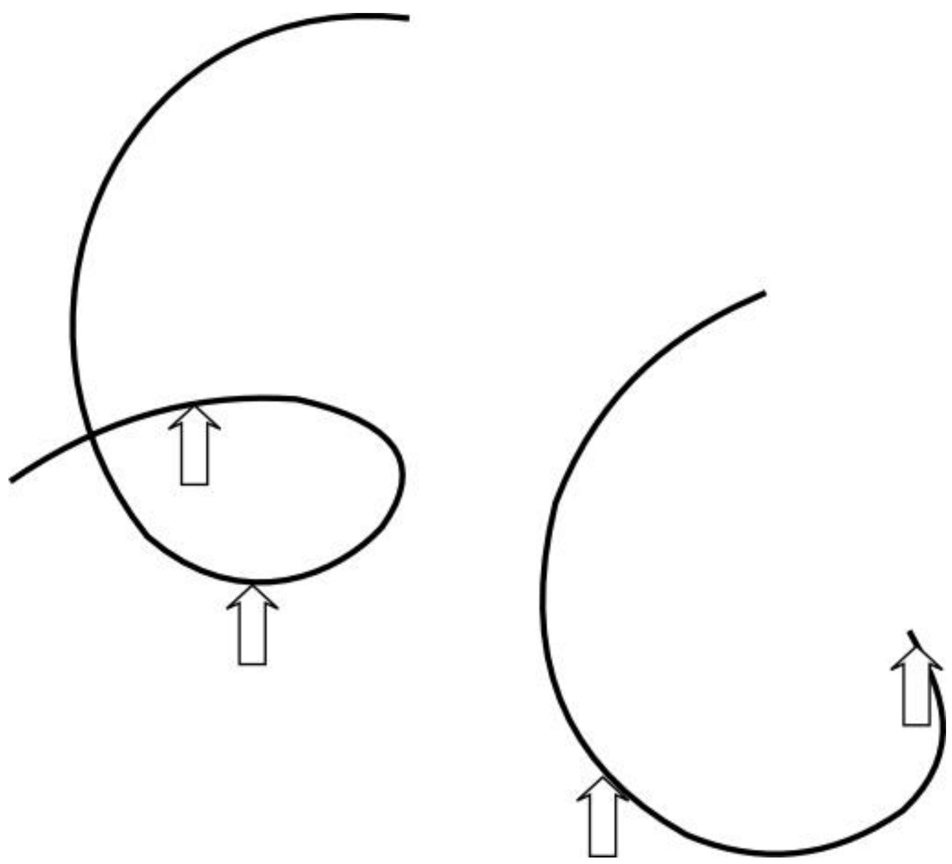

Figure 4.26: Lur Support Points

This increased loading on the tube yard undoubtedly led to failure of this on many occasions as witnessed by the many repairs that are seen on the extant specimens. On both the Lommelev instruments, for instance, cast-on ferrules are present that are clearly added after the instrument was complete and are in different places on each instrument. It is probable that these cast-on sections led to the generally accepted practice on all later instruments, of providing a ferrule, either cast separately or cast-on integrally, to join together the segments of the mouth-pipe and tube yard.

Thus, this instrument pair seems to be closely related to the Scania group but to have developed slightly more advanced features than the other instruments in the group. If this rather sparce evidence is truly representative of what actually took place, it would suggest that at this stage of development, probably during period lV the main area of manufacture and development had moved from Scania to the Danish Islands of Langeland and Falster and possibly Northern Germany.

No other instruments show the separation of the two lock functions in the way that the Lommelev locks do. It would appear, therefore, that the development of the lock that had a triangular tenon passing through the eye developed rapidly from a Lommelev-type prototype to become an accepted standard. The only notable variation on this - an aesthetic development - was the provision of scrolls on the tube yard bell, adjacent to the thickened band at the tube edge.[177]

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[177] .Broholm, 1949, fig. 13.

The Cast Boss

The alternative joining technique to the lock which was used on a large number of instruments was the cast boss. This is a rather heavy, prominent boss which breaks up the line of the instrument and frequently carries an integral mounting ring. (Maltbaek, Folrisdam). There seems no reason to believe that this is an earlier design than the demountable lock as Larsson suggests[178] It is, more likely, a different solution to the problem and one moreover that appears to have been quite successful as all but one of the instruments that have the large bosses are still intact. Thus, lacking suitable X-ray photographs, nothing can be said of their internal construction.

The one example that is available for study is the bell of a lur from Høng (SD109). It is broken at its upstream end, presumably where it met the tube yard and failed through the cast-on portion. This addition to the tube consisted of a band, cast-on around the two tube ends. The joint appears to have failed through the cast-on section and, according to Broholm, is in the form of a "thick clumsy ring."

The Development of Bell Discs

Developing from the Scania group, which had integrally cast bells was a series of instruments with permanently attached but separately-manufactured bells. As a result, partly of the decrease in diameter of the bell itself and partly of an increase in the disc diameter, the area of the disc increased. Thus, unlike on the smaller annuli of the Scania group, this bell disc was decorated.

On the Lommelev, Maltbaek and Lübzin instruments, this decoration was applied using the standard techniques of the period that were used on other bronze work. The patterns used also mirrored those used on bronze work of the period and were used by Schmidt[179] for dating this material.

As with all metalwork of this period, the first stage in its manufacture was the casting of the disc. This, however, was cast to a semi-finished state with a corded circular rim around the circumference of its rear surface. This decoration must have been built up in wax on the wax plate prior to investment. (Plate 4.5 (b), (c))

[178] Broholm, 1949, 45.
[179] Schmidt, 1915, 132.

Plate 4.5(b): Rear of a Bell Disc

The clay investment was pressed onto this rear face in several pieces, as is witnessed by the raised line formed where these pieces failed to meet, leaving voids in the mould. Following casting, the front face of the disc was cleaned up abrasively and the pattern marked on. This pattern was then punched in using a series of punches from a dotting one to a triangular forming punch. While punching in the arcuate decoration on the central part of the disc, the disc itself was placed on a hard surface resulting in bruising of the metal below. However, when putting in the circumferential wedge-shaped decoration the circular rim on the underside of the disc must have been supported on a material which took up its shape while still giving support as no sign of bruising is present on this. A modern smith would use pitch or perhaps lead to give this support but it is possible that a soft wood could have been used on this occasion. The finishing touches to this arcuate petal-like decoration was then carried out using a graver which effectively cleaned out and smoothed the profile of the punched decoration. (Plate 5.5 (b)

Plate 4.5(c): A Bell-Disc Decoration

A similar decoration is seen on the bell of the Lübzin instrument although this lacks the circumferential bands around the disc. On the Lommelev instrument the decoration is made up of many more, smaller arcs, each having a hook-like feature at the end of the arc. Schmidt[180] dates this as period IV by analogy with dated decorative discs which carry this decoration.

In contrast to this form of bell-disc was a type that was essentially complete after casting. It is seen at its peak in the Zeeland group (see below) but several simpler forms are seen earlier than these. These instruments are decorated with bosses but of a much more simple form than those of the Zeeland instruments where the bosses are generally large and very round.

On the Folrisdam instrument, for instance, the decoration on the disc consists of two concentric rows of dimples pressed through from behind. (Plate 4.6 (a),(b)).

Figure 4.6(a): The Front Face of the Folrisdam Bell Disc

[180] Schmidt, 1915, 133.

These were formed in wax prior to investment and in the cases where the section failed, this is made good by a repair patch. Repairs such as these were obviously carried out at the stage when the disc was in wax as their material is now integral with that of the disc. A peculiar feature of this pair of instruments is the difference in number of these dimples on the disc; instrument SD124 has 15 dimples on the inner circle and 20 on the outer while SD125 has 17 and 20 respectively, this being a unique occurrence on a pair of lurs. Around the periphery of the disc is a poorly-formed rim, created by adding wax to that of the disc proper during manufacture. Altogether, these bell discs are crudely made and contrast starkly with the remainder of the instruments to which they are attached. These instruments are the most uniform in conicity and size of the whole group and it is hard to believe that a manufacturer who carefully and deliberately constructed such precise tubes would clumsily dash off a pair of discs like these. Unless that is, the precision of the tubes was either an end in itself or was designed to achieve a particular acoustic effect. In this case, the aesthetic impact of the bell disc would be largely ignored, care being taken to ensure that, metrologically speaking, the instrument's air-column was correct.

Manufacture of the Bell Yard

As the lurs were by this time, being held by the tube yard or quite low down on the bell yard this had become a highly stressed part of the instrument so the tendency to use a cast-on ferrule to join segments of the tube had become fairly general. This was not so, however, with the bell yard and the meander joint continued as a constructional feature in some areas. In others, however, attempts were made to replace it and the use of a large cast-on ferrule was, most likely, rejected because of the effect of additional weight high up on the instrument rendering it less manageable and creating a greater visual impact when held above the head of the player. Instead a thinner, narrower ring was cast-on around the two tube ends and, as a joint on the bell yard only carries the weight of that tube above it, appears to have been successful. That the technology was available for exploitation in those areas where the meander-joint continued to be used cannot be doubted as one instrument from Radbjerg (SD116) has both joining techniques present on the bell. No doubt, the cast-on band represents a repair, on this instrument, but it is, nevertheless, both extremely well formed and well cast and such a successful repair could well give impetus to the use of this technique generally. However, in this area of southern Denmark the meander-joint continued to be used, while in the island of Zeeland the use of the cast-on band seems to have been more generally adopted. With this new technique, the distinction between decorative and functional usage of the segment junction disappeared. Such instruments as use this technique, therefore, have bands which are both decorative and serve to link together segments, whereas the band on the Radbjerg instrument simply replaces one of the double band-space-double band decorative elements, the meander-joints remaining between these.

When adopted initially, this cast-on band appears to have been a fairly simple added ring such as is present on the Garlstedt instrument. Among this very fragmentary material is a cast-on boss with the ends of the two adjacent tubes. On the inside of the tube is material that has flowed into the tube, possibly unintentionally, nevertheless helping to key in the cast-on part. (Figure 4.27)

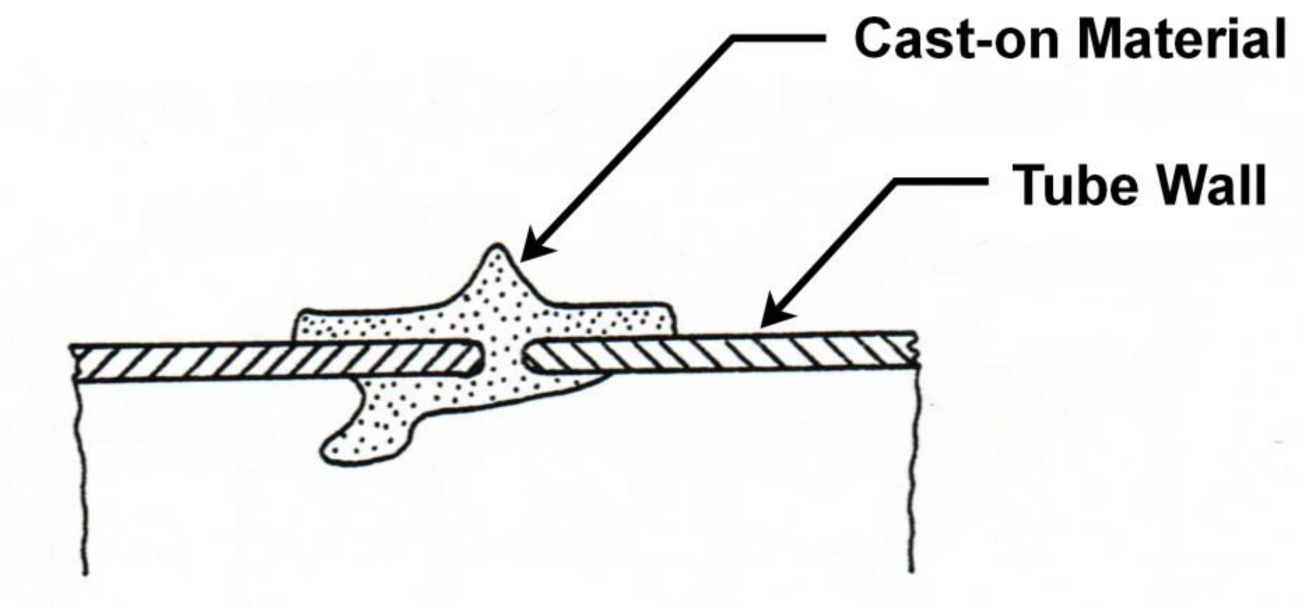


Figure 4.27: A Cast-on Joint on the Garlstedt Lur

A further instrument fragment from Northern Germany, a piece of bell yard from Hof zum Felde, has two cast-on bands. One of these is in the form of a simple fairly thick band, simply decorated by means of circumferential double scribed lines. At one point around the circumference, a portion of this tube is missing and the edge formed at this point has been decorated by means of notches at about 1*mm* pitch. However, as these notches are normal to the outer surface of the tube, they could not have been cut into the finished bronze ring without marking the tube's surface. It seems probable, therefore, that they were cut into the wax formed around the tube as a pattern. At this stage the maker, presuming he had a supply of wax, could, equally well, have built up the rest of band to correct this error. A further rather crude piece of workmanship is seen on the other band. This is apparently a repair and much abrasive working can be seen adjacent to it. The band itself was formed from a profiled strip of wax that was wrapped around the tube, presumably at the break or desired junction. However, no attempt was made to butt the two ends of the band neatly and the excess length of strip was simply wrapped over, Thus, over a portion of the circumference two thicknesses of strip together form the band. From the shape of the overlapping portion it appears that the strip had been pre-formed into a suitable cross-section, prior to wrapping around the tube.

In addition on the Garlstedt instrument is a peculiar joint, unique among the lurs, where a 4*mm* axial length of tube was cast-on, being held in by an internal annulus of material in the bore. It is clear from this that the maker did have a measure of control of the core dimensions to leave the space for metal to flow in to effect a successful key. (Figure 4.28)

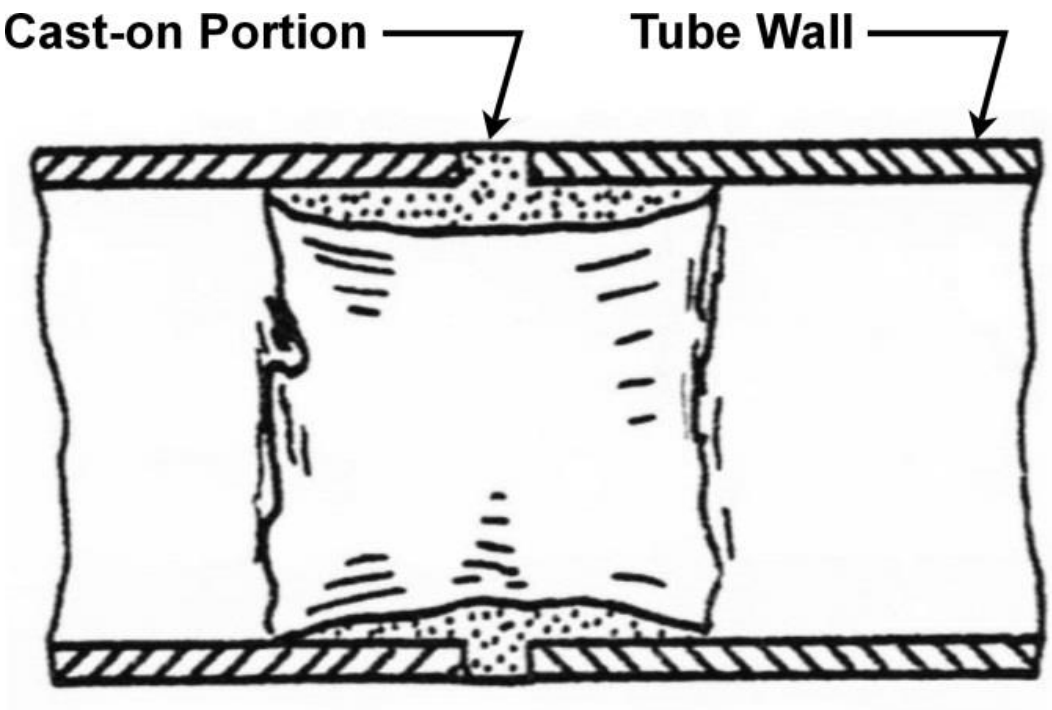


Figure 4.28: A Cast-on Portion of Tube on the Garlstedt Lur

A slightly more-elaborate version was found by Schmidt on the Daberkow instrument.[181] On cutting through the tube of this he found the cross-section as shown on Figure 4.29 and Plate 4.3(b)). Schmidt considered that the casting-on process had utilised the flowing bronze to heat up the tube ends to their melting point and hence attain a welded-joint structure.[182] In addition, slots had been made around the circumference of the tube, Schmidt claims by chiselling, and these produced depressions into the bore normal to the axis of the tube. (Figure 4.29) Similar features are present on both the Borgeby and Langlots Norregård instruments but on these, the slots are more numerous and in one case can clearly be seen to have been filed in[183] although Oldeberg, too, says these were "punched in." (Op. cit. 72)

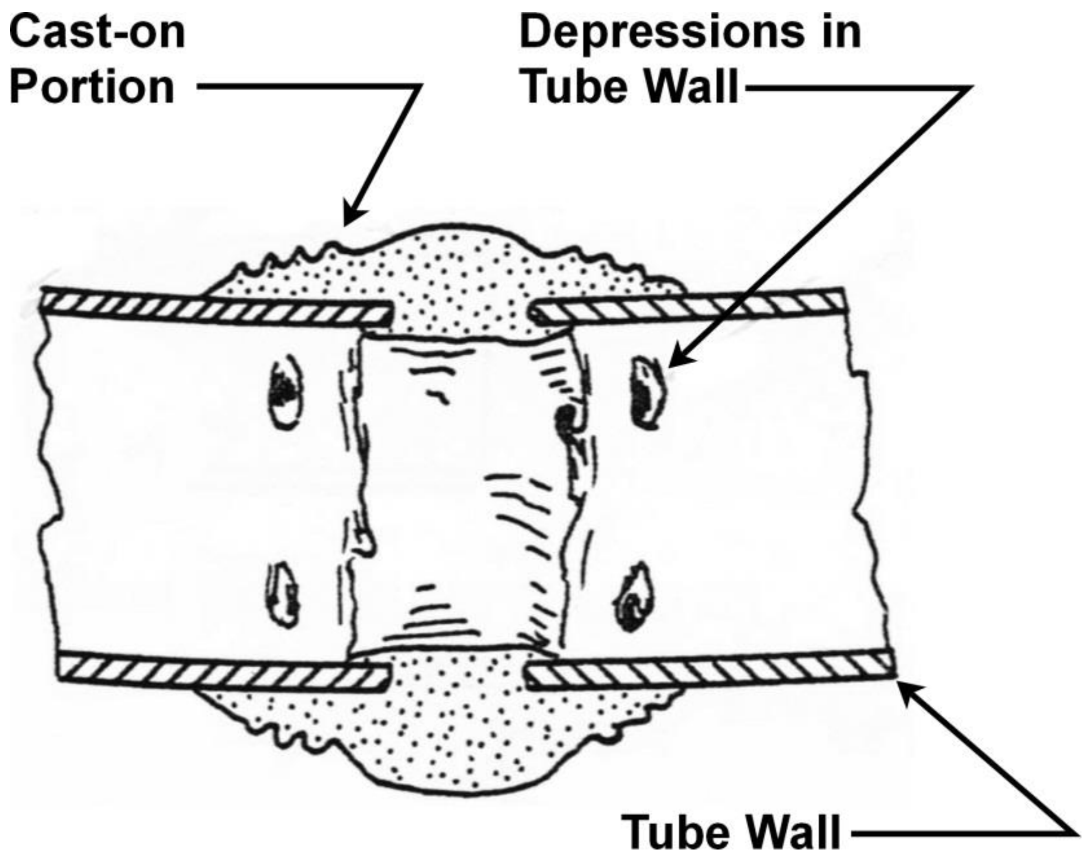


Figure 4.29: A Cast-on Section on the Daberkow Lur

[181] Schmidt, 1915, 100.
[182] Schmidt, 1915, Abb. 5, Abb. 39.
[183] Oldeberg, 1947, Fig. 53.

A lur fragment from Rossum in Norway shows a further refinement in the technique adopted to get a better key between the added material and tubes to be joined. In this, the end diameter of each tube was reduced and four holes were drilled around the circumference of these. Then, according to Oldeberg[184] the two ends were brought together, the bore filled with clay to form a core, the annulus formed filled with wax and then invested and cast in the usual way. (Figure 4.30(a).

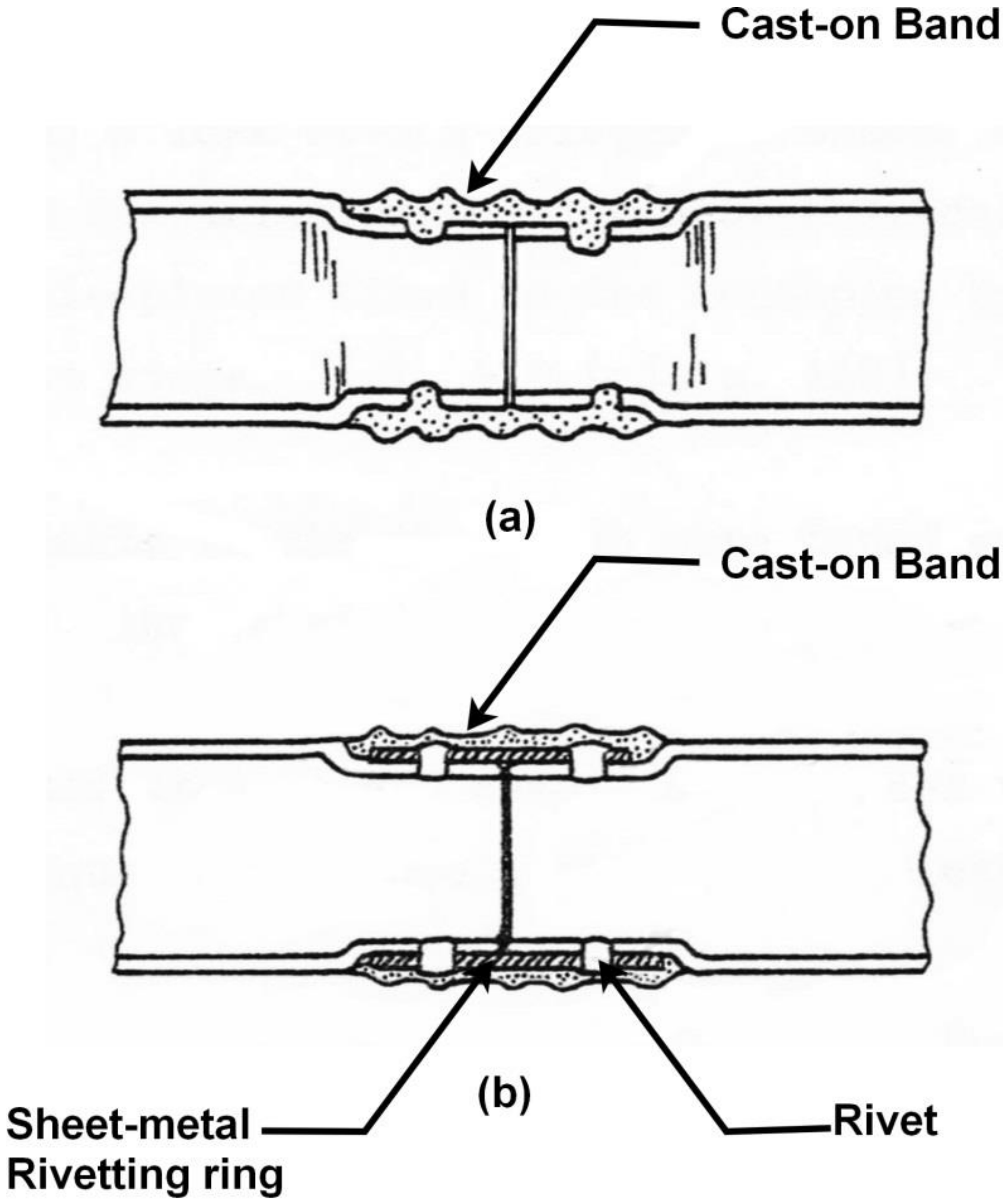


Figure 4.30: A Joining Structure on the Rossum Lur Fragment

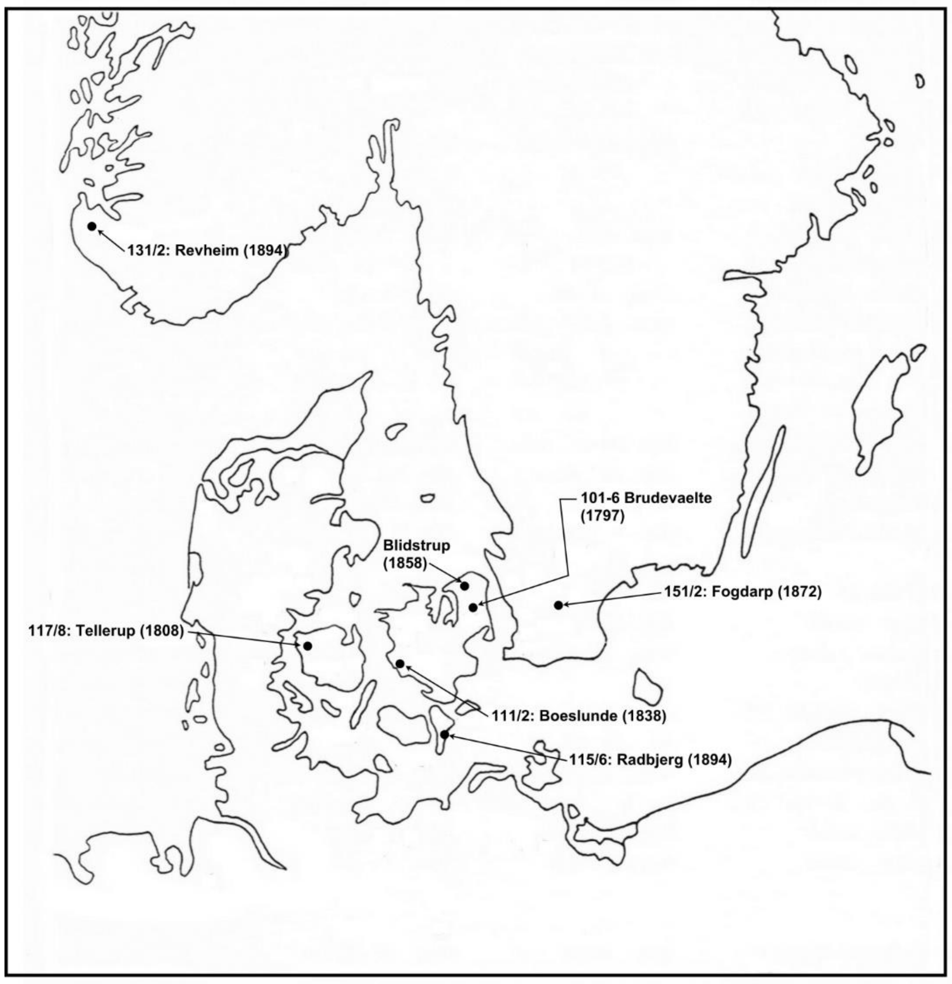
However, the bore of this joint shows no flowed-over metal either in the gap between the tube ends or around the filled-in holes. In fact, the end faces of the tube can be seen quite clearly and a considerable gap is visible all around the outer edge of the material that fills the drilled hole.[185] It appears, therefore, that the four holes on each tube end are filled by rivets which were fed through from the inside of the tube and then peened over onto a band that was wrapped around the sunken annulus. A wax ring was then formed over these with the meander decoration formed on its outer surface and this was then invested and cast. (Fig, 4.3(b)).

184 Oldeberg, 1947, 60.
185 Oldeberg, 1947, fig. 40.

On the island of Zeeland, a fairly uniform design of instrument emerged that incorporated many of the developments described above, these here being called the Zeeland group. The standard instruments of this group, all have a slightly hemispherical mouthpiece (trombone type), a mouthpipe joined by cast-on or added ferrules, a lock with a triangular tenon, a separately cast bell-disc featuring pronounced hemispherical bosses and a number of rattle-plates fixed to the mouthpipe by means of integrally cast rings. (Plate 4.3 (a))

The Brudevaelte Lur Pair

Of the instruments in the group, ten were found on the island of Zeeland itself, the remaining six being very widespread (Map 4.2). However, in spite of this group having a large cluster of similar attributes, there remain differences that, expressed in terms of sequences produce a conflicting picture.



Map 4.2: The Distribution of the Zeeland Group Lurs

The lurs in this group can be roughly sub-divided into one group with meander joints in the bell yard and the other with the cast-on bands joining tube units together. A further sequence can be constructed based on the complexity of bell disc decoration. (Figure 4.51) This figure places the simplest bell disc decoration first and, hence, places Brudevaelte (SD101/2) before the Boslunde instruments, i.e. contrary to the yard construction sequence.

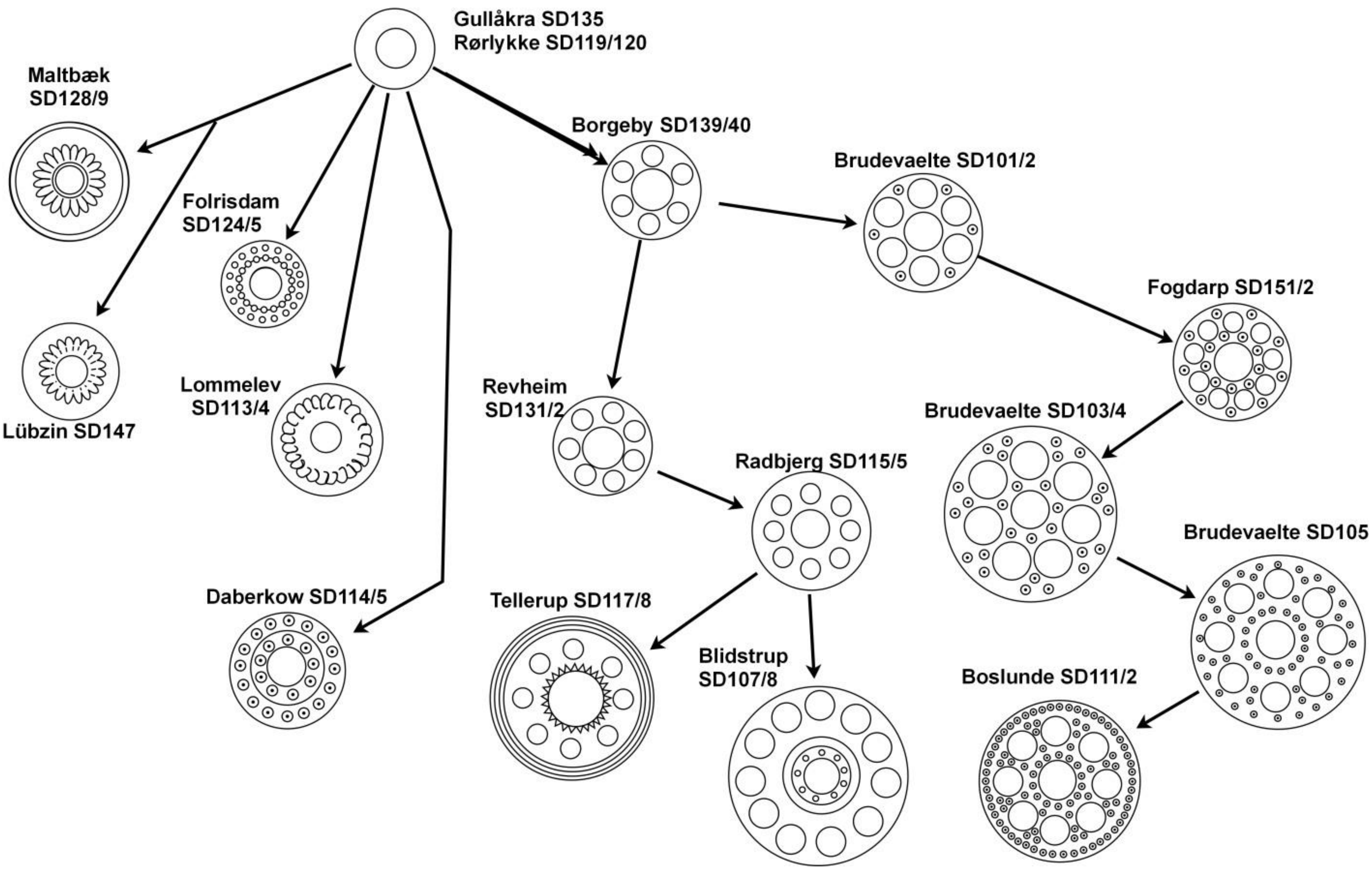


Figure 4.31: Bell Disc Designs

BELL-DISCS OF THE ZEELAND GROUP

The characteristic feature of these bell discs is their large domed bosses which stand forward of the disc surface. On the simplest of these, on the Revheim instruments, these are something less than true hemispheres and although round, variations in roundness can be detected by eye. These are the only instruments on which these hemispheres stand on a plain background, all other bell discs in this group being surrounded by a rim. (Plate 4.6 (c))

Plate 4.6(c)

These later discs also have larger bosses whose size necessitates their separate manufacture, i.e. they can no longer be produced from sheet wax by pressing through as this would cause too much thinning of the material. Instead, they must be made separately and then added to the disc proper.

The most elaborate of these bosses, on the Boslunde instrument, have a form that protrudes even more than a hemisphere and is shaped rather like the sharp end of an egg i.e. ovoid. However, measurements taken of the diameter of the complete bosses (the bell disc is rather fragmentary) are tabulated on table 4.4 and show these to be very round. These figures show a mean value of boss diameter of 50.58*mm* with a variation on this mean of +0.32, -0.68*mm* or expressed roughly as ±0.5*mm*. This suggests very strongly that these bosses were made using a forming tool, thus producing them to a given standard.

Boss No.	AZIMUTH (Degrees from vertical, clockwise)					
	0	20	45	90	135	170
1	50.30	-	50.75	50.90	-	-
2	50.60	-	50.70	50.70	50.85	50.70
3	-	50.60	50.50	49.00	-	-
4	-	-	50.80	50.50	50.90	50.90

Table 4.4: Diameters of the Bosses on the Boslunde Bell Disc

On only one of the bosses was it possible to measure five stations and this gave a value of diameter = 50.71, +0.14*mm*, -011*mm*. If this is a true measure of the roundness of these bosses then the tool that formed these was clearly manufactured by a generating process probably on a lathe.

The value of ± 0.13*mm* quoted above is the product of several stages of manufacture, during each of which degradation of the roundness figure for the former would have occurred. Thus, the original tool is likely to have been much rounder than this.

From an aesthetic point of view it is the front surface of the bell discs that is important. Thus, the wax used in forming the pattern was pushed into a female mould to form this surface accurately. This mould was most probably expendable as it would be impossible to remove a fine wax sheet from a mould of the depth seen on these bosses.

A further element of decoration was added to later instruments, the standard form of this being a circular pip with concentric circles around it. On Daberkow and Brudevaelte SD101/2, two concentric circles surround this pip while on some later instruments such as Brudevaelte SD105, and the two bell discs found at Fogdarp, three concentric circles are seen. (Plate 4.7 (a)) These latter discs, found in 1972, were studied by Lars Larsson who measured the concentric circles on these and concluded that they too had been made by means of a die as they "coincide within one tenth of a millimetre" (Larsson, 1975, 184).

Plate 4.7(a): The Concentric Circles on the Fogdarp Bell Disc

A bell disc, cast in bronze, is a relatively strong item, additional strength coming from its three-dimensional form i.e. the bosses. This is not true of the wax pattern for such a disc, however, and, on this the protrusion of the boss is a distinct disadvantage because of the low strength of the wax. The smith of the Bronze Age, when producing thin sections generally formed them onto a surface and thus never handled the delicate wax patterns as such and this is probably how bell discs were made too.

Starting with a piece of clay this would be rolled to produce a flat surface and the basic geometry of the disc scribed on this. The punch, with the male form of the boss turned onto it would then be pushed into the clay at the appropriate points. The second punch, with the pips and concentric circles on would then be pressed in to form this secondary decoration. Any other features such as the circumferential re-enforcing rim would then be cut into the clay and the whole surface of this finally cleaned up to a satisfactory state. This would then be left for a week or so to dry out thoroughly and to harden. Once hard, circles of wax would be warmed and, when soft, pressed carefully into the large boss cavities, these would then be left to harden off.

Meanwhile a circle of wax sheet would be cut out to the maximum diameter of the bell disc and the position of the large bosses marked out on these. Having been produced using dividers of some form, these scribed lines remain as incised evidence in the rear of some bell discs. (Plate 4.7 (b)) Circles slightly smaller in diameter than the bosses would then be cut out in the appropriate places and the circle of the appropriate diameter removed in the central part of the disc. This sheet of wax would then be laid over the clay mould, lining the holes in it up with the bosses beneath. These bosses would then be welded to the disc of wax, where necessary adding a filler of wax rod. The small concentric circles would then be impressed into the front surface by pressing the wax into them, possibly using a hot spatula. Surface features on the rear of the disc would then be added by welding these onto the tip of the disc. After allowing the wax to harden the whole assembly would then be invested in clay, probably a heavily grogged one to minimise shrinkage, and the necessary runners and risers provided in this.

Plate 4.7(b): Scribed Arcs on the Rear Face of a Bell Disc

Several bell discs have features which correspond with having been made this way such as evidence of the weld around the edge of the boss. On others, hooks or eyes are cast integrally with the rear face of the disc indicating that this was accessible at some stage of manufacture to enable these pre-formed features to be added. (Larsson, 1973, Figure 11)

This specialised technique for manufacturing bell discs was practiced principally on Zeeland and perhaps in Scania. However, in other areas the large bosses do not appear at all. On the Daberkow instruments, pips with concentric circles around the bell aperture, completely fill the disc. (Figure 4.1) On the Island of Funen,on the Tellerup instruments, a more complex method of fixing the bosses to the disc was utilised, perhaps resulting from failure when casting bosses the Zeeland way. On one of these instruments the bosses were cast separately and provided with two eyes on the edge of the boss. This part of the boss was then fed through the aperture on the disc and a pin wedged through the eyes to secure the assembly (Plate 4.9 (a)).

Plate 4.6(d) The Front Face of the Tellerup Bell Disc

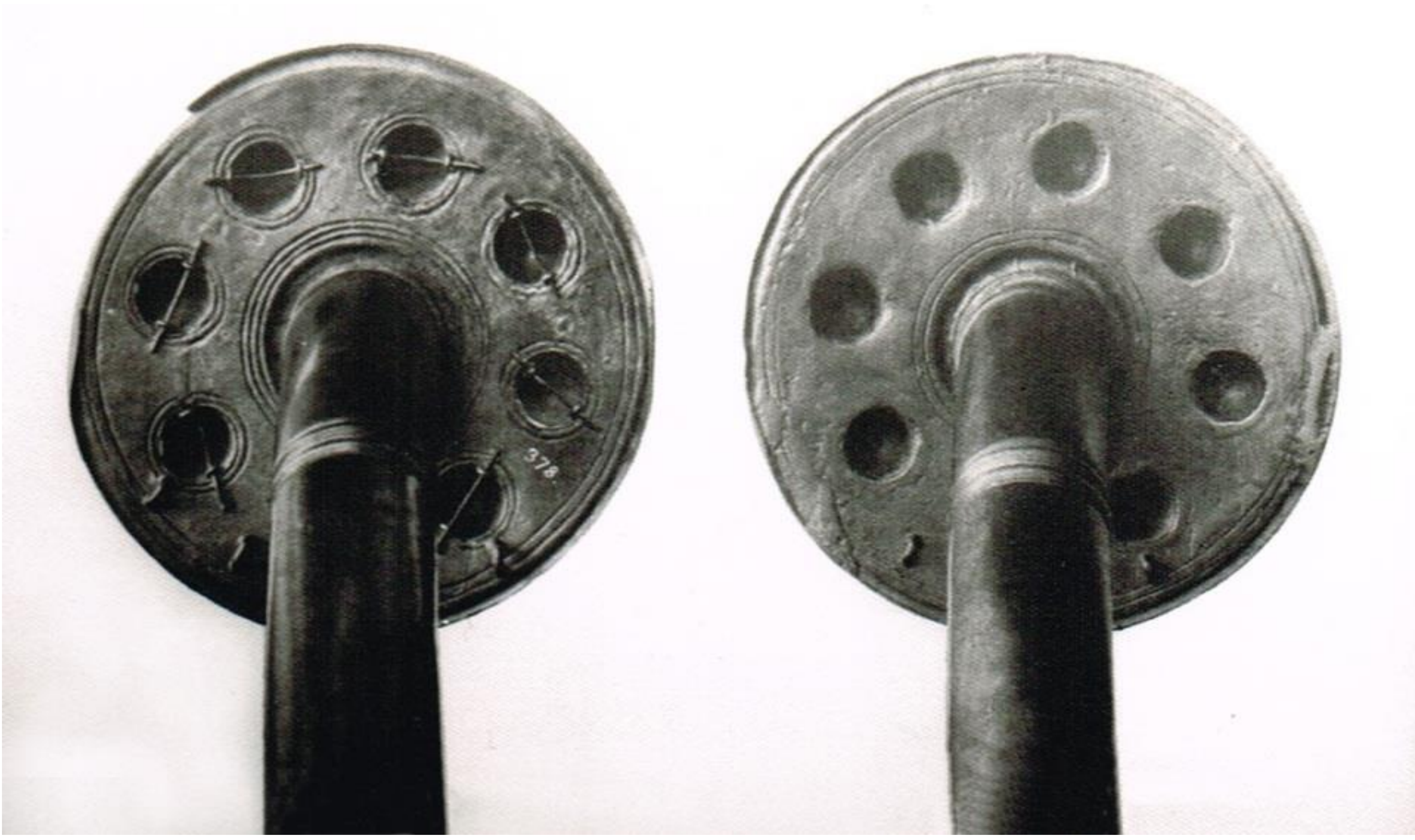


Plate 4.9(a) The Rear Faces of the Tellerup Bell Discs

These bell discs were clearly influenced by the Zeeland group but have other features more typical of other instruments from that region. The main one of these is an engraved wedge-shaped pattern around the three concentric corded circles that enclose the bell aperture.

Requiring as they did, a manufacturing technology somewhat different from instrument tubes, the lur bell discs could well have been made by different makers. The technical processes involved in the manufacture of a bell disc required precision but were much more similar to those of the general bronze worker than were those involved in the manufacture of tubes. In the case of the Folrisdam instruments, for instance, the bell discs and tubes are markedly different in their quality of manufacture. The Fogdarp find, although it is the only find of discs alone, is another indicator of separate manufacture. Of the nature of this find, Larsson (1973) draws no clear conclusions but clearly, the presence of bell discs along with other bronze objects shows that at one stage they existed separate from the lur tubes. Furthermore, close examination carried out in this study revealed no signs of these discs ever having been placed on the bell end of a lur and certainly none of them having had the bell's metal peened over to retain them, Whatever the nature of this deposit, therefore, these discs were probably in transit, having been made but not used.

AN OVERALL APPRAISAL OF THE LURS

There is little doubt that the lurs are PVAs of a sophisticated type deliberately made in pairs, to match acoustically. This they do remarkably well, the written notation for the pairs Brudevaelte 101/2, 105/4, Tellerup 117/8, Folrisdam 124/5 and Maltbaek 128/9 being absolutely identical. In addition to this Brudevaelte 103/4 and 105 match together, producing the tones shown on Figure 4.51. The actual frequencies of these tones are shown below the stave, indicating the very close similarity between all three instruments. (All frequencies in Hz).

SD103	-	77	-	153	234	317	394	477	549	632	700	790
SD104	-	75	-	150	226	307	391	466	550	634	700	794
SD105	-	79	-	153	229	312	409	-	573	-	723	822

Figure 4.: The Notes Produced on the Brudevaelte Lurs

These instruments plus, presumably, Brudevaelte (106) could have performed together with no difficulty, such deficiencies in tuning as exist being readily corrected by lip by an experienced player. The precision with which these instruments were made was most probably, a result of the desire for tuning of pairs and even pairs of pairs. Consequential on the uniformity of conicity on these instruments was the harmonic relationship between their formants. Such is the precision of this, that it seems most unlikely that the instruments were used other than polyphonically. "Wrong" notes played during unison

passages would produce re-enforcement of frequencies in their sound spectrum and, possibly lead to the use of harmonies deliberately produced in this way. The production of a range of notes on these instruments was favoured by the development of mouthpieces to a high degree. Their rim, cup and throat, all combined to produce mouthpieces well suited to the instruments to which they were attached. On the earliest of instruments such as Gullåkra, the facilities for blowing constituted little more than a mouthsupport, as on the Wismar and Teterow horns. This was progressively refined, however, to produce a conical, French-horn type mouthpiece. (Plate 4.8 (a), (b))

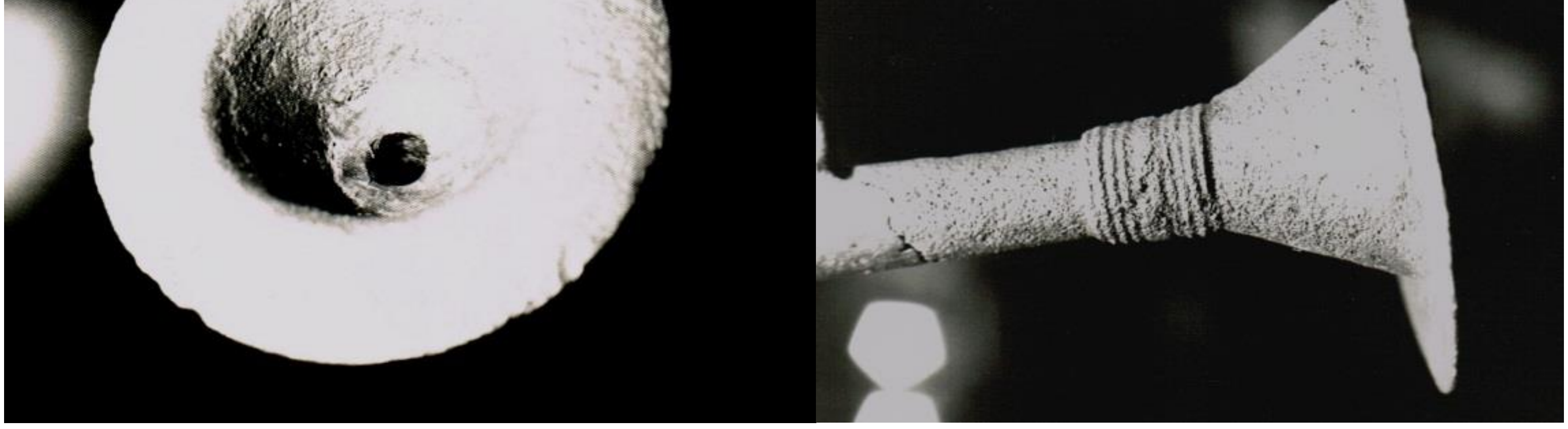


Plate 4.8(a & b): A Typical Conical Lur Mouthpiece

This itself then appears to have yielded to a type with a more spherical cup, the mouthpieces on the latest lurs, being very similar to those seen on modern tenor trombones. (Plate 4.9 (b))

Plate 4.9(b): A Typical More Cup-shaped Lur Mouthpiece

Most of the rock-carvings show instruments played in pairs and frequently in connection with, or on boats. (Plate 4.1(b)) This suggests some form of ritual in which the lurs were blown, perhaps to signal the return of a boat and procession from this to the sacred place. From what the boats return is hard to say but it seems unlikely to have been a raiding party as a pair of lurs would be the last thing to take on one of these. It could well have been a rite of passage probably a men's ceremony carried out at a secret place, away from the women. The return from such an occasion could well call for a solemn procession with the lurs playing their ceremonial part in this. The presence of pendants on the mouthpipes of many lurs points to their use on the move as these provide an ideophone accompaniment. Other workers have identified the dots on rock carvings as stars and suggest a calendrical association with the ritual. Taking place at night, this would certainly be enhanced by the lur's voice.

Tacitus, writing about 100 AD tells of a cult practice of the peoples of this area (Jutland and the Danish Islands) in which Mother Earth (Nerthus) was worshipped. In this spring-time cult, a wagon containing a hidden goddess and drawn by cows would process among the people. From the description, Tacitus seems to be describing a fertility cult held at the re-awakening of the year. (Larsson, 1973, 250) In spite of the 700 years or so that separate Tacitus from the Fogdarp bell discs, such a ritual could well be a survival of the ritual from earlier times, when the lurs were used in such a cult procession.

No lurs have been found in the vicinity of rock-carvings and it has been suggested that these instruments were not made to be seen by other than the initiated. This could account for the burial of many instruments, presumably between one ritual use and the next.

In the case of the Brudevaelte instruments, for instance, the contemporary report of their finding states that "instead of the horns lying in pairs the mouthpieces were found together, and here traces were found that seemed to indicate that same must have been tied together with a triple-braided rope."[186] The pendants on Långlots Norregård instruments were "wrapped up with a band of bast-like material, which is still there, together with fragments of birch bark," (op. cit., 32) and on the mouthpipe of the Maltbaek instrument were found the "remains of a winding of a bast-like material."

It has been suggested the lurs found in such burials were deposited as votive offerings but this seems not to be so. Many were found disarticulated and carefully placed together, frequently where the peaty sub-soil met an underlying clay stratum. This was the case in Stavanger where a pair of lurs were found near the entrance to a natural harbour. Although it is possible that this area was marshy during the Bronze Age there is no other evidence in this area (Rogaland) for votive offerings.

Against this idea of their secret use is the fact that many rock- carvings depict lurs. This could be accounted for by local variation in custom and perhaps change of custom with time. Only on Zeeland do the latest type of lurs appear on rock-carvings, i.e. those with bell discs. It could be, therefore, that only in this area did the ritual permit the uninitiated to see the instruments. If this is so then a further explanation needs to be sought for their burial here - perhaps it was simply a case of protecting them against marauders.

The dimensional analysis of these instruments has shown that they developed as precision products, manufactured with what would appear to be clear organological aims, i.e. the production of harmonically related formants. For the user to formulate this design requirement, he would need to be a sophisticated performer and hence, to practice on the instrument. Many features serve to re-enforce this view, from the development of mouthpieces to the uniform conicity of the instrument tubes. The lurs, therefore, must appear to the modern performer as instruments not only made to be played but made to be played well. They seem almost as far-removed from simple ritual sound producers as one could imagine. When their performance involved the use of pairs of instruments, this would call for serious and concentrated practice of the performers. Such a pattern of usage would hardly include a period of burial of the instrument as the users of these would, most likely be specialised in this role and, hence feel that they had a distinct proprietorial interest in them.

It is clear that a school of craftsmen developed manufacturing technology very specific to these instruments which was capable of production to a close tolerance. In the process of this they appear to have adopted or developed such features as the plane surface, the lathe, the straight edge or the technique of using a taut wire/cord and spacer to form a straight edge. Whatever the techniques used, they were deliberate, with a deliberate aim. What has been lacking in this study is information on tube wall thickness as no equipment was available to measure this. This situation may well have changed now, as ultrasonic inspection equipment now appears to be available to measure this to the required

[186] Broholm, 1947, 16.

accuracy. The value of this information is clearly considerable as measures of the outer diameter of a tube-wall contains error both from the out-of-roundness of the core and from errors in wax sheet thickness. Values of wall thickness would enable these errors to be separated and valuable - information on manufacturing techniques to be deduced.

The span of usage of the lurs is variously quoted, generally being considered to be between 1500 and 500BC. However, no lurs have been found in contexts that allow precise datings, although the Fogdarp find gives some indication of a date. These discs are dated by Larsson[187] to Period V which by comparison with other recent datings he identifies as between 900 and 600BC. Many questions remain to be answered about the relative chronology of the lurs, however, in particular with respect to the rate of their development from simple forms such as Gullåkra to the complex Zeeland Group. Conventional dating would suggest that this process took some 500 years or so and was, thus a very slow developmental process. However, it has been suggested here that developments that took place with the later instruments were deliberate and resulted from directed effort by the maker or user. If this were so, then the time-scale for significant development could be of the order of a lifetime and hence, much more rapid than conventional dating would allow. Just when development changed its pace from serendipitously-sourced change to change of a deliberate nature is hard to determine but it could well be that for the majority of years during which development took place it was only chance development. If this is so, it is hard to see why so little remains of the early material unless this was scrupulously recycled as a scarce commodity, all bronze being imported from the South. Thus, the lurs may have existed for the thousand or so years generally suggested but with development proceeding at an exponential pace with the Zeeland group developing in only a generation or so from earlier instruments.

Among the remarkable features of this group, is the dimensional stability of their form. It is clear that more than visual perception was used to store the information and it seems likely that units of measurement were used as a basis for these standards. Much more work must be done on the lurs to investigate this phenomenon, if they ever become available for study again.

Quite dramatically, at the end of the Bronze Age the lurs ceased to be made. Instruments from this area during the Iron Age utilise the animal horn in their construction. One of these, SD249 from Stenstugan is made from an animal horn with wrought fittings and appears to lack a developed mouthpiece. The other two instruments, SD271 from Konsterud and SD272 from Sandbacksmyen, are both cowhorns with integral mouthpieces and five and four finger-holes respectively. All three instruments represent a considerable change from the tradition that led to manufacture and use of the lurs.

Many factors could have led to the demise of the lurs and it is hard to assign orders of importance to these. Above all, however, the lurs were cult objects and changes in the cult could well have brought about a lack of demand for their use, or perhaps even a prohibition. More prosaically, a lack of bronze, the basic raw material of the lurs, could have brought about a scarcity of instruments and, hence, an accommodation in the ritual

[187] Larsson (1973, 169 ff.

to suit. At their peak, during the time of the Zeeland group, the lurs had a very stable and consistently made form and this manufacture could well have been carried out by a small group of smiths on the north of this island. They would have developed and refined the manufacturing technology, passing it on from father to son. ln this way, the development could proceed rapidly but was very liable to be upset by any development which disrupted this group. Any attack from outside, in destroying this school of manufacture could, in effect, destroy the Zeeland group. Perhaps the group of six lurs found at Brudevaelte (SD101 - 6) represent the attempt to preserve these in the final stages of this group's manufacturing activity.

Whatever happened, by the close of the Bronze-Age, lurs were no longer made in Scandinavia and, presumably, no longer used. The death of the cult may have required the burial of the sacred instruments, perhaps in some form of ritual, preserving for us a sample of the latest of the line. Scandinavia then settled down to producing simpler finger-hole horns which offered the potential for melodic performance and were similar to those still made today in that area.

CHAPTER 5

The Irish Horns

During the Late Bronze Age in Ireland, a remarkable school of instrumental performance existed. It was supported by an equally remarkable school of manufacturer which produced instruments for the players and, over a period of time developed manufacturing techniques which enabled these instruments to be made to deliberate designs with considerable repeatability. A unique feature of these instruments is the presence of both side and end-blown instruments which, from their overall design and manufacture, are clearly from the same school of manufacture and made to be played together. (Plate. 5.29). From both organological and technological points of view this feature has important ramifications.

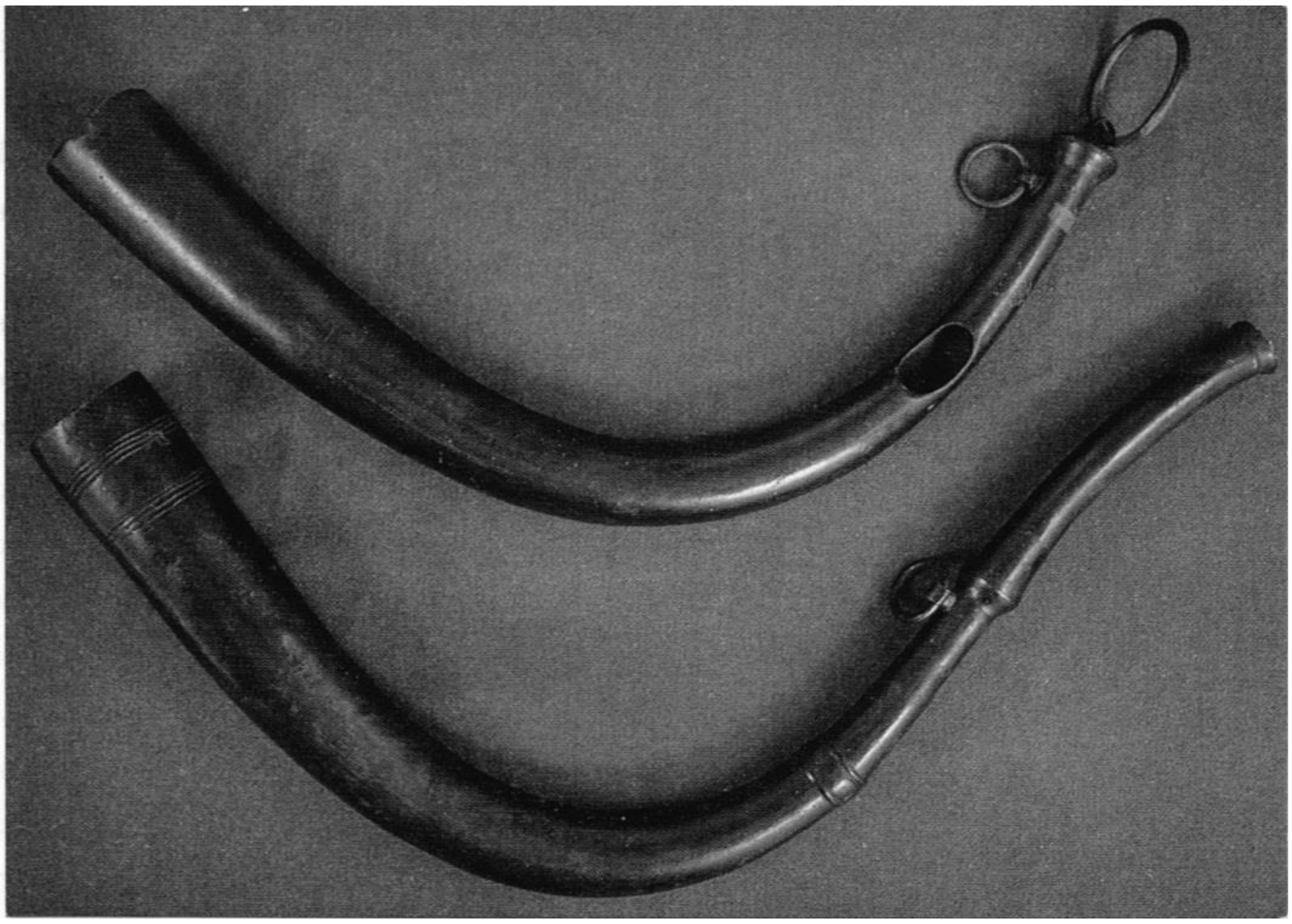


Plate 5.29: The Drumbest Pair of Horns
This plate has been moved forward for convenience

The instruments have been studied for over 110 years, first being listed by Coffey in 1860, to be followed in 1881 by Evans and in 1945 by MacWhite. Most recently they have been studied by John Coles in 1963 who outlined the previous classifications and dating by these authors[188], and provided a comprehensive catalogue of all instruments known to that date[189] In addition, in his paper, Coles proposes a typology which is considerably simpler than those of Coffey and Macwhite and when related to the geographical spread of the instruments, shows a most convincing divergence between his type I and type II instruments.[190] This distribution map shows all the type I horns to have been found either in the northeast of the island or at Dowris, while all but one of the Type II instruments are found in the southwest or at Dowris.

Class I side-blown horns are generally of a smooth appearance and those with decoration have ribs or domes of low profile and incised or slightly raised ribs, grooves or zigzags. Their tip form runs smoothly into that of the horn body, sometimes having a somewhat spherical knob and sometimes a flared termination. Generally, two carrying features are present, frequently typical Late Bronze Age loops, one at the instrument tip and one between this and the blowing aperture. Some instruments, however, lack the tip loop and others have ring mounts added to the tube and tip, frequently with a ring still in the mount.

Class I end-blown instruments are generally similar in decoration to the side-blown ones and similarly have loops. Tubes of this type generally terminate in a female aperture and the bells in the corresponding male protrusion.

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188 Coles, 1963, pp. 326 ff
189 Coles, 1963, pp. 349 ff
190 Coles, 1963, Fig. 3).

Class II side-blown horns are, as a group larger than their class I counterparts and terminate in a large conical feature at their tip. Their mounting features are generally added to tip and tube (as Class I), often still retaining the rings fed through these. At the bell end, conical spikes decorate the tube and holes, usually four, are spaced around their periphery.

MANUFACTURE OF THE HORNS

Practically all the Irish horns retain evidence of having been made in two part-moulds with a core to define the form of the instrument's bore. Thus, their manufacture would have involved the construction of two separate halves of a mould - the cope and the drag - and a centrally located core to form the bore. (See Figure. 5.1).

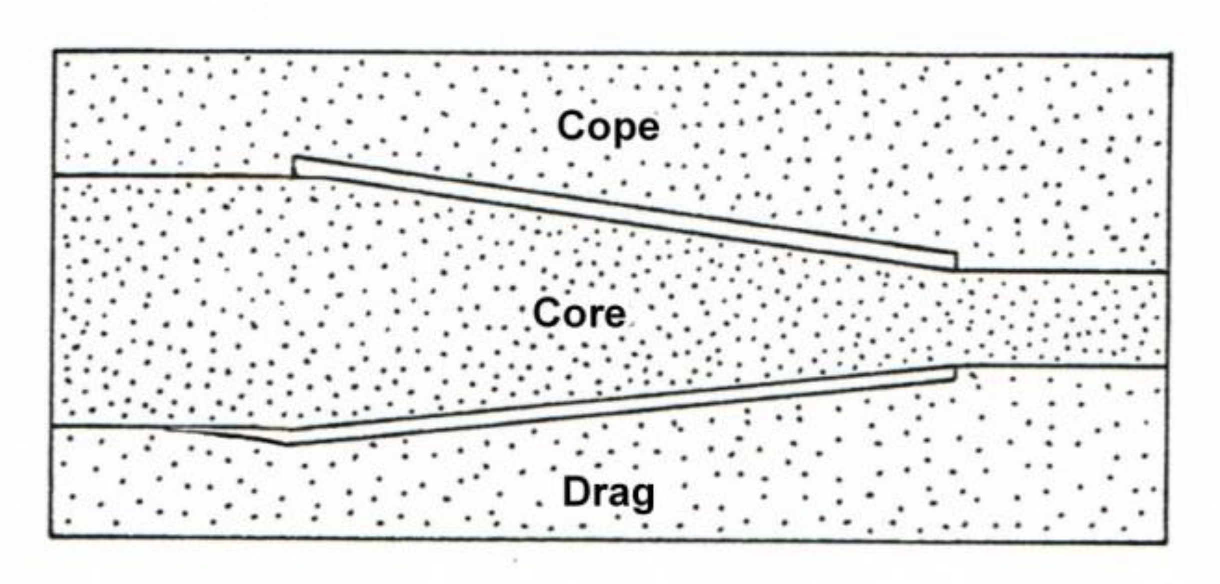


Figure 5.1: The General Layout of a Mould and Core

Most of the extant material has clear joint lines either as cleaned-up remnants of the flashlines or as featured decorative lines along the joint lines of the mould. Some instruments, presumably those which had developed faults in the casting operation, were not finished and still retain this extensive flash along the joint-line (See Plate 5.1(a) and 5.1(b) and Plate 5.2(b))

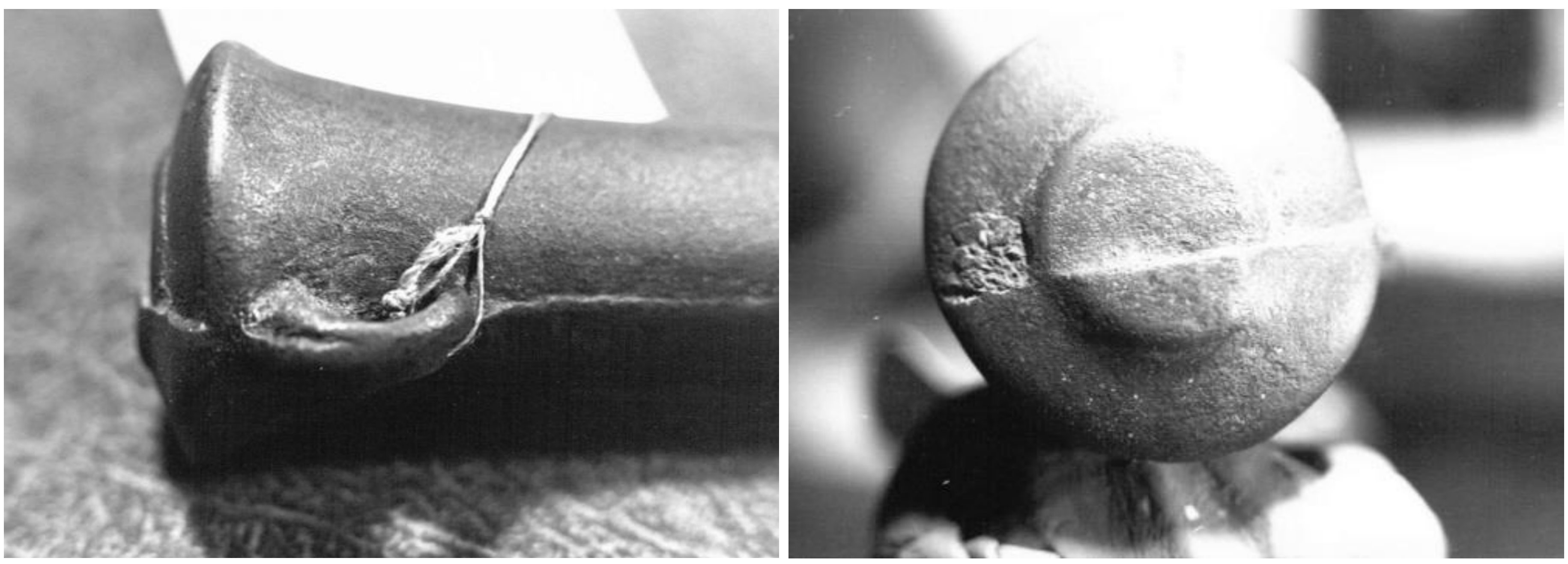


Plate 5.1 (a) & (b))

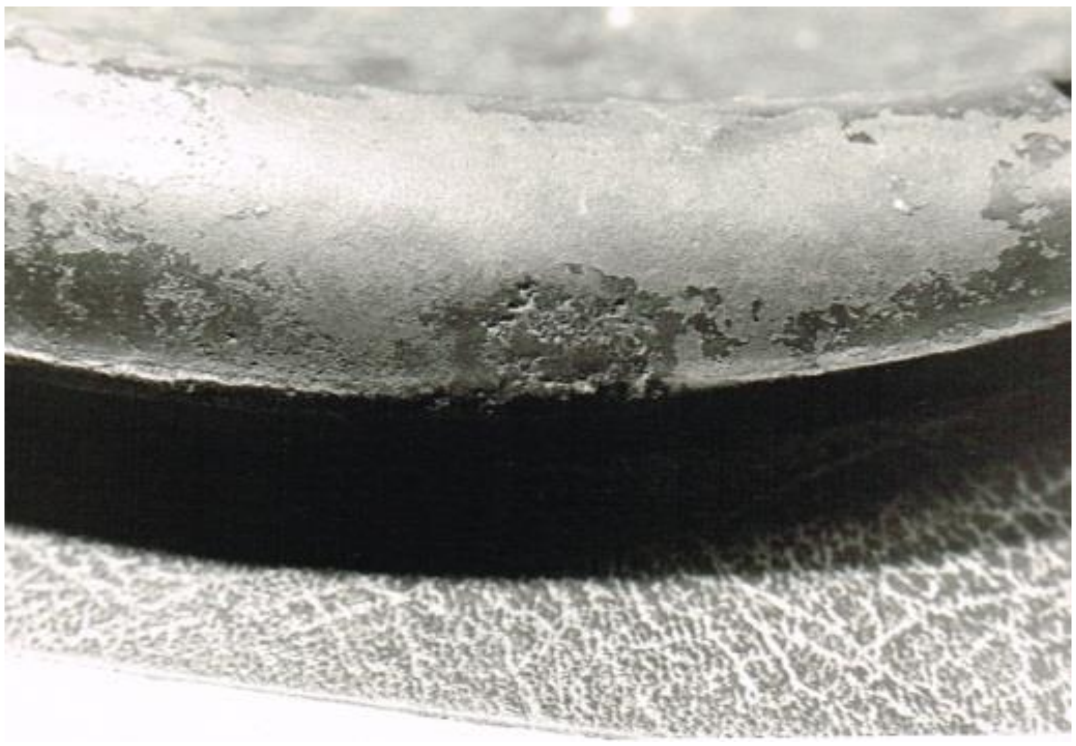


Plate 5.2(b)

Some instruments such as Dowris (14O) have flash remaining on the end face of the bell, where the metal has flowed between the male and female core prints during casting. This evidence suggests that, in this case, the core prints were the same diameter as the bell-mouth bore.[191]

When using two—part moulds accurate registration of the cope and drag is essential in both longitudinal and lateral directions. Many instruments display faults due to poor registration to some degree as illustrated below in Figure 5.2.

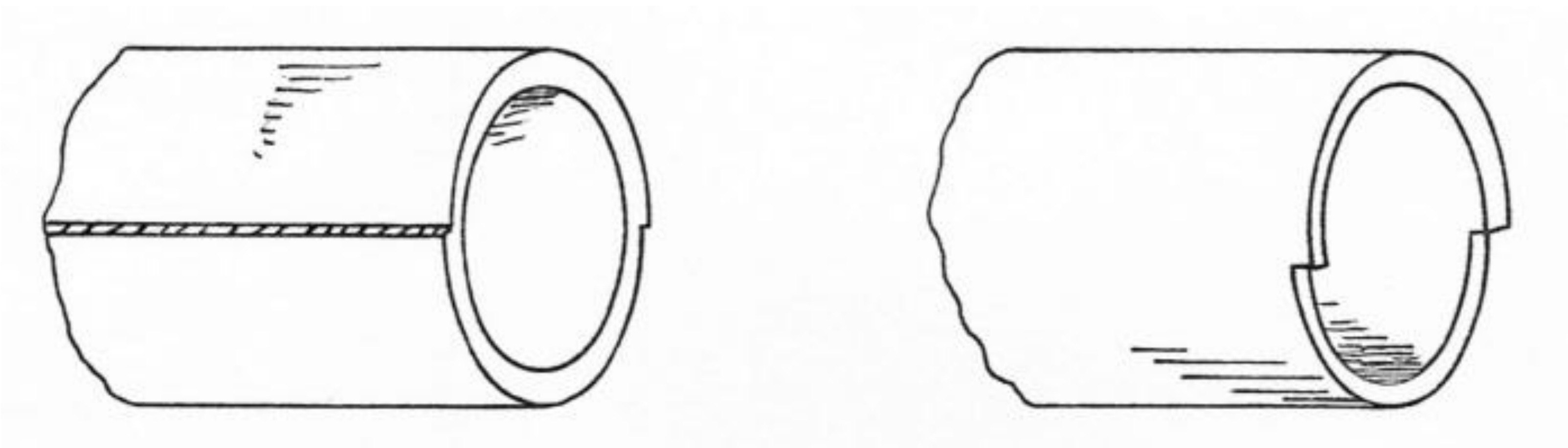


Figure 5.2a and 5.2b: Registration Errors in a Finished Casting

In (a) the fault due to poor lateral registration is shown while the fault due to poor longitudinal registration is illustrated in (b) that Such errors are seen on SD14E, 14G, 31), (See Plate. 5.1a and 5.1b (above); Plate 5.10 a, (below).

Even when accurate registration of the cope and drag has been achieved any radius or chamfer on the mould edges gives rise to a raised joint line. On some instruments this has been abraded away but on others the feature has been deliberately emphasised for its decorative effect. (See Plate. 5.2a.) It may also have been realised that this decorative feature down the length of the instrument also served to disguise poor lateral registration when it occurred.

[191] Coles, 1963, pl. XXXI (upper).

Plate 5.2(a): Chaplets, Carrying Rings and Casting Seams

A wide range of materials is used today to manufacture moulds and cores for casting but the evidence from Ireland in the Bronze Age seems to suggest that clay with or without admixture was the major constructional material. No moulds or fragments have been found which can be identified with the manufacture of horns but several are known that have been used to cast swords, axes and other such items. These mould fragments suggest that two-part mould casting was widespread in the highland parts of the U.K. and Ireland and contrasted with the extensive use of lost-wax casting in central, lowland, Britain and right throughout Europe.[192] The major application of the two part mould technique in this latter area was in the use of gravity die-casting with re-usable moulds of bronze which were built up with a core and header [193]

Evidence of the material used for the cores of instruments is obtainable from those horns that have blind ends, i.e., the side-blown types, where the casting core has been left in-situ following casting, and, to some extent, in the material adhering to the inner walls of the instrument, where the manufacturer was unable to remove this. (Plate. 5.3 (a))

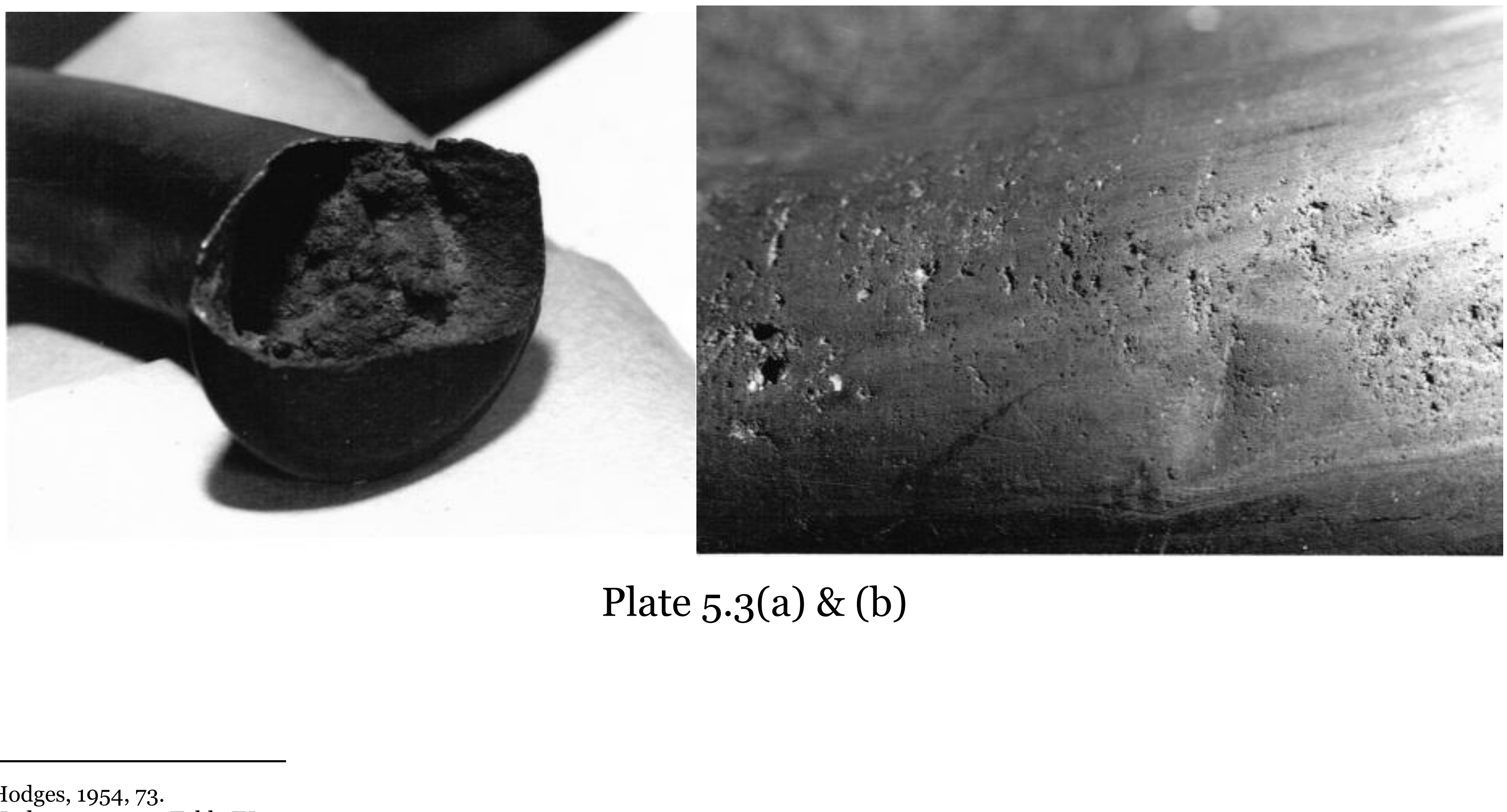


Plate 5.3(a) & (b)

[192] Hodges, 1954, 73.
[193] Hodges, 1954, 72, Table IV.

In its simplest form, this type of casting requires three parts to produce an instrument: two mould halves; top = cope, bottom = drag, and core. (Figure 5.1) Once made, these would need to be spigotted together so that registration errors were avoided and the core was held in place by the fit between its prints and the cavity formed by the assembled cope and drag. This mould assembly would then need to be fixed rigidly and the cope weighted down while pouring so that the metal could be poured in and allowed to fill the mould cavity, Several instruments (e.g. SD29C) have inhomogeneities in casting quality which differ from one side of the joint-line to the other. On this instrument the obverse side (see appendix IV for definition of terms) has several areas where the casting has failed, with holes in the tube wall and areas of sluggish metal flow while its other side is relatively free from defect. (Plate. 5.3b)

This evidence suggests that the mould was actually poured while horizontal and filled up progressively along a horizontal line, leaving defects aligned to this. Other evidence also strengthens this view such as the non-supported chaplets seen in instruments SD14M, 36B, and 40. These are simply irregular shaped pieces of metal, presumably broken off from earlier castings, which, when present as chaplets in tubes, lie flush with both outer and inner tube walls. Thus, during casting these were simply trapped between the core and mould and on those occasions when they were not held firmly by the mould/core surfaces were able to fall out of position. On 14M, one chaplet which was not adequately trapped slipped out of position to become trapped on the mould joint-line where it remained during casting. Another chaplet, which was considerably thinner than the mould/core gap remained in position as it had been placed on what was presumably the mould drag, being held there by gravity. On casting, this produced a thinner section at this point. See Figure 5.3. Had this mould assembly been stood vertically this chaplet would clearly have moved from this position.

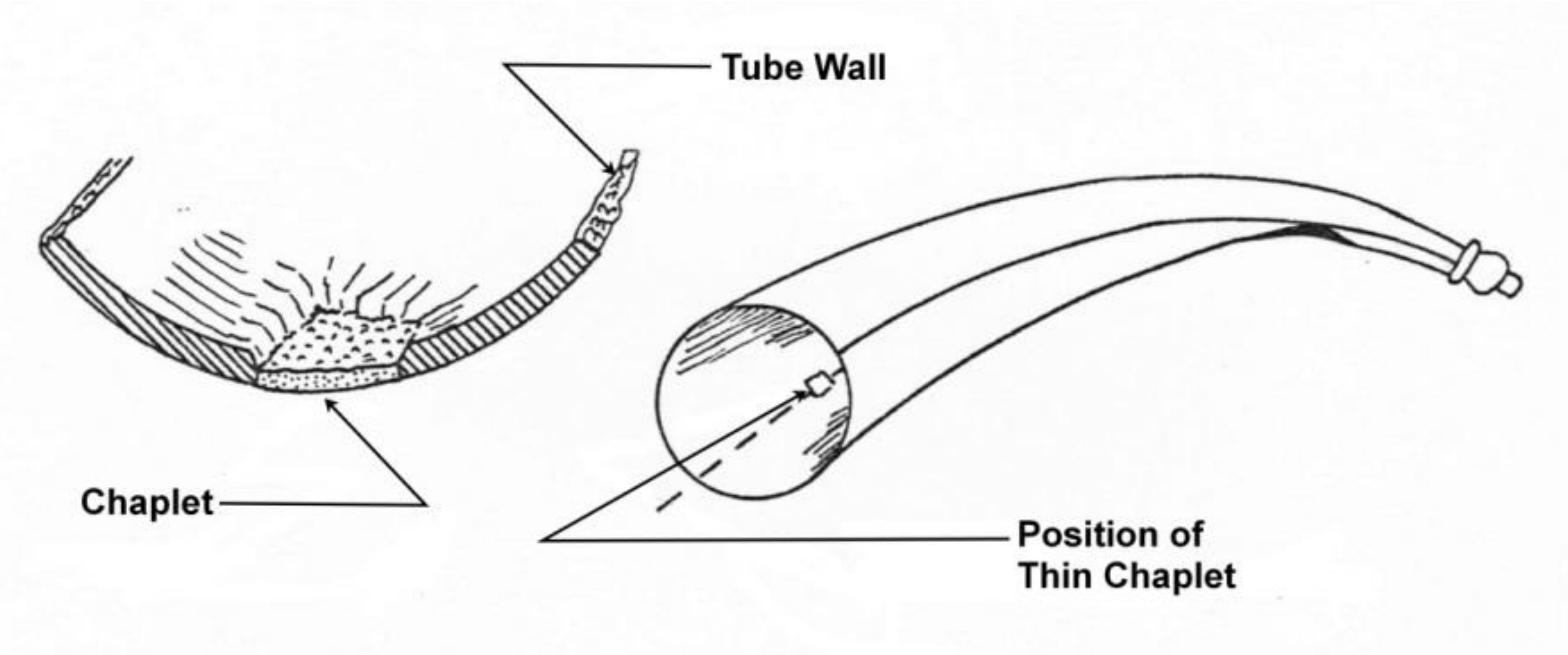


Figure 5.3 Surface Chaplets in a Tube Wall

The most common section failure on these instruments is along a line at right-angles to the joint-line and along the central part of the curved surface. See Figure 5.4. This is consistent with core rotation resulting from failure of the core prints to restrain this adequately. Again, such rotation would occur with gravity acting upon the mould when in a horizontal plane.

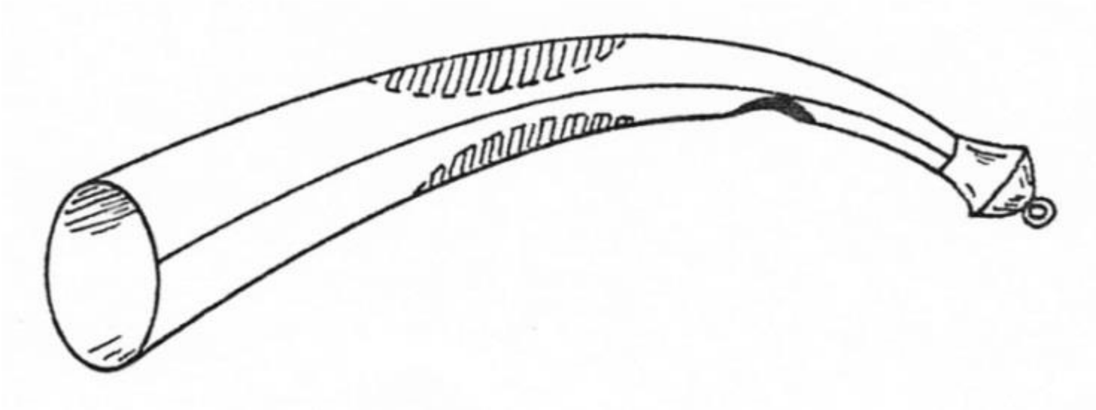


Figure 5.4: Areas where Castings Show Thin Sections

If instruments were cast in a vertical position then the core would have to be supported on the mould at some point, i.e. either at the tip or bell-ends. The evidence (discussed below) suggests pouring from the bell-end and, hence, this support would need to be from the tip. Thus, in the case of side-blown instruments a support of some form would need to be provided and should now be visible on the tips of these instruments. Only one specimen has such a possible feature (SD 36A) but this is problematic and is overwhelmed by the negative evidence of all the other instruments. In addition, those side-blown instruments which are fractured through their tips show no signs of sprues at this point and, in the case of those with tip loops would be difficult to sprue at this point. Hence, while many of the above factors are specific to side-blown instruments it also seems unlikely that the maker would develop two different casting procedures for side and end-blown instruments.

Runners would obviously be necessary to provide an entry for pouring the molten metal into the mould cavity and modern casting practice also utilises risers which act as vents, allowing the air and other gases inside the mould to be expelled as the metal enters. Lacking actual examples of moulds in a recognisably complete state, there is no evidence to suggest that runners and risers were used. Neither is it justifiable to assume their use as Coghlan did, when carrying out the experiment he reported [194].

Experiments carried out in the course of the present study suggest that the problem of gas entrapment may be less severe when using clay moulds than with modern moulding materials. Having formed a cavity in the two halves of the mould, these must be left for a week or so to dry and then may be subjected to further heating. During these processes water evaporates from the clay and then chemical recombination will occur if the material is heated strongly enough. Both these processes involve a decrease in volume of the clay which in a mass of material of complex form occurs in a complex way. The result is warpage partly caused by the complex shrinkage process and also possibly by inhomogeneity in the makeup of the clay mixture itself. Thus, the joint surfaces which previously mated accurately do not necessarily do so after drying and heating.

[194] Coghlan, 1951, 56.

On the experimental castings produced in clay moulds for this study, a considerable flash-line was obtained which indicated that flow of metal and hence, of air had been possible between the two parts of the mould, allowing the air to escape from the mould and preventing miscasting.[195] A further possibility for the escape of casting gases would be presented by an air exit path between the core print and mould surfaces were the end-faces of the print to be open to atmosphere as suggested in Figure 5.1. On instrument 14O, for instance, the bell terminates in a clear rim of the same form as the featured joint-line. However, this bell rim is not straight or normal to the axis and is bounded at the down-stream end by a continuation of the tube diameter. See Figure 5.5. For the metal to flow into this zone the gas pressure must have been low, possibly atmospheric, suggesting that a, perhaps unintentional, gas vent existed at this point.

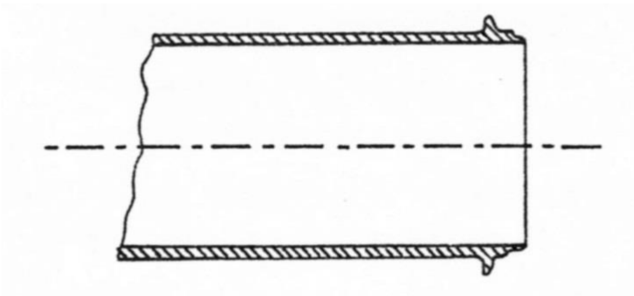


Figure: 5.5: A Bell-end Cross-Section

Shrinkage of the mould material can be reduced to some extent by mixing sand and/or grog (previously-fired clay) with the clay used to make the mould. However, as sand is added to the clay, it becomes less plastic, i.e. harder to mould and more coarse-grained, i.e. less able to reproduce detail from the pattern, or to be worked by hand to fine detail. The sand does increase the porosity of the clay mixture somewhat as the clay constituent shrinks away from the sand to leave voids. It does not, however, necessarily increase the permeability of the material which is the desired property if air entrapment is to be avoided.

Another admixture used in moulding materials is finely comminuted organic material. This has been obtained in the past from animal manure as this contains finely ground-up plant parts as well as longer strands of hay/straw etc. on drying, the smaller organic parts shrink leaving voids, thus increasing the porosity of the mixture. Longer organic strands similarly shrink, but, because of their length and larger cross-section tend to bind the clay matrix together while in the green state. However, if the mould is subsequently subjected to a degree of heat that will carbonise or even burn away this organic material, (c. 900°C) the porosity is increased by the removal of the fine material and the permeability by that of the coarse. In all cases of admixture, the passage for air to escape through the mould is likely to be far less than that provided by the poor fit of the mould halves.

On the clay moulds found both in Ireland and the U.K., the metal-contact surfaces are generally coated with a layer of fine clay. This enables a better surface finish to be obtained on the surface of the casting and finer detail to be reproduced. However, this layer is critical in terms of mould permeability as it effectively seals off the outer layers of the

[195] Curle, 1932, 120.

mould with a fine impervious clay. Thus, if such a layer is used, and remains intact during the casting process, it negates attempts to provide a path for air by use of a porous or permeable mould material.

A further treatment is visible on some of the mould fragments from Jarlshof in Shetland. These have had the casting surfaces painted over with a black coating, which according to Curle[196] was probably composed of "a fine clay slip mixed with soot." Such a coating would serve to produce a smooth surface on the mould as well as forming a release surface. Modern casting practice utilises similar release agents to ensure clean release of the casting from the mould.

MANUFACTURE OF THE COPE AND DRAG

The two mould halves require a female impression of the horn outer surface to be produced on their mating face. This can be done by carving the form out from a block of clay or by using a pattern which is pressed into the two mating blocks. Several problems arise in the former case as with a large object which has a thin wall-section accurate registration of the two mould halves and the core is absolutely essential. If the wall thickness is 1 mm, for instance, an inaccuracy in registration in the two mould halves of the core of only 1 mm could result in the complete loss of wall section at some point. Added to this is the fact that it is more difficult to produce the required shape in mirror image, particularly as this is female in form. It is not possible to fully utilise parallax effects to judge roundness, depth etc. when the surfaces involved are sunk below the joint-line. In addition to this, each new mould comes out different from the last and, thus, precludes steady development towards a uniform product. It is, of course, not impossible to manufacture an instrument in this way but it seems likely that a maker would tend to follow the pattern method were he to make more than one instrument to one specific design.

The use of wooden patterns for the production of moulds is known from Ireland[197] both from the existence of patterns themselves and from surface texture on castings which reproduce the grain of the wooden patterns used to make the mould. It seems reasonable, therefore, to propose that patterns were used to produce the complex moulds needed for these horns. The only evidence which exists for their use is on some side-blown instruments which lack tip rings. (SD14 O, 17A, 36A). On these, the instrument tip is moderately round (Plate. 5.1b, above and Plate 5.4a, below) but the joint line cuts this circle into two very unequal parts.

[196] Curle, 1932, 119.
[197] Hodges, 1954, 64 ff.

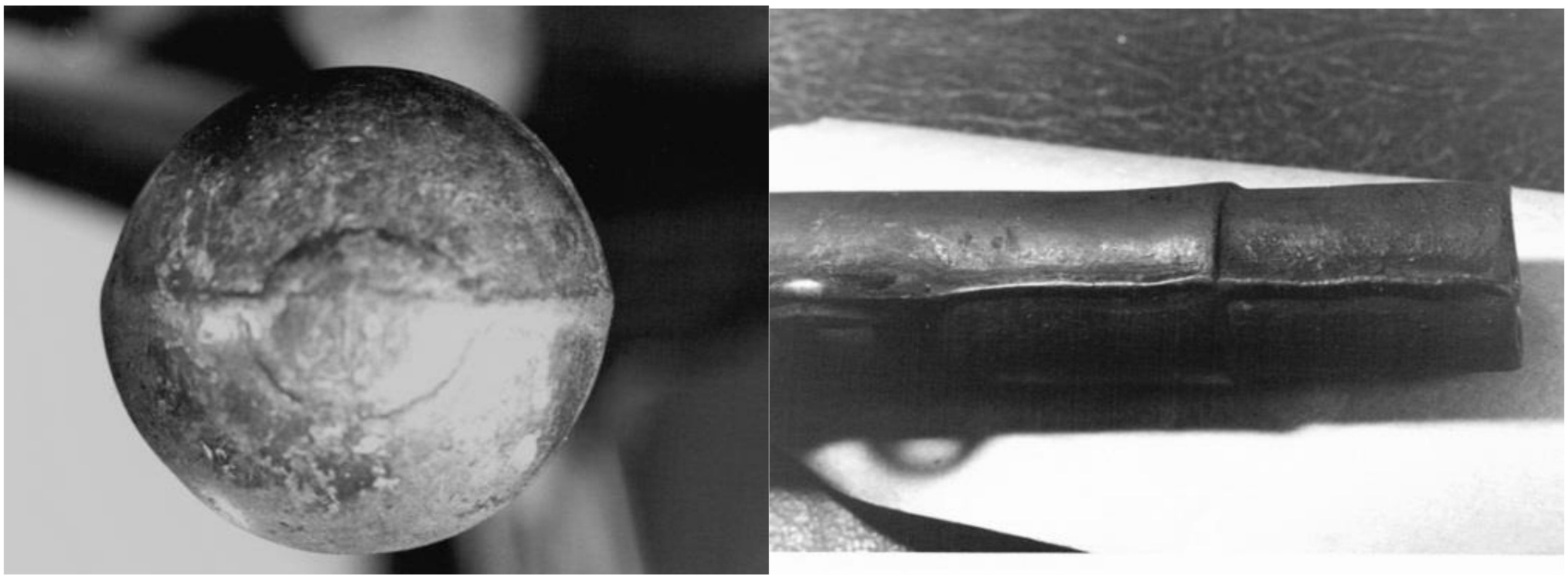


Plate 5.4 (a) & 5.4(b)

From this it would appear that the pattern was impressed into the second mould half while seated in the first presumably the deeper one. (The high degree of mould/core registration on instrument 14O is discussed below). What form the pattern took it is not possible to say. Indeed, at the time when these instruments were first made an existing instrument may well have been used to make the moulds for new instruments. Were this to be done too often, however, the maker would soon become aware of the decreasing size of his product and produce a standard from which to replicate.

The pattern used did clearly not contain all the features that were formed on the mould prior to firing. On instrument 14G, for instance, the smooth flow of the tube into the tip is broken by a step, in contrast to the design of all other such instruments. It appears in this case as if the major mould cavity was made with one pattern and the tip cavity formed by means of a second small pattern. Perhaps the tip end had been broken off the original pattern and a second pattern made to form the tip. Clearly had this piece of mould been hollowed out by hand, a smooth line into the tube form could readily have been generated.

On some instruments on which the joint-line is featured as a decorative element this is clearly not straight but undulates while maintaining a relatively constant thickness. (e.g. 14J, Plate 5.4 b, above and Plate 5.5a)

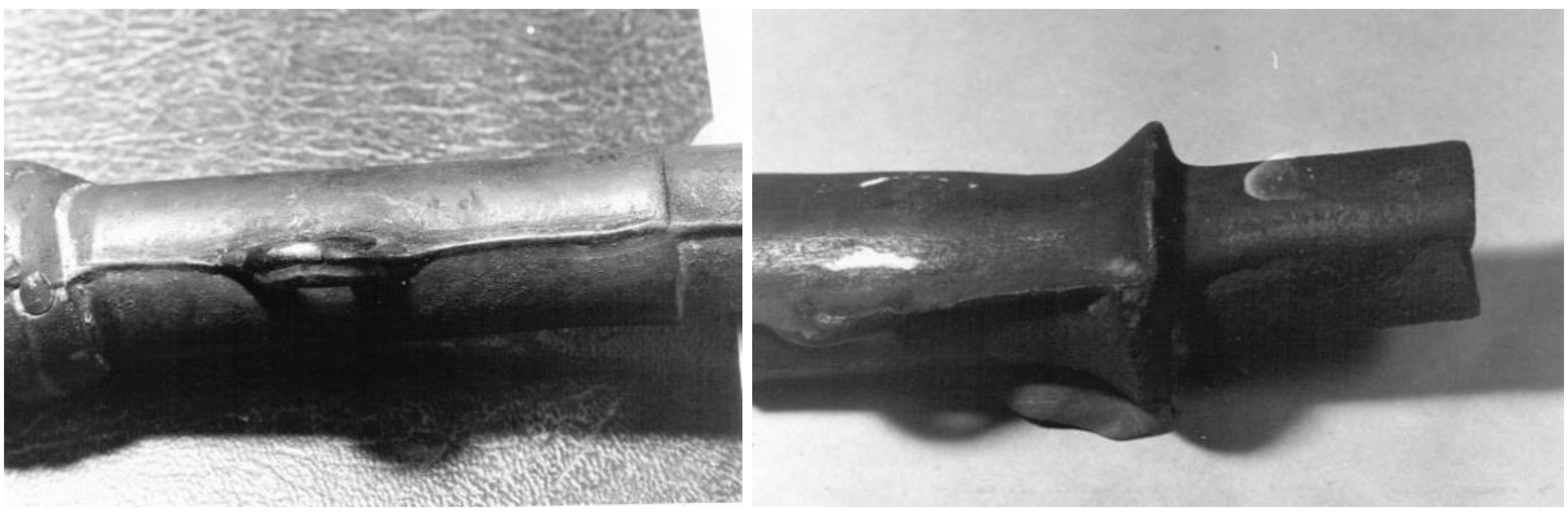


Plate 5.5(a) & 5.5(b)

This also points to the use of a pattern as, were such an undulating line to be produced independently on separate mould halves it would be highly likely that the joint-line would vary greatly in thickness. However, registration of the cope and drag would be considerably assisted by the interlocking of these two mould surfaces.

If as suggested below, a side-blow and end-blow instrument constitute a pair, the maker would be required to produce instruments in pairs. He could have done this by producing a pattern for one type of instrument and modifying this to form the mould for the other. This seems to have been done on SD4A, 37B, 39 and 14J, (Plate 5.5 b, above), the first three of these having cone-shaped features typical of the tip of a side-blown instrument but extended to form a parallel projection. In the case of SD39 this projection is quite clearly added oblique to the rest of the tube, its parallel portion having a distinctly-different surface-finish. Similarly, the surface-finish of the projection on 14J differs from the smooth surface of the remainder of the instrument, having a polygonal form made up from series of axial markings probably from tooling out the clay mould at this point. This part is integral with the remainder of the tube as the joint-line passes uninterrupted from one surface to the other.

Perhaps other end-blown instruments were produced by means of separate patterns for the instrument body and its tip end, as suggested above for 14G. If done skillfully, and the small pattern cavity blended in smoothly, no evidence need remain for this having been done. Having produced a suitable pattern for a particular instrument, a mould can be made from this. The process is not simply one of pressing the pattern into the mould material, however, as this does not flow readily to allow the incursion of the pattern. Rather, the mould material must be removed progressively while offering the pattern up to it, until the cavity is sufficient to allow the pattern to enter up to its centre-line. The pattern, thus serves only to shape the detail of the mould, the bulk of the cavity being excavated separately. The mould material can be made softer and, hence, more mobile by adding water but this is effective only to a limited degree as, when very wet, the clay becomes sticky and adheres to the pattern, preventing its removal. In fact between the dry powder form and that of suspension (clay slip) clay presents a whole series of faces. It is understanding of these that enables one to work it accurately, for instance, knowing when it is too dry to make additions that will integrate onto the surface and when it is too wet to have the necessary strength to prevent warping of the joint-line when the mould halves are handled independently.

It is quite clear that the use of two-piece moulds made of clay required a deep understanding of clays and clay mixtures quite as deep as but different in content from that required in lost-wax casting using clay. Indeed, Hodges[198] comments on the ability of the mould maker to refine his clay to a higher degree than the pottery maker of the time, but the potter created an object from a homogeneous mass whose shrinkage on drying would not impair its function. Furthermore, the actual degree to which it shrunk and, to some extent the distortion of the original form were both immaterial to the maker. In contrast, the moulder used clay as an engineering material. He made several parts which,

[198] Hodges 1954, 63, footnote.

when dry, had to fit together and required an awareness of shrinkage rates. From these parts, he expected a performance to suit their specific use in the mould. Thus, it is not surprising that the mould maker experienced a more intimate relationship with his working material and, most probably understood it better than his contemporary craftsman, the potter.

Having formed the basic shape of the horn in the mould, and repaired where necessary, many details were then added. These are principally features which could not readily be formed on the pattern or would prevent its removal from the mould.

The most obvious features added were the decorative spikes present on later instruments. If incorporated on the pattern these would prevent its removal from the mould by creating re-entrants. Figure 5.6).

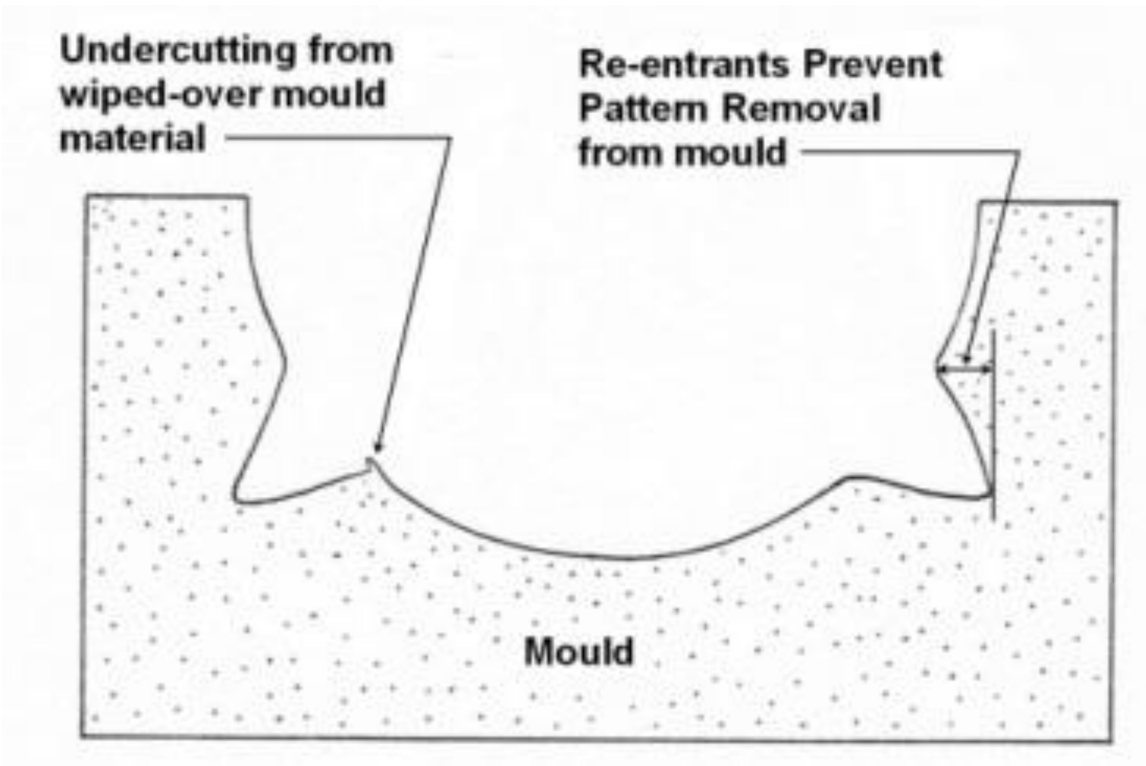


Figure 5.6: The Re-entrant Nature of Spikes

These spikes were probably produced by pressing a separate small pattern into the mould to form the required cavity. Undoubtedly the use of small formers would tend to distort the adjacent portion of mould and this would then be cleaned up or perhaps radiused in. In one case on SD7B the mould was wiped over for some reason, forming an overlap that subsequently left an undercut at the base of the spike. (Figure 5.6, above)

Three instruments (SD7F, 31 and 37B) have circumferential bands towards the bell end which were produced by removing rings of material from the mould surface. On SD31, the resultant cast raised bands are interrupted, on the inner and outer curves of the instrument, by a casting joint-line, indicating that they were developed on the mould prior to casting. On SD36A, three groups of bands were cut into the mould to form a bell decoration but between two of the groups a zigzag decoration was cut into the metal of the horn itself. It may have been that the maker saw the difference between an incised and a raised decoration as significant but it seems more likely that the difficulty of cutting this evenly on a female curve was too great.

Two instruments from Corracanvy (4B and 4C) have rope moulding cast integrally or cast-on around their bell. (Plate 5.6a)

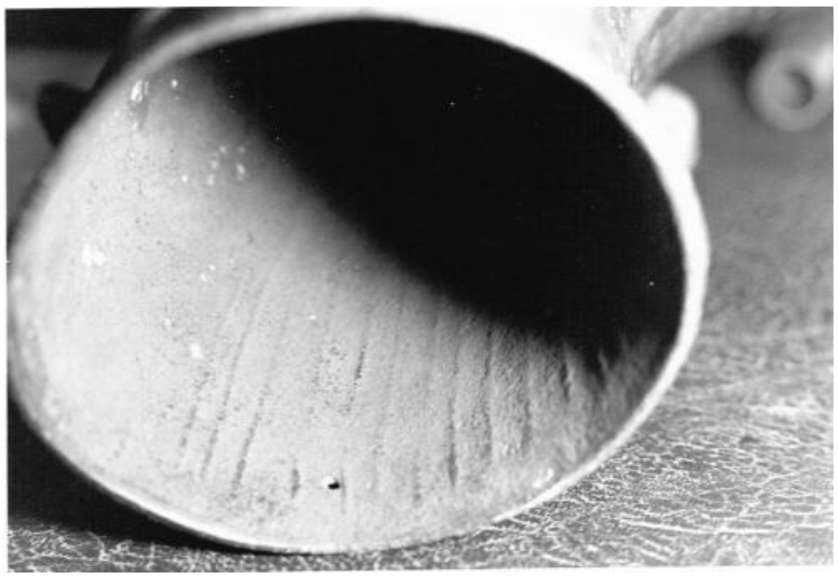
 

Plate 5.6(a) & (b)

The decoration is a true twisted decoration and was made by impressing a twisted string or wire into the wet clay mould. On 4B unwinding of the individual strands of the forming medium is visible while on 4C some 5*mm* of longitudinal mould offset shows the decoration to have been applied on the mould.

MANUFACTURE OF THE CORE

Following the manufacture of the mould, the core would need to be produced to suit this. Modern practice would utilise a core box which forms a core to the required dimension but no evidence exists for such a practice on these instruments. Cores can, of course, be hand formed and, subsequently worked to fit the mould, giving the required casting wall thickness. The limitation on this technique is imposed by requirement of wall thickness for, as the wall becomes thinner, it becomes increasingly difficult to manufacture a core which is both curved and round, to fit a mould to the required accuracy. Thus, as the trend towards thinner wall sections proceeded, i.e. towards lighter, more economical instruments, a technique was sought to produce accurate cores. This seems to have utilised the mould as a core-box to form the core, similar in some respects to the technique used to make cores for gravity die-casting of axes. However, if a core was pressed into a mould of dry-green clay this would rapidly absorb moisture from the mould and, hence, stick to it. This would suggest that the moulds themselves were actually fired so that at least their surface had been changed to ceramic and the danger of adhesion removed.

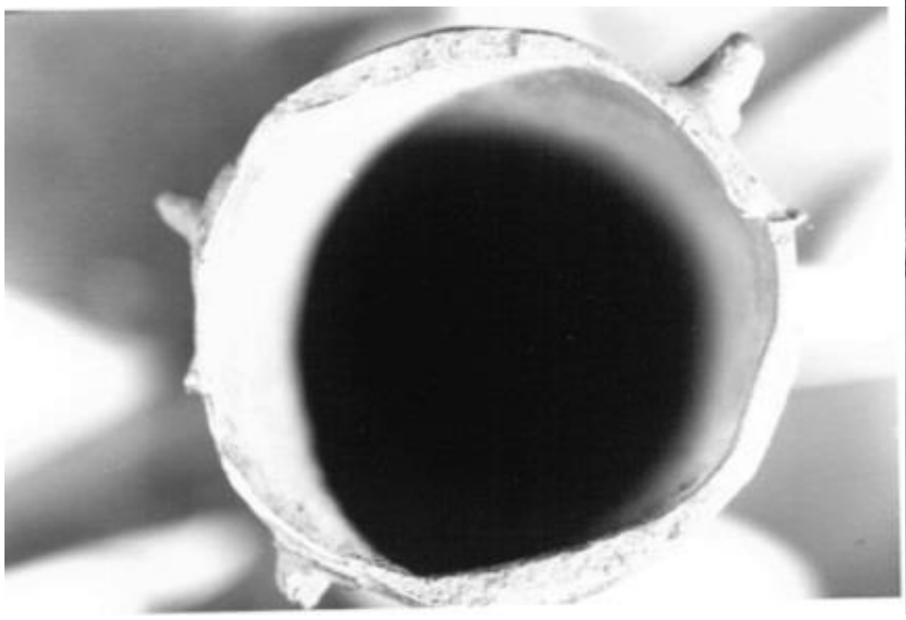
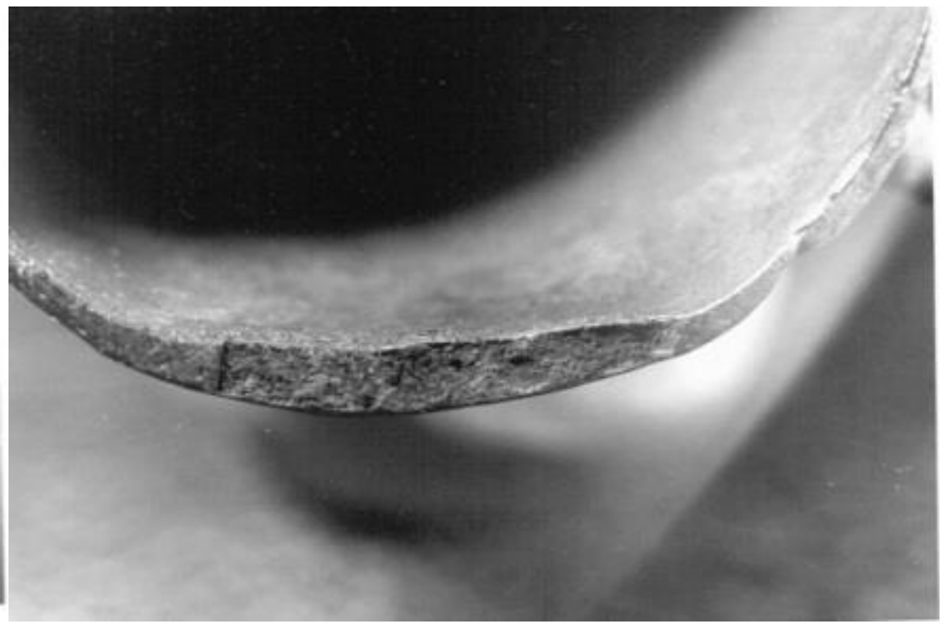



Plate 5.7a and Plate 5.7b

The evidence for use of the mould exists on tubes such as SD6C, 7D and 17B where features on the outer surface of the instrument are replicated in the bore i.e. tending towards the production of a constant wall thickness. On other instruments it is seen as hollowing underneath integrally cast spikes principally at the bell-mouth, these being more visible at this point. (Instruments SD13, 22B) (Plate. 5.8a).

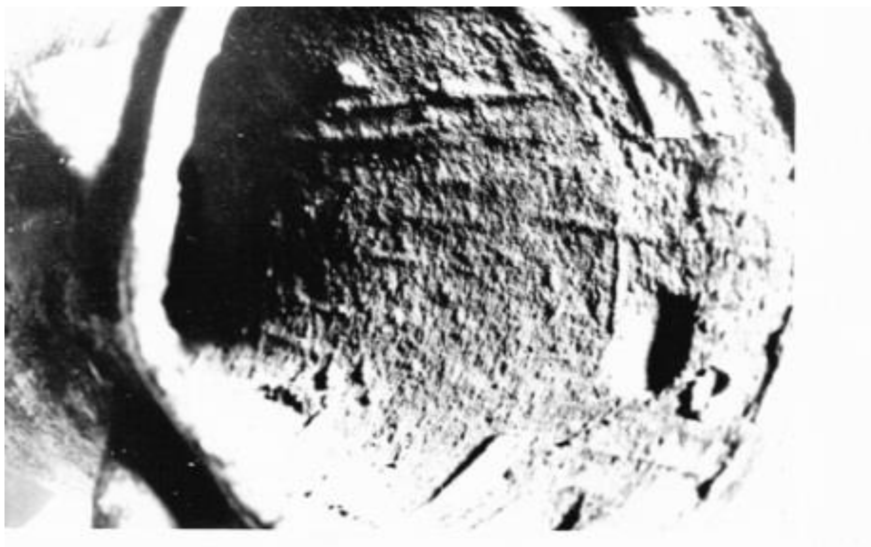
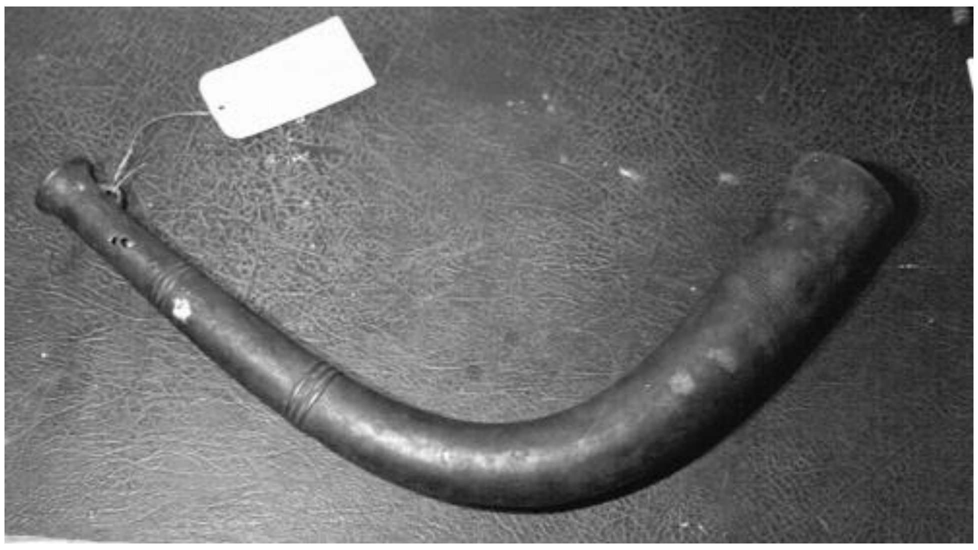



Plate 5.8(a) & (b)

Having produced a core to the same dimensions as the mould this, on -drying would shrink, becoming smaller in all three dimensions as well as changing its overall form. Thus, diameters produced from a mould would decrease to about 90% of their original size, so generating automatically, a gap between mould and core. In the case of a mould of 30*mm* diameter (approx. size of type II tubes) the core produced would shrink to about 27 mm, giving a core/mould gap of 1.5*mm*. In the case of the large diameters seen on bell ends e.g. SD41 its diameter of 93*mm* would shrink to about 84*mm* giving a core/mould gap of 4.5*mm*. However, on SD41, for instance, the tube wall-thickness averages 1.6*mm* indicating that the core, if made this way, would have required building up.

Other dimensions would, of course, also change as the clay shrunk and in the case of straight tubes would give rise to a clearly visible difference between the mould and core.

on 6C for instance, the difference would be of the order of 70*mm* over its length and the maker would certainly have to accommodate such a change in length in his detailed manufacturing system. This can be fairly readily done with a straight parallel tube, where an additional section can be set into the core but this is not so for a curved conical tube. In this latter case the mean length of the tube decreases, reducing both the radius of curvature and the chord length. The resultant mismatch of shapes is such that after shrinking, the core no longer fits inside the mould. (Figure 5.7).

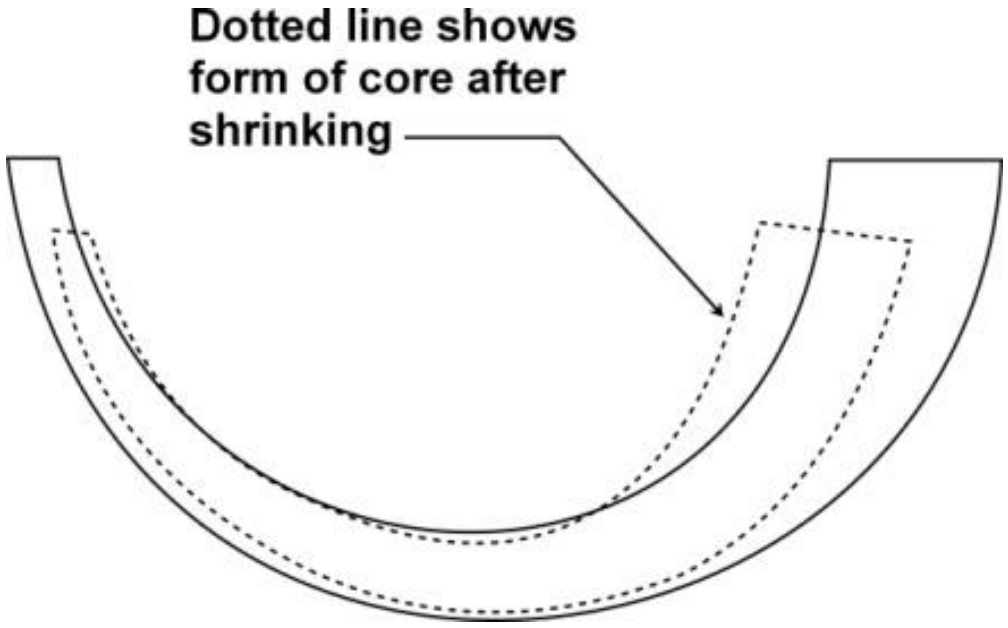


Figure 5.7: The Shape of a Core after Shrinking

Where such highly curved instruments were made, the cores were produced in parts, allowing the dried core to fit in the mould, albeit with an unequal mould/core gap. As individual matching of the core to the mould appeared to have been used, the mould/core gap had to be checked for each assembly. Apparently, to facilitate this, the core was further subdivided along a horizontal axis. This half-core could then be laid in the mould with chaplets or clay pieces to maintain the casting cavity and the flat "diameter" of the core trimmed to lie flush with the mould's joint-line. Bore evidence in the form of flash lines both along the axis of the instrument and normal to it are seen on instruments SD7E, 7G, 13, l6D, 27A, 27B, 29C, 36A, 40 and 41.

A further solution to the core-fitting problem was to design the instrument so that the dried core shrunk to a form that still fitted inside the mould. This was done by eliminating curvature at the tip and bell of the instrument and restricting this to its centre. Thus a curved "L" shaped instrument was evolved, on which the core shrunk towards the centre of the curve. (SD4A,4B, 14D, 14F, 14S, 16A, 16B, 31, 36A and 40) None of these instruments have a multi-part core. (Figure 5.8a, above and Plate 5.8b, above).

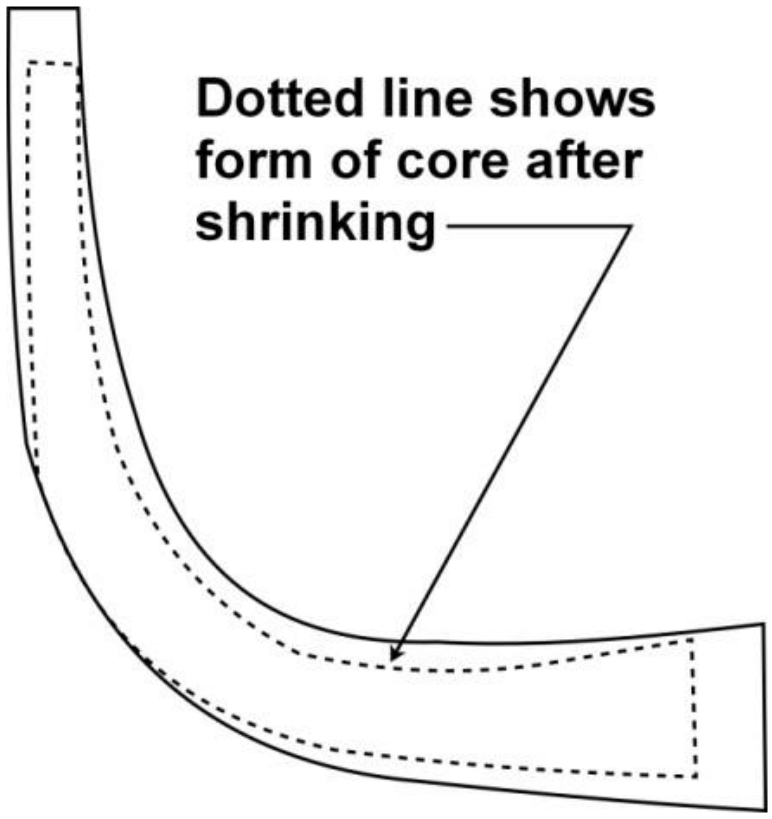
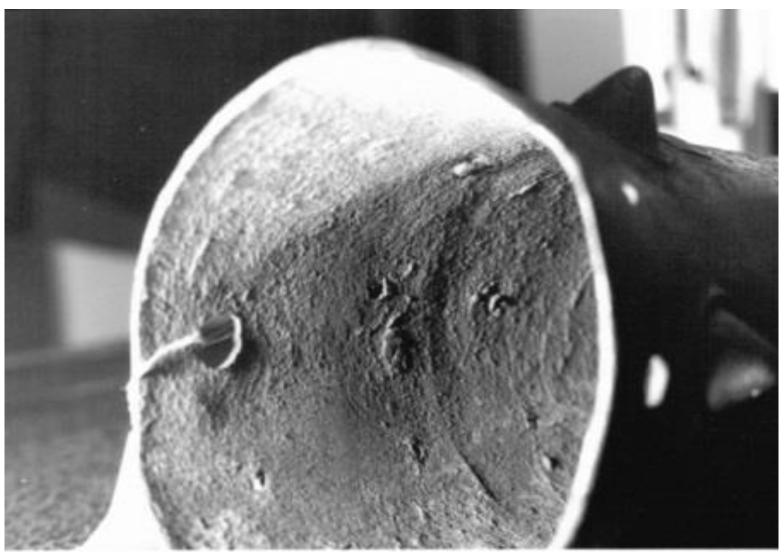


Figure 5.8(a): A Further Core Shrinkage Pattern

Several surface features are present on the bores of instruments and these are clearly attributable to the surface finish on the cores. On several of the Dowris instruments (14A, 14E, 14P, 14R and 14S) as well as 19A, the bores show features which are most likely produced from finger marks on the core. This suggests that these cores were not subjected to extensive working either while wet or dry and this seems to match the other primitive features of these instruments in terms of manufacturing technology. The thick walls of this instrument would accommodate considerable variation in form between the core and the mould without a hole in the wall being produced. Thus, it is possible that a core was produced from the finished mould in the case of these instruments, the shrinkage and consequent divergence in morphology of mould and core being accommodated in variation of wall thickness.

On other instruments e.g. SD37A and 41 the bores are very smooth, as if produced from a very fine clay which was subsequently worked to a very smooth finish, while others have a prickly appearance, dotted all over with fine incursions into the bore. (Plate 5.9a, below)



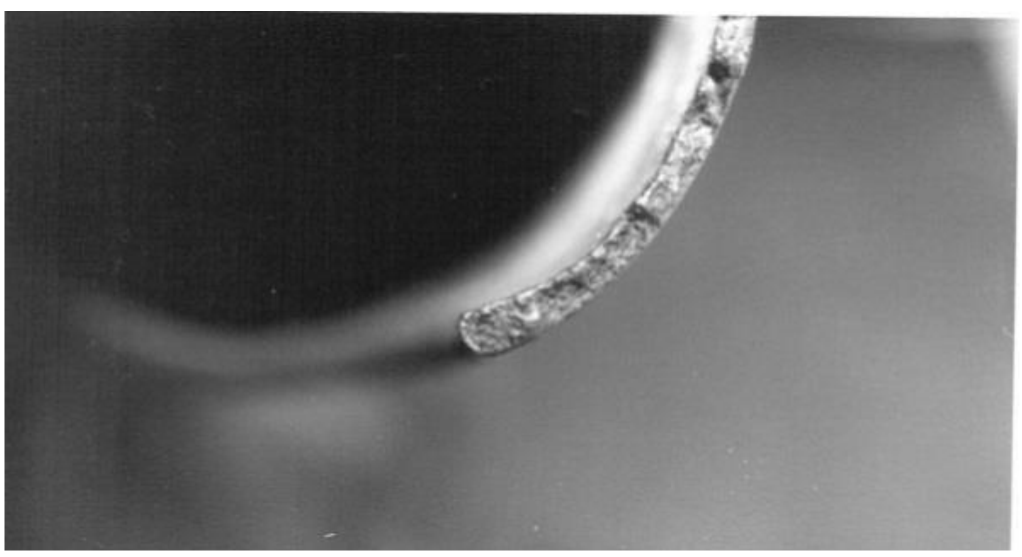


Plate 5.9 (a) & (b)

These instruments (e.g. SD29C, 14S) may have had a sandy core with this coarse material having pulled out on the surface leaving the voids or the sand could have been used as a parting material, hence leaving the hollows in the core. Two of these instruments, SD13 and 14S show signs of attempts to clean up this rough bore by use of a wet spatula wiped over the surface. Several instruments have axial striations in the bore, produced by scraping hollows in the core. On the finished instrument, these mimic growth lines seen on a natural horn as shown on Plate 5.29b. Two examples on the bronze instruments are seen in plates 5.6b and Plate 5.8 a, above.

Plate 5.8b: Growth Marks on a Natural Horn

FEEDING THE CASTING

If as suggested above, the moulds were poured while horizontal the metal could have been introduced from either tip or bell end of the instrument. However, in order to maintain constant practice when casting both side and end-blown instruments the most likely position for gating the mould would be at the instrument bell end. That this was the practice is borne out most clearly on instrument 14E which has two thickened sections of tube at its top and bottom surfaces. At these points the metal has clearly been fractured off and not subsequently cleaned up. (Figure 5.9 and Plate 5.7 a/b), above).

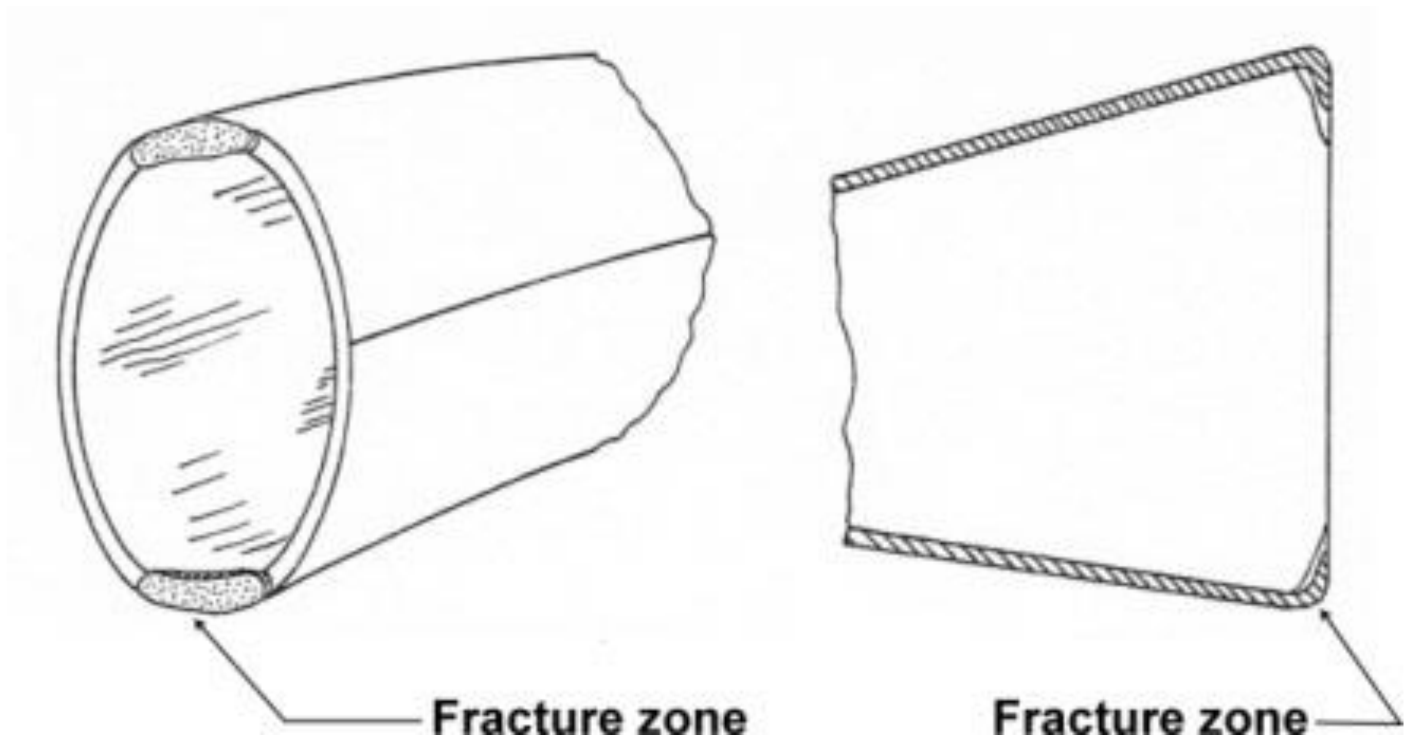


Figure 5.9: Evidence for the Sprue at a Bell End

No other instrument has such remnants showing the sprue fracture zone as, generally speaking the excess material has been abraded back. However, similar features, machined back, are present on SD14G, 27A, 29C, 32 and 40,and on SD27A and 40 the somewhat bulbous termination of the sprue remains at the bell end. Figure 5.10.

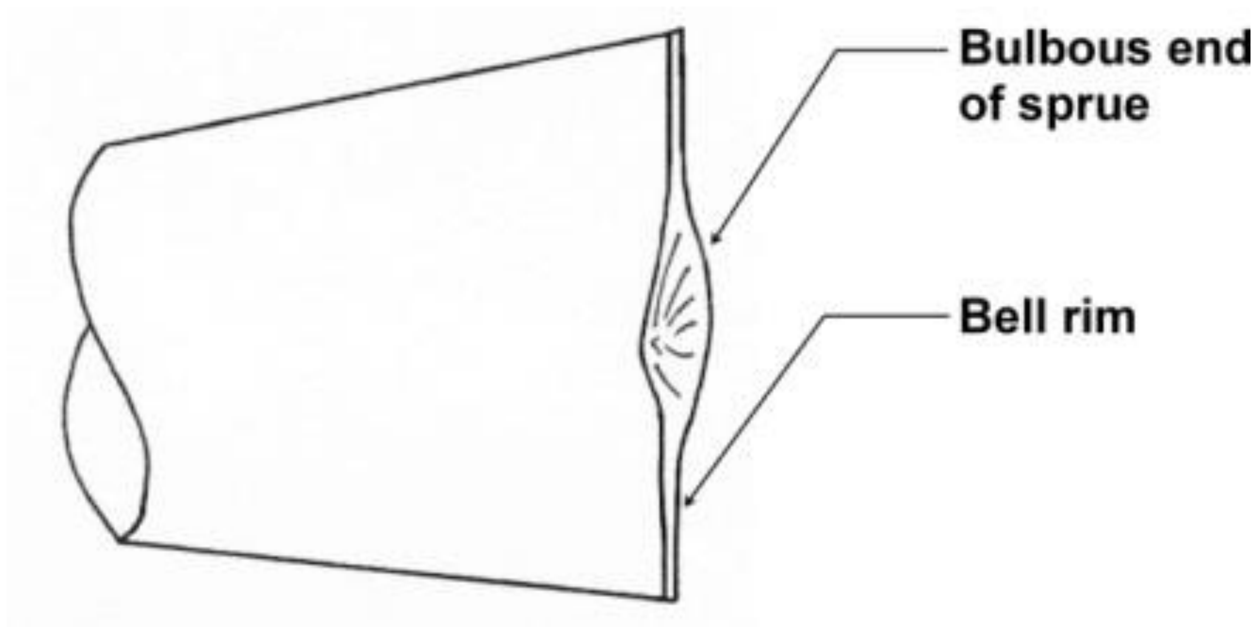


Figure 5.10: An Abraded-back Sprue Ending

The evidence on SD14E suggests that the sprues were simply fractured off from the tube to remove these and, in the case of SD40, while the one sprue was fractured satisfactorily, a section of tube was broken away when removing the other. This fracturing of the tube wall appears to have been a common occurrence and evidence of it having happened is also present on SD14L and to a lesser extent on several other instruments. (Plate. 5.10a)

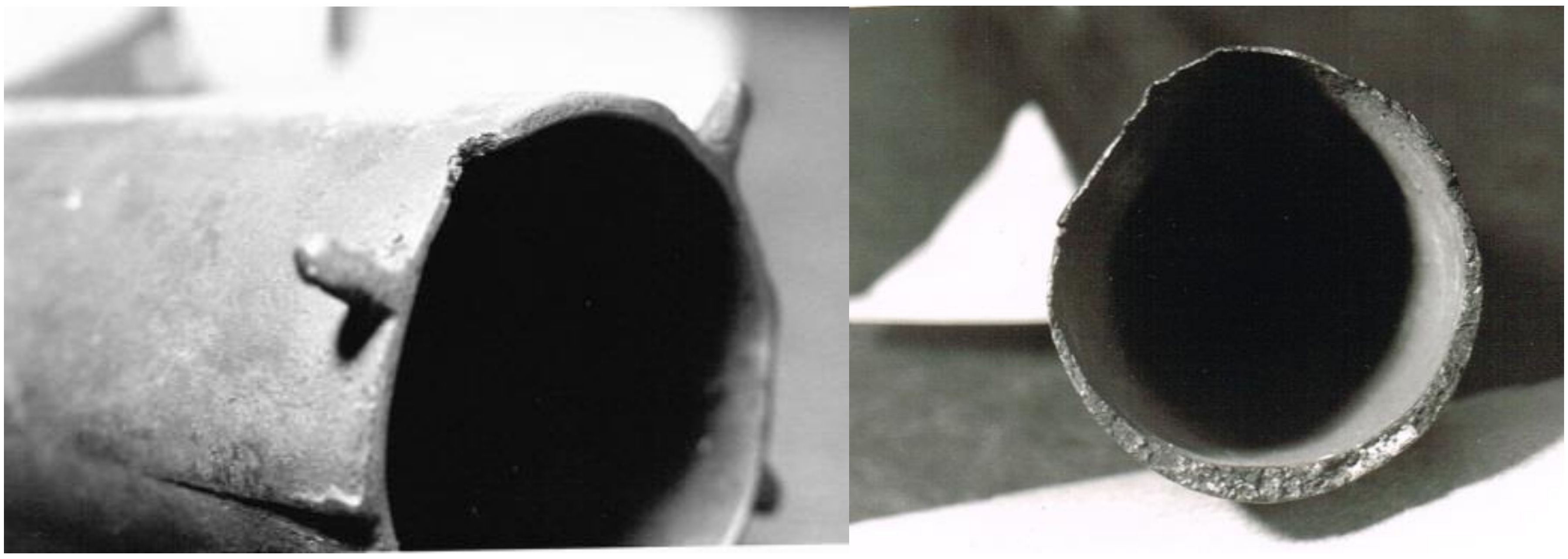


Plate 5.10: Registration Errors on Bell Ends
And Broken-off Sprue Endings

Only one instrument (SD14F) shows signs of possible gating from other positions although the evidence on this instrument is rather problematical.

Thus the mould cavity was probably fed from a sprue entering at the bell end. (Figure 5.11) This would have to feed through the core-print and may have been connected to the bell with a narrower feeder to facilitate its fracturing off later.

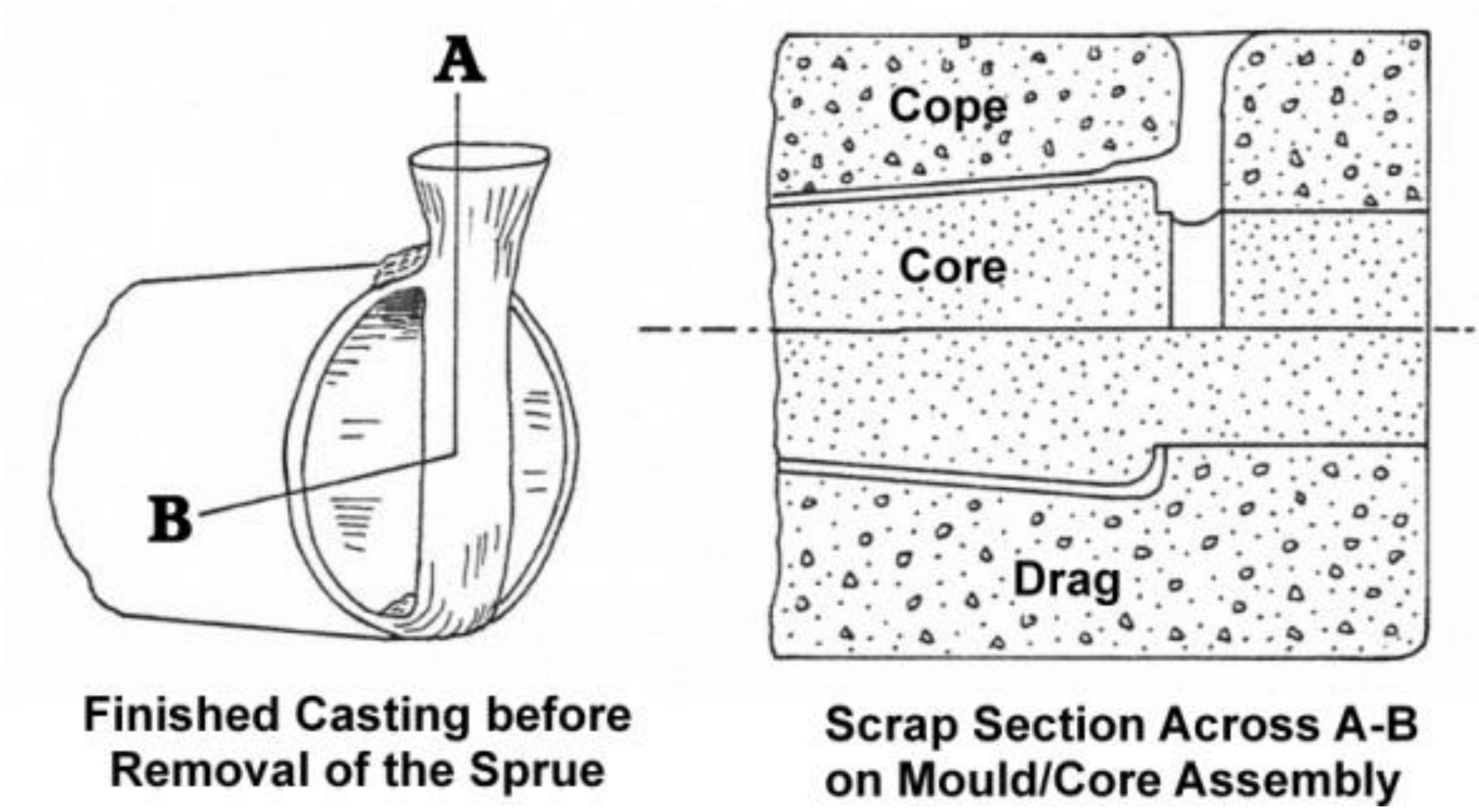


Figure 5.11: Feeding the Casting

Such an arrangement although probably arrived at empirically would prove reasonably effective, providing that the feeder was not fully blocked by metal during pouring. When partially open, this would allow entrapped gases, steam[199] etc. to escape and the mould would fill up from the drag expelling air into the cope and hence up the feeding channel.

On instrument SD27A, one sprue junction, probably that on the drag, is adjacent to the tube joint-line. Such a gating arrangement would remove the necessity of making a hole through the core thus weakening it. The probable gating arrangement is illustrated in Figure 5.12. This may well have been the technique adopted on instruments with split cores where this type of gating avoided having to align the two mould halves longitudinally to a high degree of accuracy.

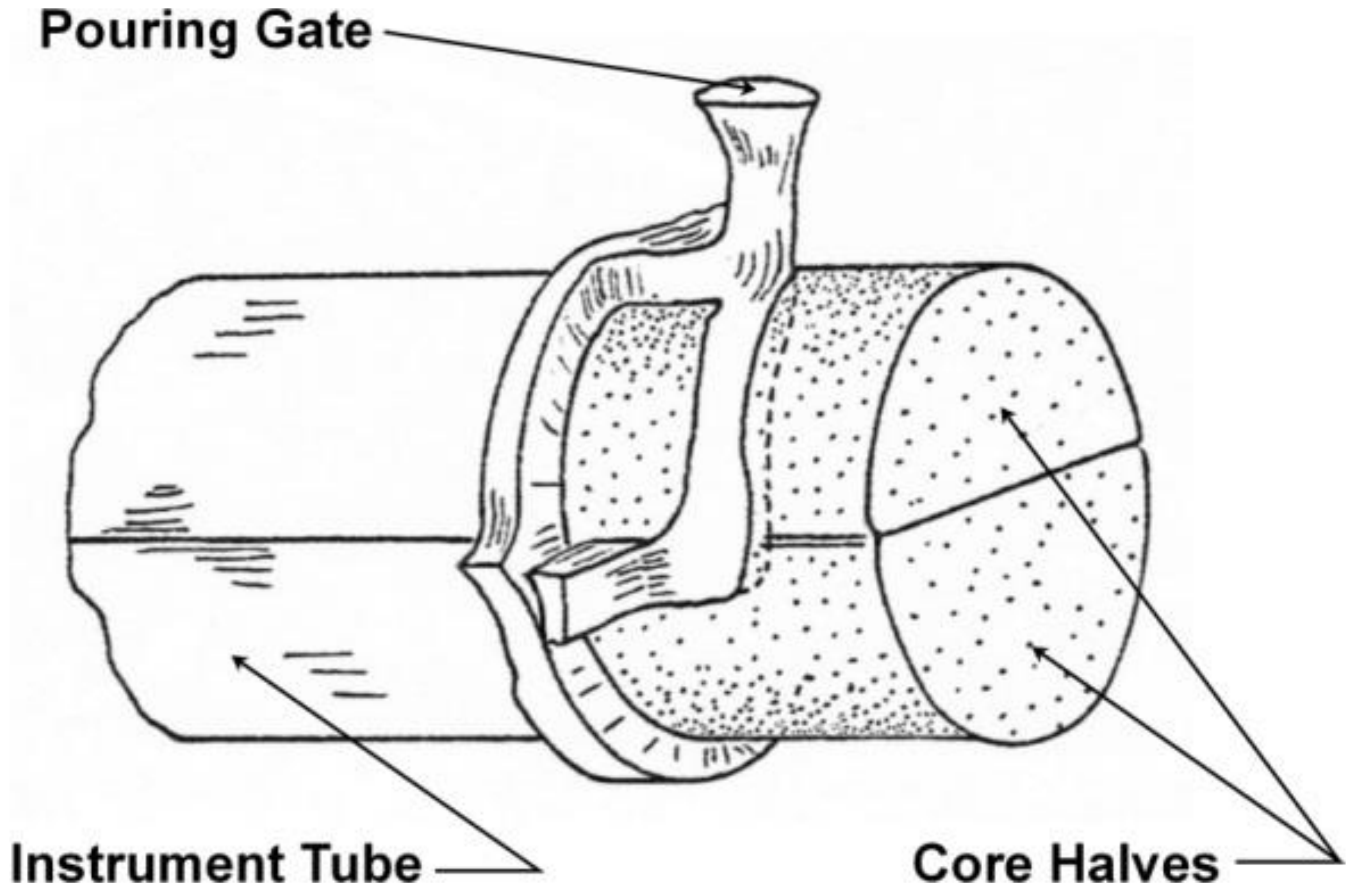


Figure 5.12:Gating Evidence on Bell Ends

No fragments of moulds remain to indicate whether or not these were fired prior to casting. Curle[200], describing moulds found at Jarlshof, Shetlands, suggested that the moulds for axes had been fired prior to manufacture of the core. Certainly, the core fragments remaining in the side-blown instruments are in the dry-green state with the ceramic change being visible only on that area in immediate contact with the bronze tube. It seems probable, therefore, that the mould/core assembly was not heated prior to casting, or at least to no high degree. This would account for areas of sluggish metal flow on instrument tubes, presumably where the metal was losing fluidity as the mould was being filled. (Particularly noticeable on SD29C, Plate 5.3b, above). It would also account for the feature on SD14M where a thin chaplet had acted as a chill and the casting charge

had failed to flow over this to fill up the space between this chaplet and the core - see Figure 5.5 (Left).

[199] My own subsequent casting experiments indicate that there would like be no steam present as the mould would need to have been preheated. Dampness in a casting environment can be disastrous!
[200] Curle, 1932, 122.

The simplest parts of instruments, in terms of manufacture are those which have apertures at both ends, allowing their cores to be supported adequately by core prints, such as instrument 14P and 14Q. (Figure 5.13).

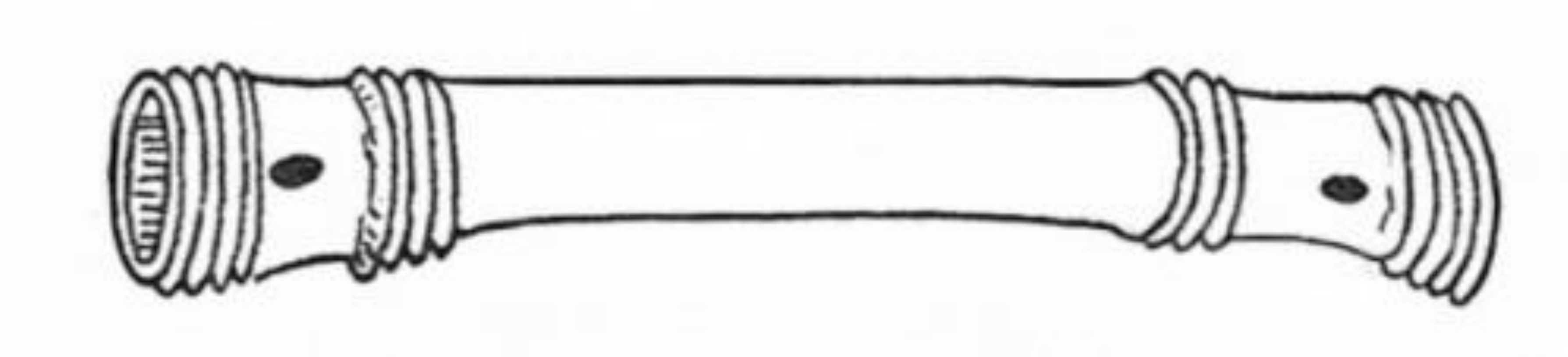


Figure 5.13

This could be cast quite simply as shown in Figure 5.1. However, as longer tubes are made, accurate positioning of the core becomes increasingly difficult even with straight tubes. Thus, any discrepancy in alignment of the core's prints or its axis will give rise to discrepancies in the thickness of the final tube wall. However, when tubes are made with curved axes the prints must not only restrain the core in a vertical plane but must also prevent it twisting inside the mould.

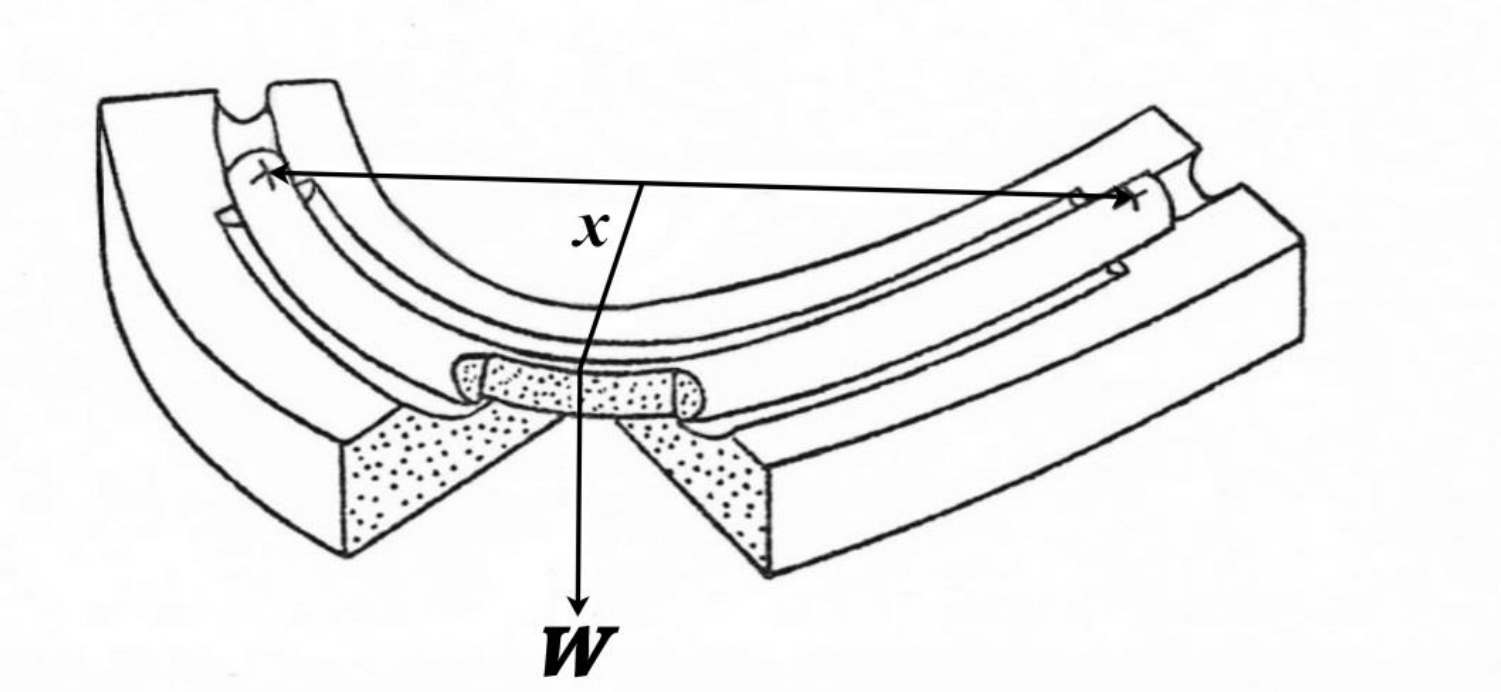


Figure 5.14: The Twisting Moment Acting on a Curved Core

Figure 5.14 illustrates the situation where a core weight of W acts at a distance of x from the pivotal axis of the core prints to give a turning moment of Wx. Accurately made core prints/print cavities would be sufficient to retain the core in position provided the cope were tightly held onto the drag. While the mould is assembled, the weight of the core tends to pull it downwards, thinning the section in the drag. However, when bronze is poured into the mould, the core is buoyant in the molten metal due to the difference in densities between these (approx. 8:2). Thus, if the core prints are a loose fit, it will tend to rise into the cope giving a thin section in this. A similar effect is also produced by the flow of metal

into the mould, this hydrodynamic lift also tending to lift the core in the mould. However, if the metal remains molten after the mould is filled the core has time to settle and regain an equilibrium position. Undoubtedly, misplaced cores have given rise to many thinly cast and missed sections on horns such as SD36A, 14I, 14R and 4A, the first three of these occurring at a point consistent with twisting of the core having been a cause. (Plate 5.10b, above).

Just whether the remedy of providing chaplets was worked out from observation of failed castings or from the desire to fix an insecure core is hard to say. The latter case would be an obvious one but to suggest that the makers were unable to understand the implications of thin sections produced from a seemingly adequate mould probably underestimates their understanding of the whole process.

The simplest complete instrument that utilised a mould made of the three basic parts would be a fairly simple analogue of an animal horn cast in bronze with the addition of a tube-mounted carrying loop. It would be made as a side-blown instrument with a cast-in blowing aperture. The apertures of instruments of this type are clearly cast-in and were probably made by protrusion of a suitably shaped portion of core through the core/mould gap. This piece of core would itself provide some positive location and is on these instruments, the only feature designed to maintain the core centrally. (Figure 5.15).

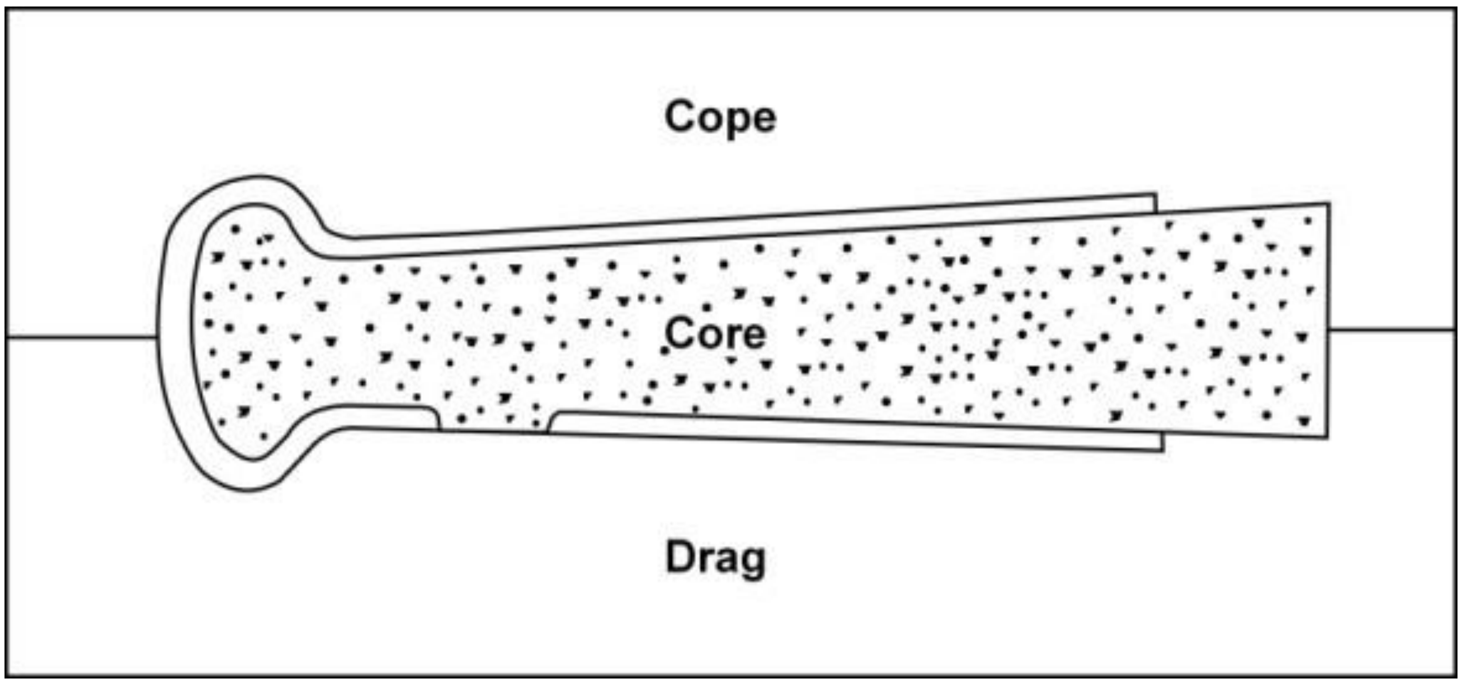


Fig 5.15: The Core-Support System for a Simple End-Blown Horn

Practically all the horns have smoothly-formed blowing apertures which show no signs of having been formed after casting. It seems reasonable to assume, therefore, that the core was used to form this aperture, it being easier to work accurately to achieve a desired shape.

As the blowing aperture is pressed to the lips when playing the instrument, it seems almost certain that the edges of this would be cleaned-up abrasively, before the instrument was used. This seems even more likely when considering the likelihood of a flash-line being formed over the aperture when the core is not pressed firmly onto the mould or does not

seat accurately all round the edge of the blowing aperture core. (Figure 5.16 (below) and Plate 5.11a, below).

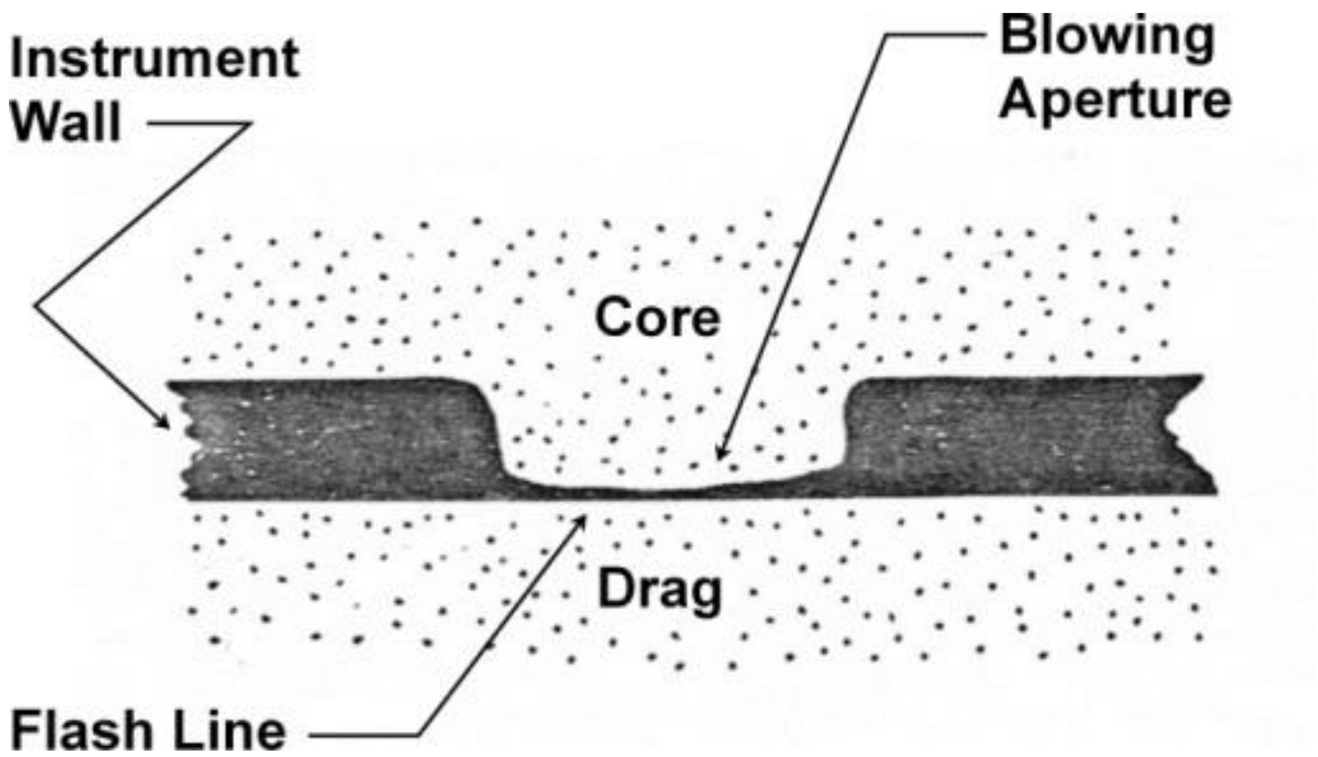


Figure 5.16: Possible Metal Flow Path over Blowing Aperture

The smoothly-radiused blowing apertures of the side-blown instruments could only have been formed by abrasive working (Plate 5.9 b, above) as to produce such a smooth flash-free aperture directly from a casting would require an extremely high degree of precision. Two instruments (SD4B and 36A) have a raised moulding around this aperture, the manufacture of which clearly required a very precise location of the core relative to the relevant mould-half. In order to form this, the core would have to protrude into a cavity formed in the mould itself. Whereas the location of a simple aperture would be determined by the core itself, however, both core and mould would be required to form a rimmed aperture. See Figure 5.17.

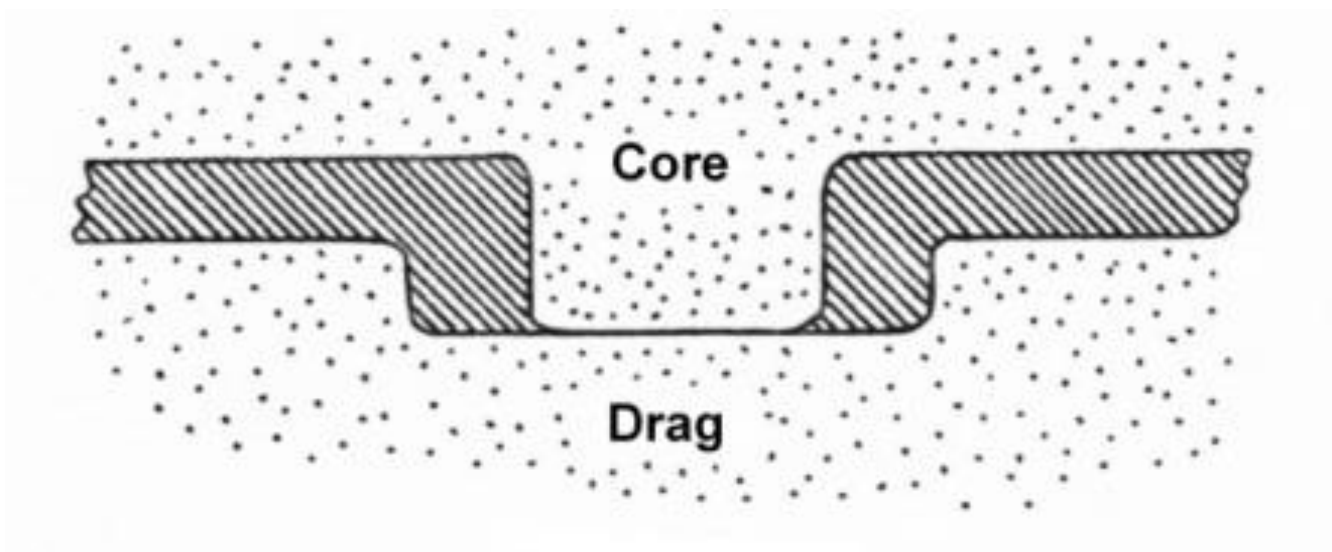


Figure 5.17

In view of the changes in both mould and core morphology which occur with the drying of the clay, such accuracy could only be achieved by producing the aperture cavity on the mould on final assembly. (Plate 5.11a)

Plate 5.11(a)

SUPPORTING THE CORE

Having made a mould and core, the maker would have to assemble these and would soon learn that accurate location of the core in its prints was essential if thin sections were to be avoided. He would thus, presumably, stand the core on either the cope or drag and check the casting cavity. The joint-line gap could be checked visually but not that beneath the core. Modern practice in checking this would be to put thickness gauges below the core to check if this rests on these. Somewhat less accurately, but more common in practice, plasticine or similar material could be placed under the core and this pressed down until it rests on its core-prints. The plasticine can then be removed and its thickness measured to give an indication of the core/mould gap. A similar exercise could have been carried out using wet clay and the support obtained from this might well have given rise to the idea of chaplets. Similarly, when assembling the two halves of a mould and the core, the casting cavity cannot be measured other than by use of spacers as described above. This problem was quite likely to be investigated as the core could well fit both mould halves, only to give mutual interference problems when the two mould halves were offered together, again giving rise to thin sections and totally missed sections of tube. It is not surprising that such failures are the most commonly found ones on these instruments.

Plate 5.12: Chaplet Evidence on Tube Walls

Side-blown instruments obviously differ from end-blown ones in that, lacking a straight-through core, additional core support problems are experienced at the instrument tip. Chaplets were obviously used here in the tip but their application was aided by the fact that the cores were left in the tip of practically all side-blown instruments and, hence, the intrusion of a large chaplet here was not considered to be detrimental to the performance or appearance of an instrument. On SD49, a fragment of the tip of a side blown instrument, its end is broken off and, between its mouthpiece and tip end a 7*mm* x 4*mm* tanged chaplet can be seen protruding into the core, obviously having provided considerable support during casting. (Plate 5.11b, above)

Plate 5.11(b)

The use of clay to measure the core/mould gap would demonstrate that the core could be supported at the critical points, i.e. around the tube curve, maintaining the gap. However, the use of clay as a support during casting would leave holes in the tube when the supports were removed subsequently. These would need to be cast-in as has been done on SD14F. On this, eight holes spaced four on the top tube surface around its curve and four similar ones on the bottom surface have been filled by cast-on material. (Plate 5.12a, above) One other instrument, SD14A has similar cast-on features but on this they appear to have a well-defined decorative function the group at the tip lying between two raised bands and those at the bell lying just upstream of the incised decoration. However, the clay that formed these holes could well have played an important role as a support during casting. As mentioned above, metal supports were used on quite early side-blown instruments to support their blind tips, these remaining in place after casting, and being concealed by the core left in this tip. On two instruments however, SD14J and 14S, two very large (in terms of chaplet size "enormous") pieces of metal were pushed into the core, to protrude just enough to support this in the mould. These were clearly put in place while the core was soft as no cracking or other distortion is visible adjacent to these chaplets. Spaced on the instrument curve, these were obviously placed there to prevent core rotation and were made from a piece of bronze c. 20*mm* by 2.5*mm* cross-section and protrude into the bore some 10-15 *mm* . Their innermost part has been formed into a crude point by breaking off the edges of the material. (Figure 5.18).

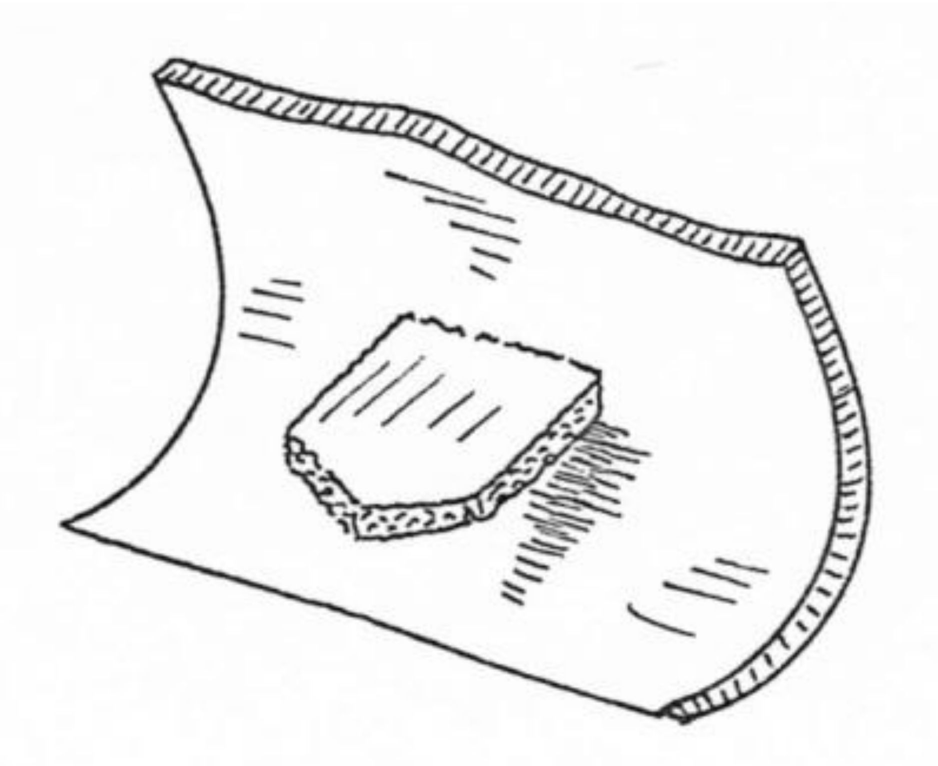


Figure 5.18: A Tanged Chaplet

The simplest (earliest?) developments in the application of chaplets, however, used irregularly-shaped pieces of bronze with edges up to 15*mm* long which were simply trapped between the core and mould (Figure 5.2 b, above and Plate 5.13a/b), below). Having been broken off from cast sheet, the chaplets are generally noticeably less round than the adjacent portion of tube and their surface extensively pitted. Also their junction with the cast tube material is almost always visible their perimeter being marked by a distinct hollow, probably as a result of chilling. One instrument, 14R, has one such chaplet placed in the centre of the tube's curve. In this particular case the arrangement proved inadequate as the core became displaced the thickness of the resulting tube varying from 0.46*mm* to 3.3*mm* as shown in Figure 5.19, below. More generally, a row or rows of such chaplets (here called "surface" chaplets) were used, the earliest positions of these appearing to be on the bottom centre-line of the mould as on instrument SD4D.

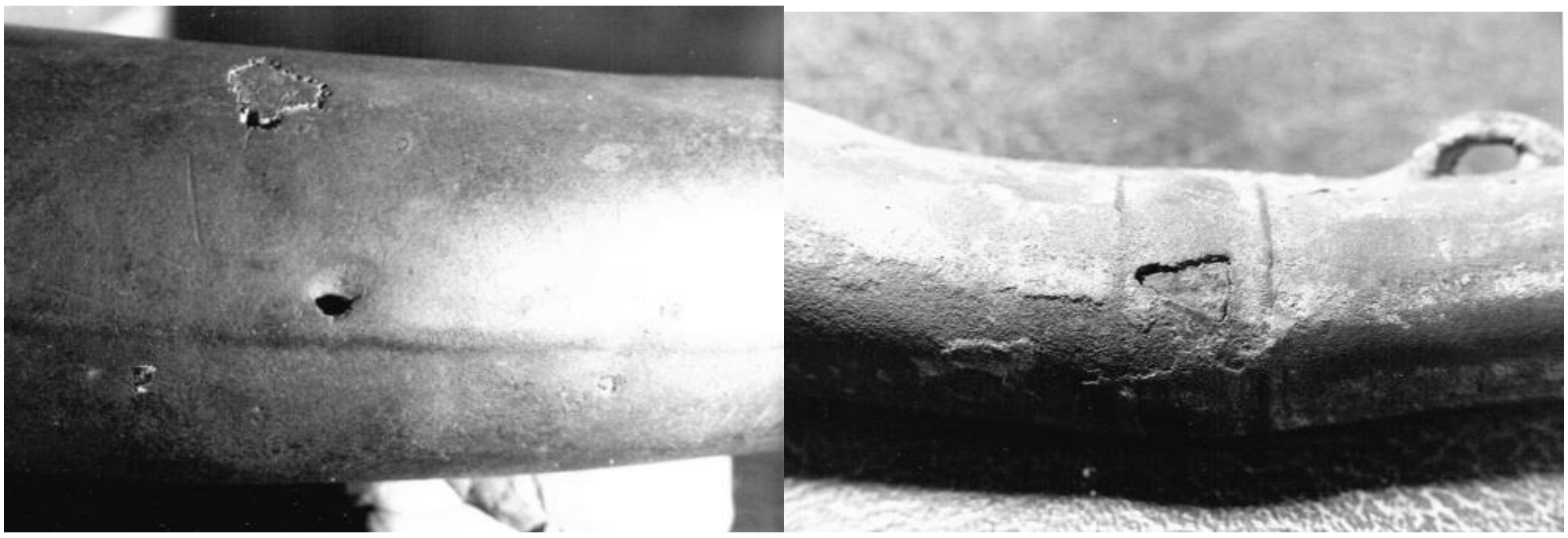


Plate 5.13

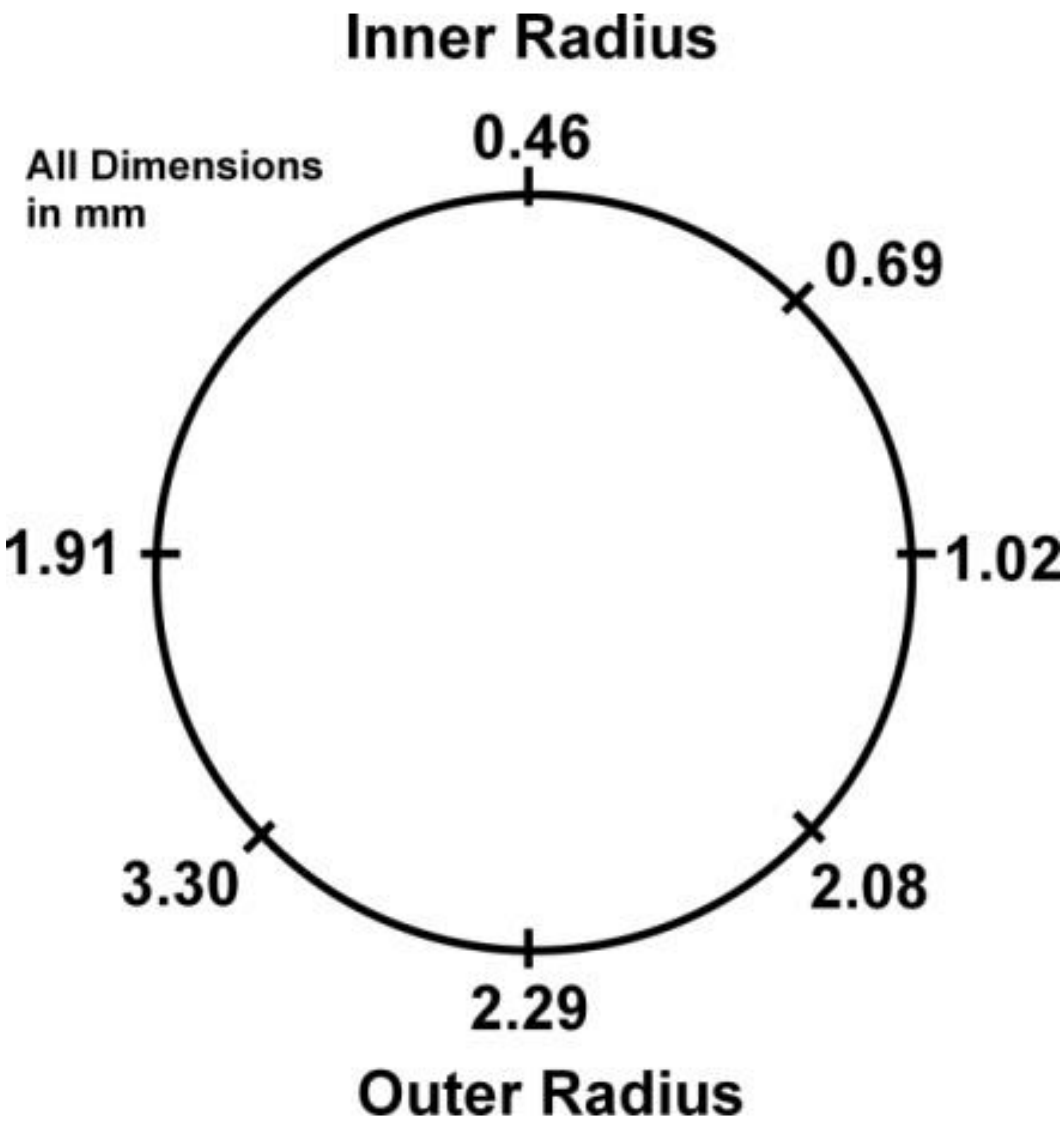


Figure 5.19: Tube Wall Thicknesses on SD14R

Two problems associated with the use of chaplets now presented themselves:

i) that the chaplet sitting on the core/mould surface, i.e. restrained by the nip between these surfaces, was liable to be displaced when this nip was insufficient
ii) either single or double rows of chaplets were insufficient to restrain the core adequately during pouring of the casting.

The evidence suggests that these two problems were worked on by more than one local industry, parallel development taking place, although there appears to have been some interchange of techniques between these. The single row of chaplets while providing static support for the core prior to casting did nothing to overcome its bouyancy during casting giving rise to thin sections on the instrument's top surface. Thus, moulds with two rows of chaplets were made, one row on the top of the mould and one on the bottom (SD1, 14D, 14E, 14J, 14K and 17A).

Although two rows of chaplets restrained the core more tightly, the loose chaplets were still able to slip out of position (Plate 5.14a, below), perhaps when the mould was being handled prior to casting or perhaps when the core moved as metal was being poured in.

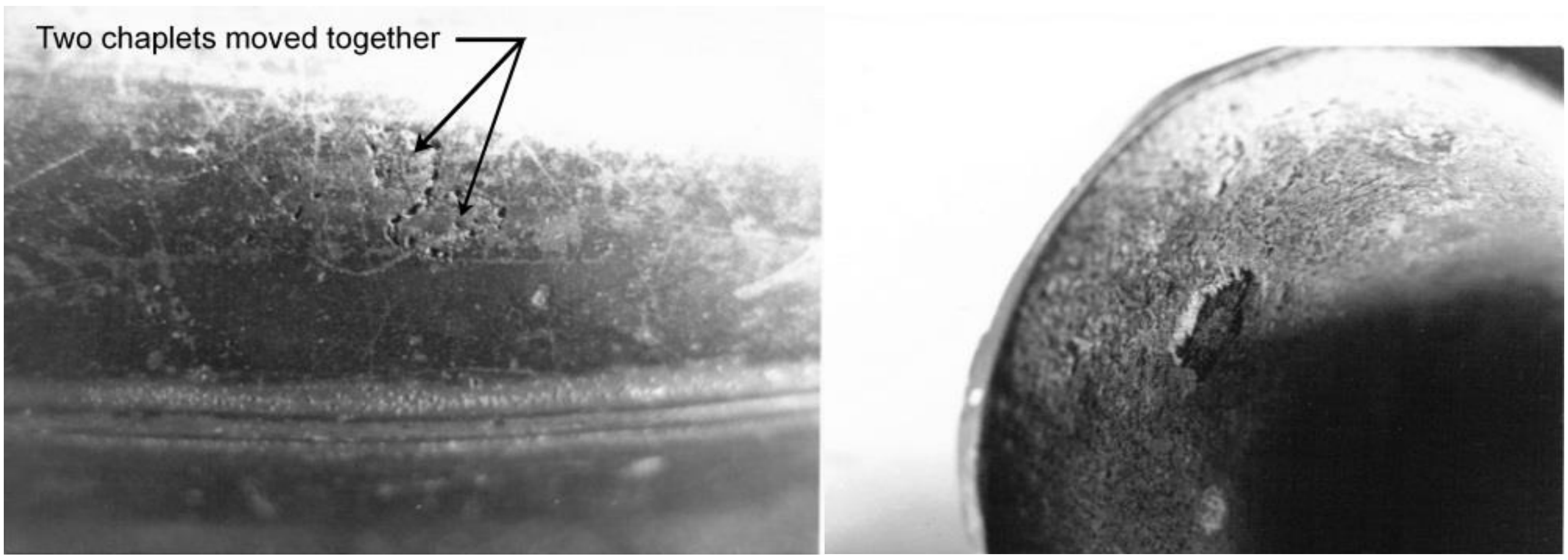


Plate 5.14: Chaplets in situ

Thus, a modified method of restraint was developed where the chaplet was thicker than the final desired instrument wall-thickness by 1 to 1.5*mm* and was pressed into the core by this amount (here called a keyed surface chaplet). This held in place satisfactorily and, when the core was removed subsequent to casting, left the chaplet to penetrate into the bore. (Plate 5.14b, above) Instruments SD1, 14K and 17A have the two row arrangement of chaplets with these pushed into the core. With the adoption of this technique, the chaplets used tended to be smaller than the earlier type, many being only half this earlier size and others being as small as 1.5 mm across. However, this pattern of development seems not to have occurred in all areas as instruments and SD14M and 36B have the simple surface chaplets but these are arranged in six separate rows. Thus, it seems that the industry that produced these chaplets concentrated on the development of a more satisfactory chaplet configuration while elsewhere workers were developing more sophisticated forms of chaplets themselves.

It is not possible to pick out a single stream of development beyond this stage, as both the chaplet form and configuration were undergoing developments in parallel, with constant cross-fertilisation between the two.

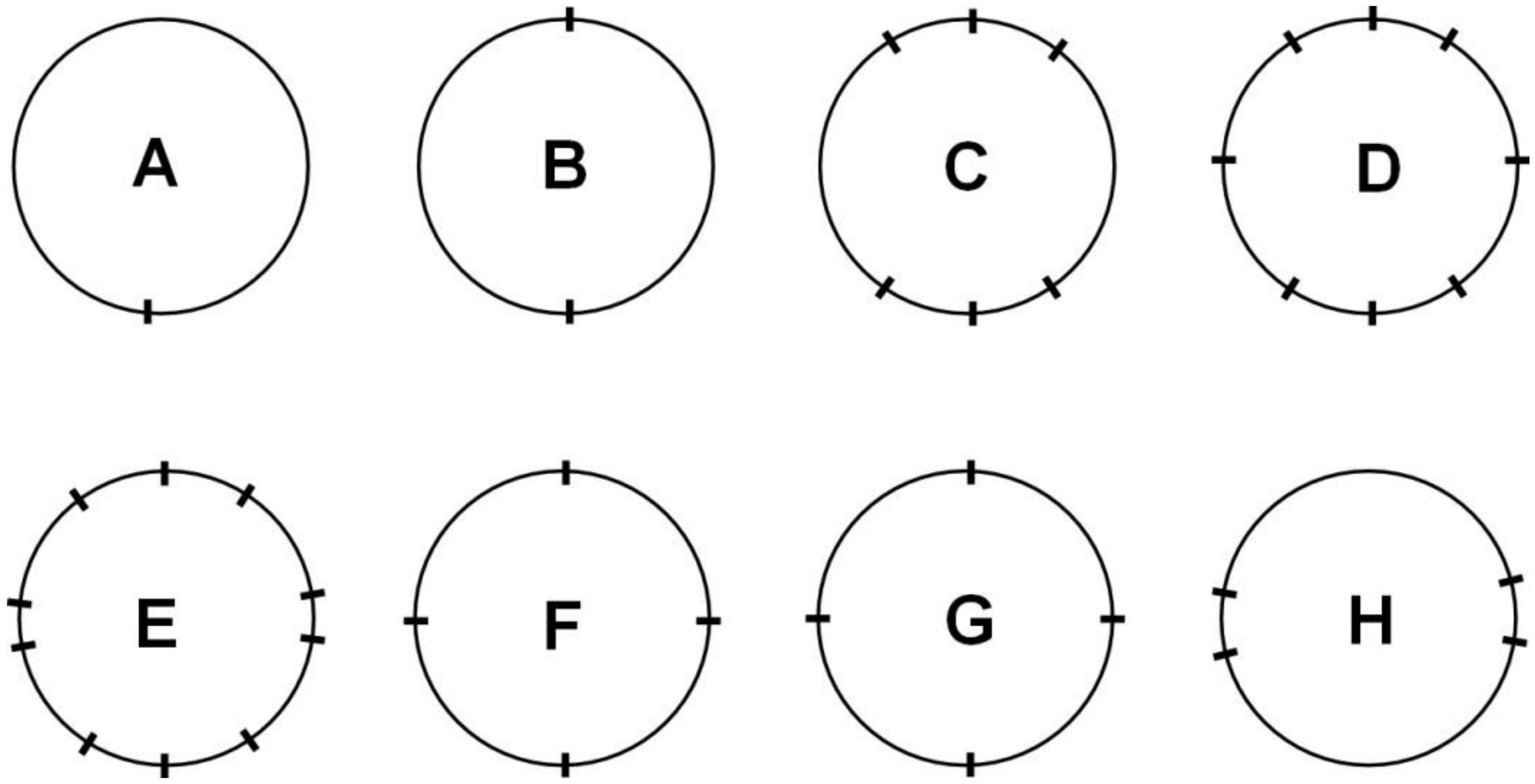


Figure 5.20: Different Chaplet Configurations

In terms of configuration, the six-row pattern 'C' on Figure 5.20, along with its variant D were the most common arrangements of chaplets seen. Pattern 'C' gives fairly uniform support all around the core although on most tubes none of the chaplets could be seen once the core was in place in the mould. With arrangement 'D', however, the two rows of chaplets on the joint-lines could be seen and their positions checked. It could also have been possible with these joint-line mounted chaplets that they protruded into the mould and rested in grooves cut in the joint-line surface. This protruding part could then be cut away following casting along with the flash on the joint-line itself.

Another arrangement where the chaplets could be seen on assembly but not allowed to protrude was configuration H. In this, the row of chaplets just below the joint-line (i.e. when core lies in the mould) serve to locate the core in its lateral position. In 'E' similar rows are used in conjunction with the six-row pattern (c). (Plate 5.12b, above and Plate 5.13a, above) Pattern 'G‘ is seen on SD14L, 4l and 43, where chaplets are placed top/bottom and left/right positions and one instrument (SD 7D) has pattern F.

Many of the instruments studied have chaplets which are still present. On these, it is often possible to locate chaplets by bore evidence using internal inspection equipment (Rank-Taylor Hobson Fibroscope) but extremely difficult to relate the observation to angular position (azimuth) on the instrument. However, with either improved fibre-optics devices or an attachment to give a measure of angular rotation of the viewing optics it would be possible to gain a much more complete picture of arrangements of chaplets on these instruments. As the chapletting of the core is such a fundamental feature of the casting

technology used, a correlation between chaplet configurations and the other products of local industries of the period might emerge.

Most of the larger chaplets are readily visible, except where a particularly heavy patina has covered them over. They would have certainly been visible on a newly made instrument and presumably this prompted the makers to attempt to reduce their visual impact by reducing their size. On 14D, some of the chaplets are in the form of largish irregular shapes while others are turned so that they protrude into the bore some 7*mm* or so. However, the two groups of three chaplets nearest the bell end are of the type which lie flush with the bore and are, thus, not too noticeable when looking down the bore. On this instrument, therefore, the maker appeared to wish to minimise the visual impact of those chaplets that could be seen, restricting the penetration into the core to those less visible ones.

Other instruments such as SD4A. 4C, 7B have yet narrower chaplets which were pressed into the core and protrude some 7*mm* or so into the bore. It appears that, whereas the piece of material used to form the earlier types of chaplet had been laid flat on the core, this type was now twisted so that the centre-line of the sheet lay along a radius of the core. (Figure 5.21) Thus, on these instruments the end face of the chaplet seen on the outer surface of the tube is much less noticeable.

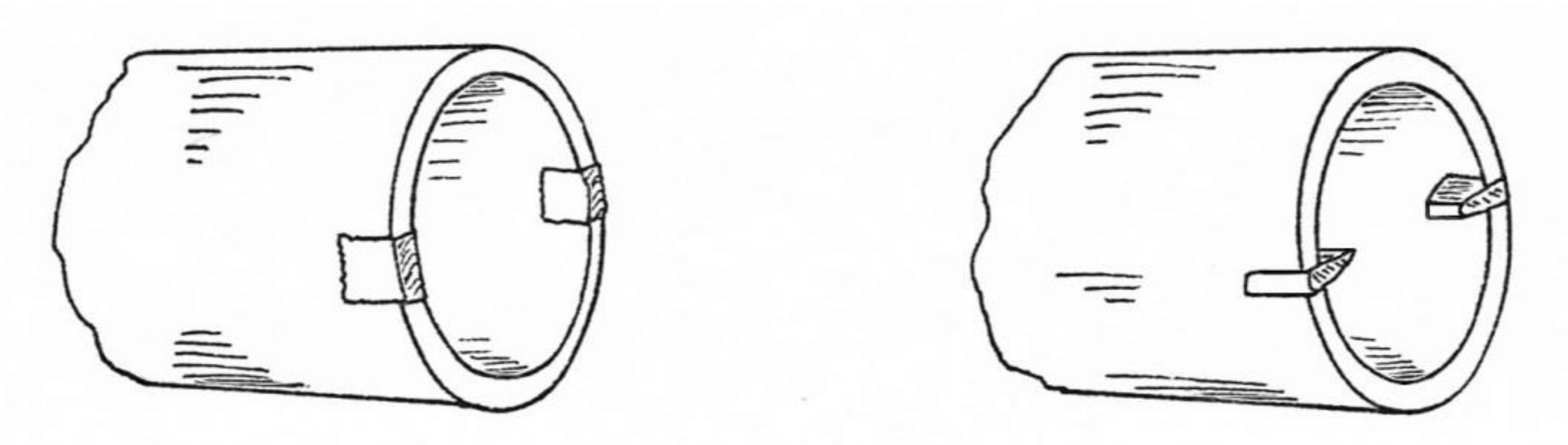


Figure 5.21: Bell-End Chaplets

The material for earlier chaplets had been fractured off from other cast material and had rough fractured edges. These later chaplets, however, were frequently hammered into a more lozenge or occasionally a triangular shape. (Plate 5.15a, below) The face presented to the molten metal by these chaplets, therefore, was smoother, gave poorer adhesion and more frequently leads to the total loss of the chaplet in use than width the earlier types. (Plate 5.13a, above ; and Plate 5.28b, below)

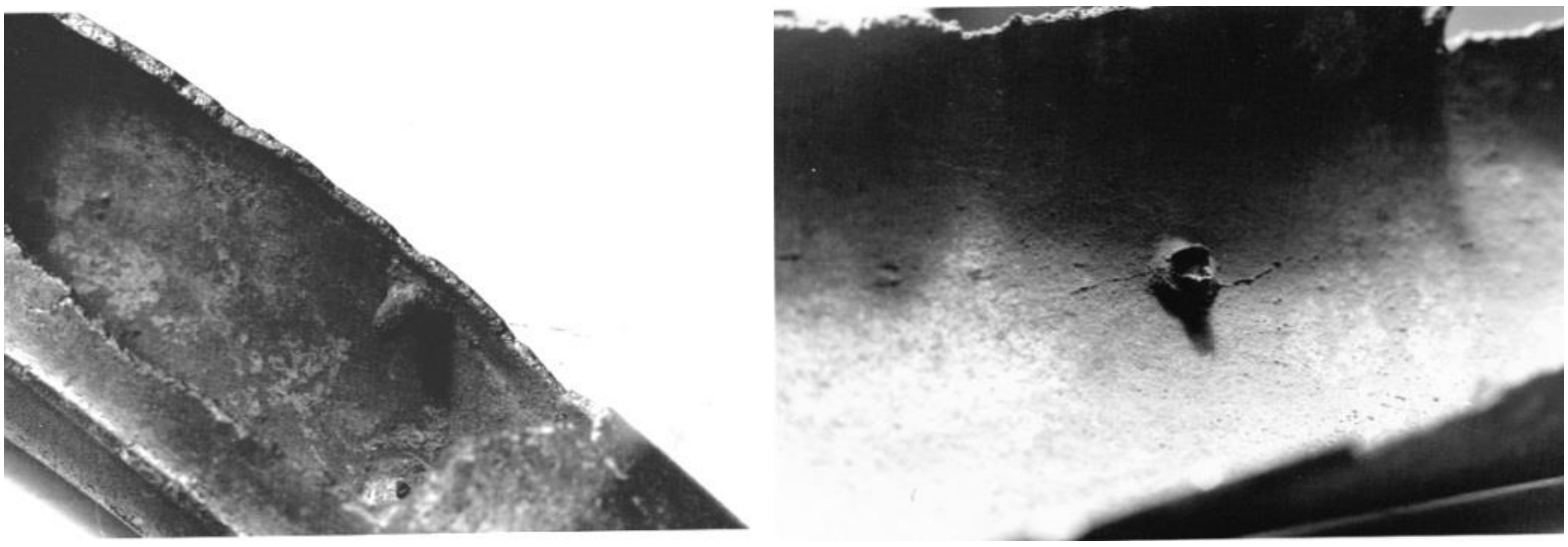


Plate 5.15: Chaplets in situ

Working the material in the way described, caused the metal of the chaplet to flow and, eventually led to the formation of a distinctly tanged type of chaplet. on this, the tang provides a feature which eases penetration into the core and serves to retain the chaplet during handling. (Figure 5.22, Plate 5.15b).

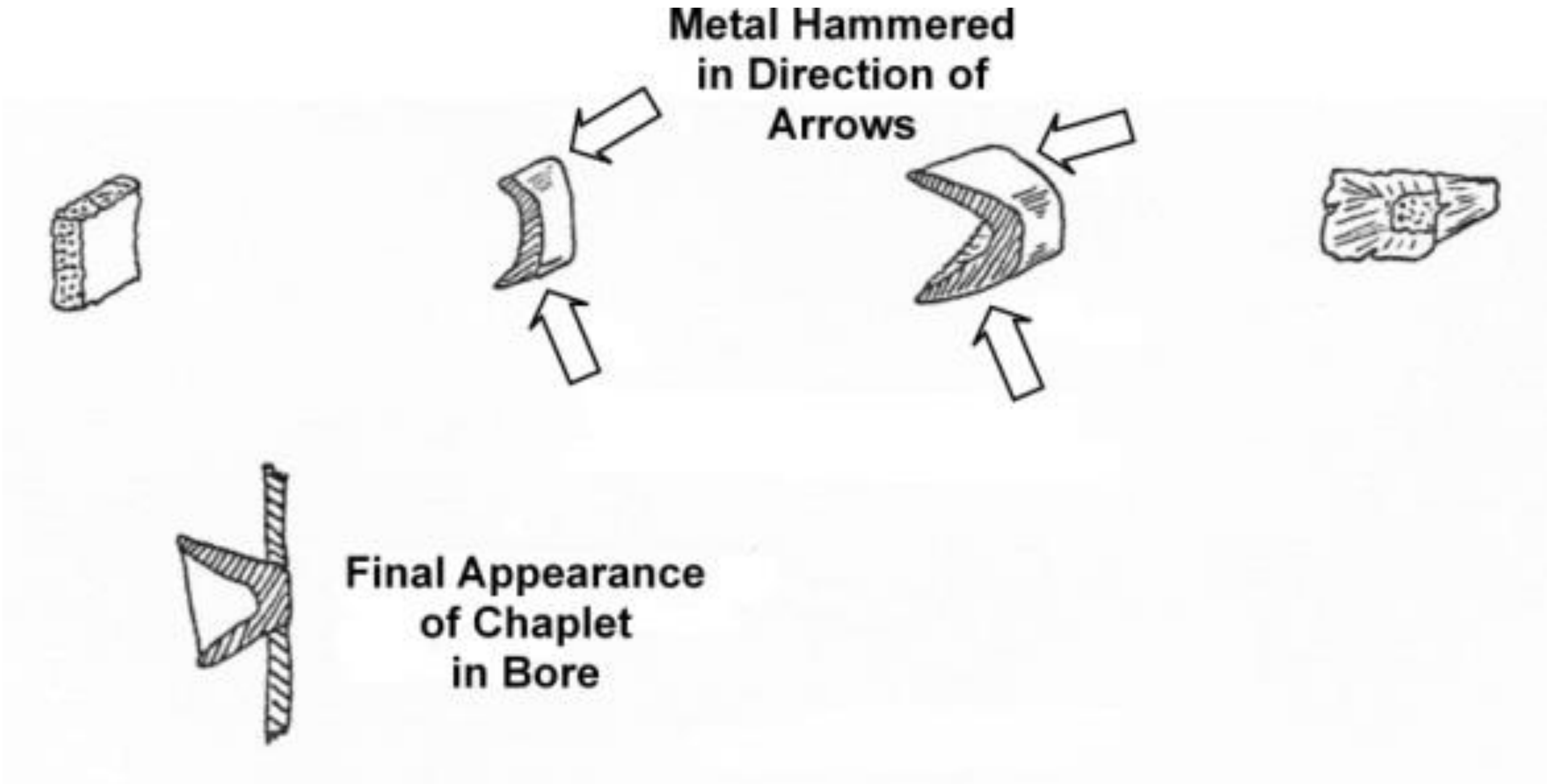


Figure 5.22: The Creation of a Tanged Chaplet

When the core is removed after casting the tang remains in the bore with the appearance of a tube projecting some 2-3*mm* into the bore. Where the chaplets have fallen out, their distinctive wedge shape can be seen in the hole remaining, along with a faceted outer form developed from the hammering of the metal. (Plate 5.28b, below) These chaplets are seen on five instruments (SD6C, 27A, 29C, 30 and 32) from both the north and south but all of a fairly advanced form. One of these (SD30) is fragmentary, allowing closer examination of the bore and, on this, the disturbance to the core caused by pushing in the chaplet can be seen as a raised annular feature around this. Also emanating from the chaplet site, is a crack which runs along the axis of the instrument to meet a crack developed at the neighbouring chaplet. (Figure 5.23,below, Plate 5.15b, above).

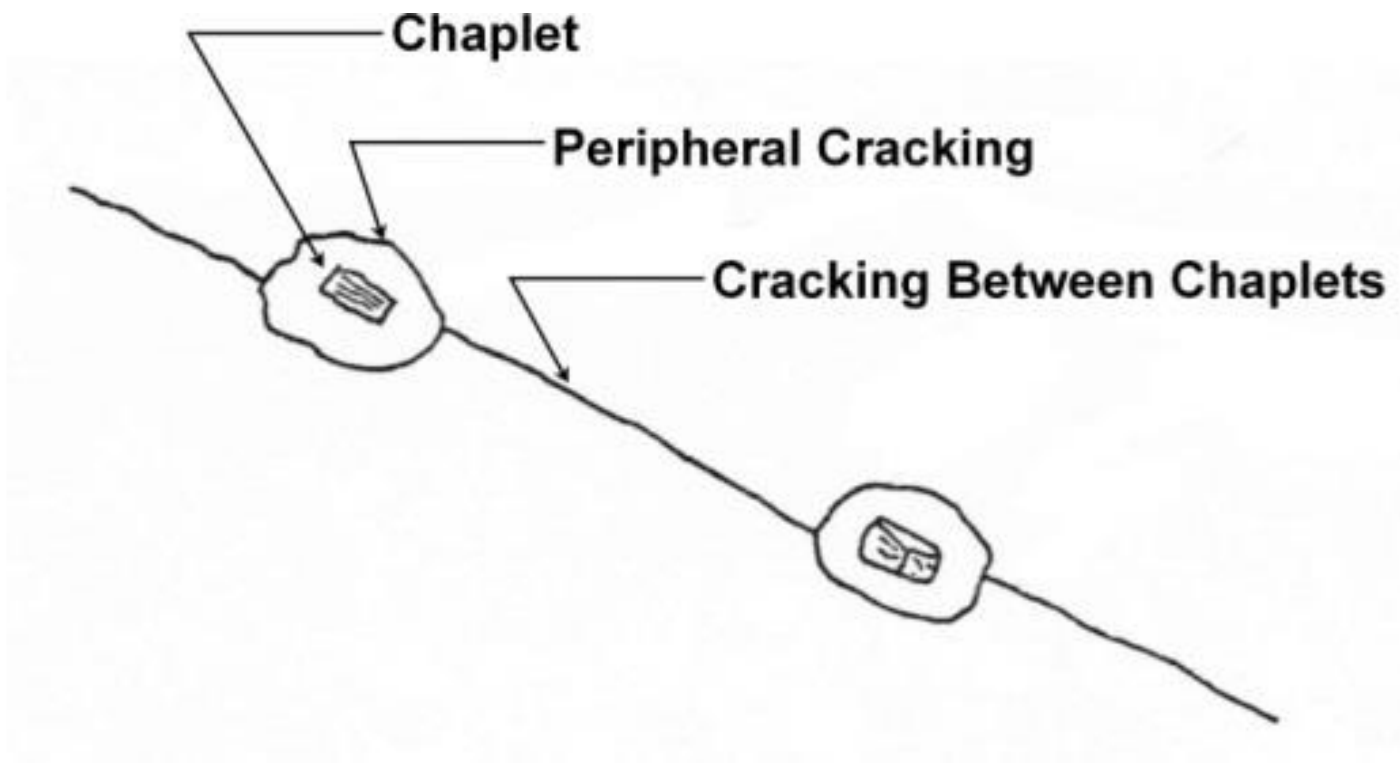


Figure 5.23: Cracking of the Core Around a Tanged Chaplet

This suggests that these chaplets were inserted while the core was in a fairly hard condition, perhaps "leathery" or even harder, a day or so after its basic manufacture. A few of the chaplets worked in the way shown in Figure 5.22 appear to have been folded over during working, again forming a type of hollow tube.

One other form of chaplet seen on instruments SD4A, 37A and 37B is a small, almost round (1-2*mm* diameter) rod which is either flush with the bore or penetrates into this a maximum of 2*mm*. On instrument SD37A these are spaced alternately down each side of the joint-line at about 25*mm* centres this characteristic position being seen all other instruments with this type of chaplet. (See Plate 5.12b, above and Plate 5.13 b, above) This instrument is peculiar in having these fine chaplets in conjunction with those of a "surface" type. As several stages of evolution separate the two types of chaplet it would appear that the fine joint-line type evolved separately and was then incorporated into a mould (SD37A) which had a "traditional" six-pattern of surface chaplets. No examples have been observed where these joint-line chaplets are used on their own. Many instruments now have holes left by chaplets which have fallen out and some of these have been filled sometimes with a soft grey metal like lead and at other times with bronze or brass. It is generally difficult to distinguish ancient repairs from modern but, whereas most of the lead infillings seem to be recent, i.e. they are superimposed on the instrument's patina, others are possibly ancient cast-in chaplet cavities infilled with a lighter-coloured metal, the repair having been done very neatly and now appearing quite unobtrusive.

INSTRUMENT TUBE WALL THICKNESS

The major parameter controlled by chapletting was the thickness of the instrument's tube-wall, as only with very firm control of the core could one ensure that it remained centrally

located in the mould during pouring of the cast. A maker would become aware of the limitations on sectional thickness that arose from his chapletting arrangement and the fluidity of his melt by regard to his scrap-rate. This would clearly be a powerful indicator of what he could attempt in terms of wall thickness and, indeed a progression to thinner walls and, hence, lighter, more economical instruments can be seen in these instruments. Measurements were taken on these horns using conventional measuring equipment viz. micrometers, calipers etc. The ultrasonic thickness measuring equipment currently available can tolerate neither the poor surfaces found on these castings (giving rise to poor acoustic coupling) nor the large-grained and frequently porous metal (giving rise to high signal attenuation) that makes up their bulk. It is hoped by the manufacturers that the first of these problems will be overcome shortly and that use of a variable triggering threshold will enable the second problem to be met on an ad-hoc basis. Thus, the measurements available for analysis in this study are those near the edges of instruments i.e. at their bells, their mouthpieces and fractures. Three sources of variability in wall thickness exist with the casting technique employed here:

i) the difference in size and morphology (mainly roundness) between the core and mould
ii) the disposition of the core relative to the mould at the time when the metal solidifies
iii) the accuracy of registration between the cope and drag - mainly in the lateral mode - at the time when the metal solidifies.

Instrument SD32 shows errors in wall thickness resulting from the situation described in i) above. The instrument had a split core and was, thus, liable to variation due to the specific treatment applied to the joint faces of the core. In this particular case, the joint faces either needed to be rubbed down by a further 0,76*mm* or were being held apart by some material 1.52*mm* thick (This latter case is not too likely as a gap in the core of this magnitude would (a) be seen and (b) lead to a considerably more-prominent joint-line in the bore. Figure 5.24 shows the wall- thickness at the bell.

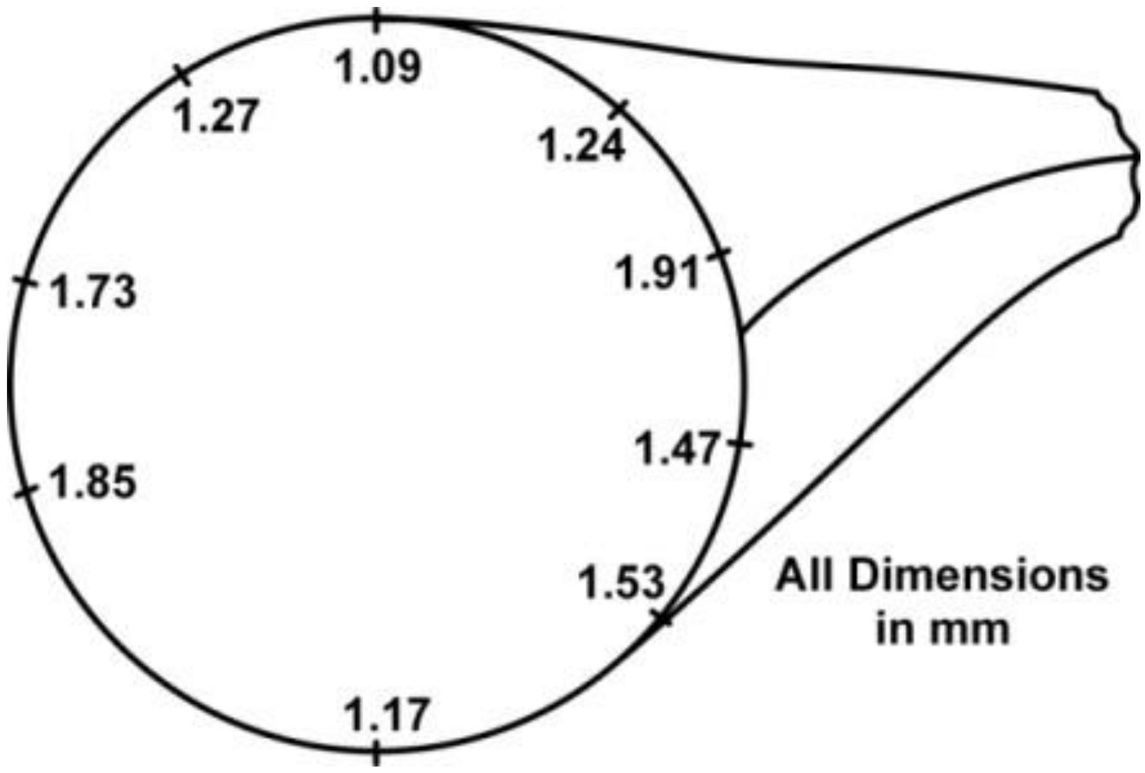


Figure 5.24: Measured Wall Thicknesses on Instrument SD32

Instruments SD16A and 40 both show errors that seem to arise from the dispositional relationship between the core and the mould, i.e. type (ii) errors above. In the case of 16A the core appears to be displaced towards the obverse side of the mould by about 1.0*mm*, while on SD40 the core seems to be displaced by about 0.37*mm* towards the reverse side of the mould.

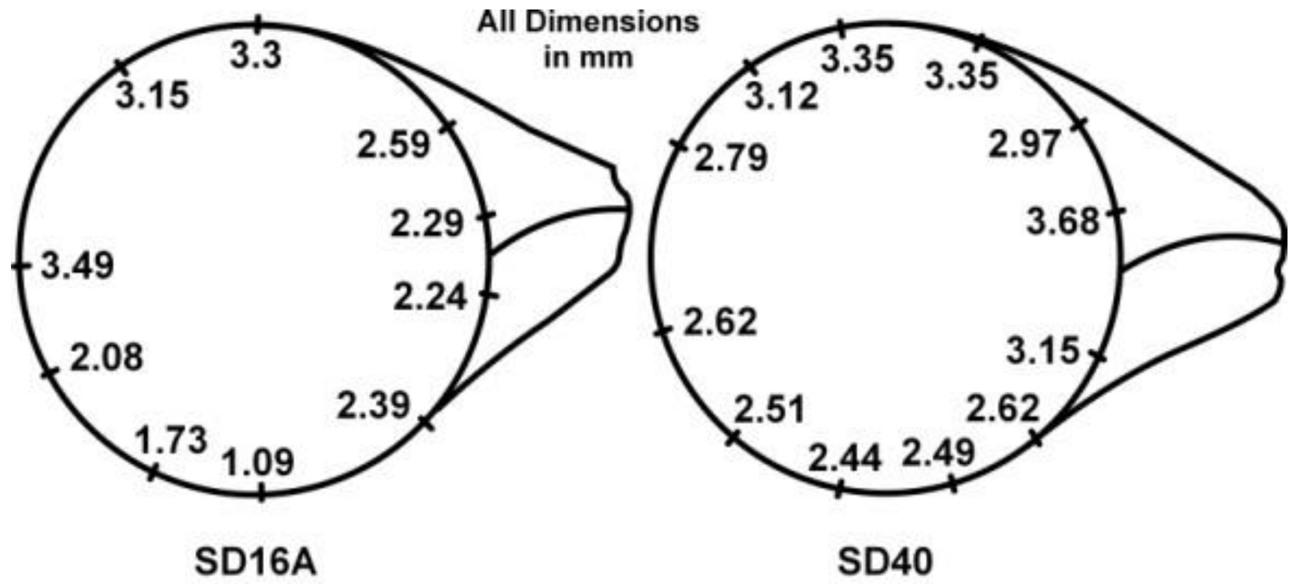


Figure 5.25: Measured Wall Thicknesses on SD16A and SD40

Error resulting from poor lateral registration is present on SD19A; where one half of the mould is displaced by about 1.0*mm* laterally relative to the other half. This is shown in Figure 5.26(a- left) along with the resulting thicknesses when a lateral shift of 1.0*mm* is applied to "correct" this error. (Figure 5.26b - right) These latter figures show also that the cavity in the obverse mould half was actually 0.50*mm* wider than the reverse, giving a section generally thicker by half this amount on the obverse side of the instrument.

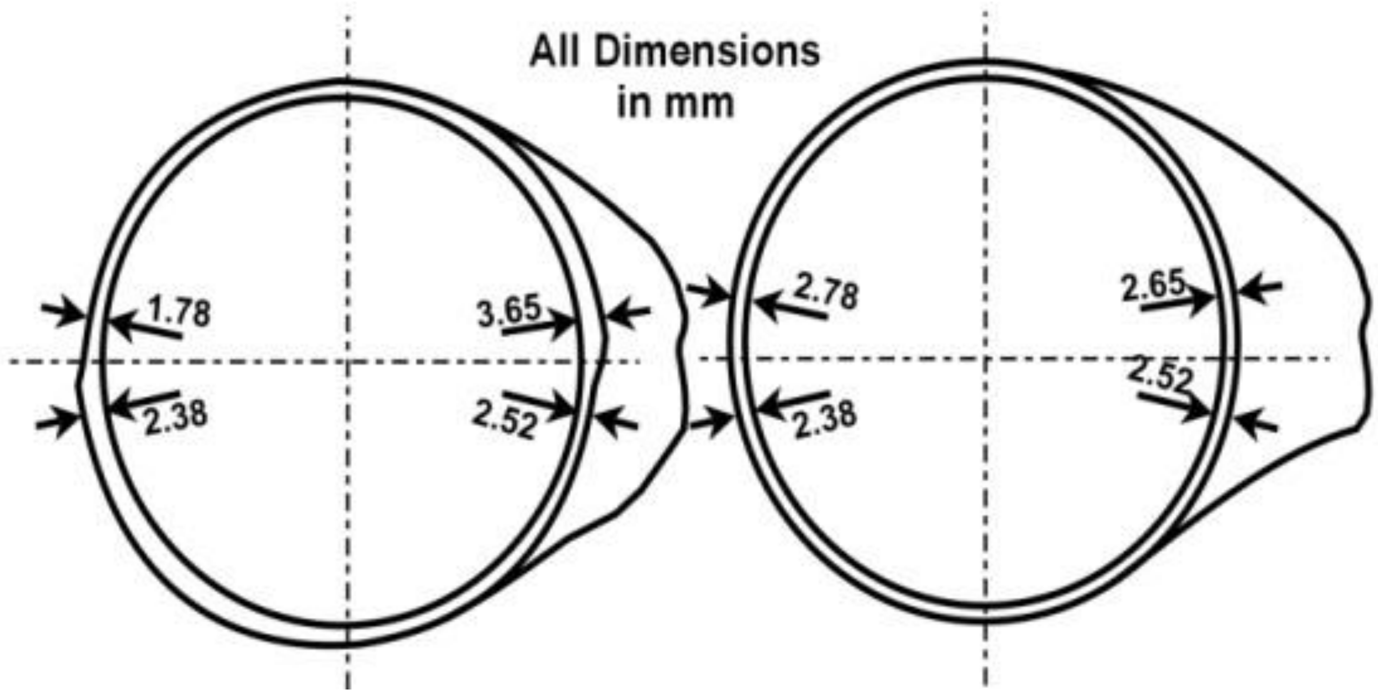


Figure 5.26: Measured Wall Thicknesses on SD19A

No instruments measured showed large random errors resulting from poor match of core and mould. Thus, these must have been made to the same standard of form, i.e. roundness or one generated from the other, presumably the core from the mould. In fact, more noticeable than error is the generalised high degree of accuracy. On SD14E for instance, six wall thickness measurements at the bell gave values of (in *mm*) 2.39, 2.36, 2.49, 2.49, 2.44 and 2.39, i.e. a measured value of 2.43 ±0.065 mm or a maximum variation in bell

wall thickness of 0.13 mm. Similarly on instrument SD14O, eight measurements around the blowing aperture give a wall thickness value of 1.08 ±0.075*mm* i.e. a maximum variation of 0.15*mm*. Measurements at the bell of this instrument gave a mean of six value of 1.36 ±0.23*mm* i.e. a maximum variation of 0.46*mm*. In addition, the measured diameters at the bell of this instrument were (4 stations in *mm*) 25.79, 25.53, 25.75 and 56.19, a diametral variation of 0.66 mm.

These figures cannot claim to be truly representative of the instruments as a whole nor of the generalised value of wall thickness over their whole surface. However, they do indicate that, in the limited stations measured, the makers were able to form both core and mould to match accurately and, in the case of 14O, round to within 0.66*mm*. In the case of SD16B, the instrument showing the roundest element, one carrying ring measured 29·21 ±0.03*mm*, i.e. it was round to within 0.06 mm. (4 Stations) (Figure 5·6, below).

Thus the cores were obviously made to suit the mould and very carefully and firmly assembled prior to casting. There seems to be no clear relationship between the actual thicknesses of these castings and the variation on the instruments measured. However, the sample measured was very small and, in any case, one is only looking at the successful castings, the others, presumably, having been re-melted as scrap. Were the mould halves to be used as core boxes, they would need to have been fired first and these, complete or fragmentary, would then have been quite durable. It seems strange, therefore, that none of these have been reported in Bronze-Age finds.

POST-CASTING TREATMENT

Following removal of the casting from the mould, several operations would be required prior to its use. Firstly the sprues would need to be removed and these seem to have been broken off with the result that a portion of the instrument bell often broke off with the sprue. (SeePlate. 5.10a, above) On some instruments, this coarsely-fractured surface was cleaned up abrasively (SD14G, 27A and 32) while on SD14E it was left in its fractured state.

The casting core would then need to be removed; however, it appears that, on several instruments where failures in wall section had occurred, this core was utilised in the casting-on process. This could be done either by pouring metal directly onto the failed tube or, more elaborately, by removing the core beneath the edges of the tube to give a key to the cast-on metal.

Following any casting-on that may have been required, the core could then be removed. This seems to have been done by poking it as out dry and not by soaking it out as could have been done with an unbaked core. The use of water in this way would have softened the clay at the instrument tip equally and removed this too, whereas most side-blown instruments have the core remaining in the tip. Other instruments also have clay adhering to the more inaccessible parts of the bore; this also would have been removed by soaking out.

Excess flash could then be removed first by chipping off and then by abrasive working. Some instruments feature the joint-line and, on these, the flash would be cleaned up carefully to radius off its upper surface neatly as on SD36B (Plate 5.2a), above). On this instrument, the top and end surface of the joint-line have clearly been worked but the radius between the joint-line and the tube surface is in an as-cast condition. This indicates that this radius was very carefully formed on the edge of the mould prior to casting. The flash in the carrying loops would then be removed by means which are discussed below.

Several instruments (SD4A, 4B, 14P, 14Q, 16A, 16B and 37A) have incised decorations on the bell that was clearly cut in after casting. On five of the instruments this decoration consists of groups of circumferential lines cut into the tube. In the case of the two Dowris tubes (SD14P and 14Q) the lines are very heavily incised into a thick wall while instruments SD37A, 16A and 16B are more lightly done. On 37A, however, the form of the groove cut externally on the bell can be seen on the bore, where the maker came very close to abrading right through the tube. Instrument SD4A has an incised decoration at the bell end consisting of two circumferential cuts downstream of a series of vee-shaped cuts at the bell end. A more elaborate decoration of the same general style is seen on SD8 and consists of three groups of four circumferential cuts with two rows of v-shaped cuts between these. (Figure 5.27) On SD57A a decoration using the same basic elements is used but has an incised v decoration between three groups of raised line.

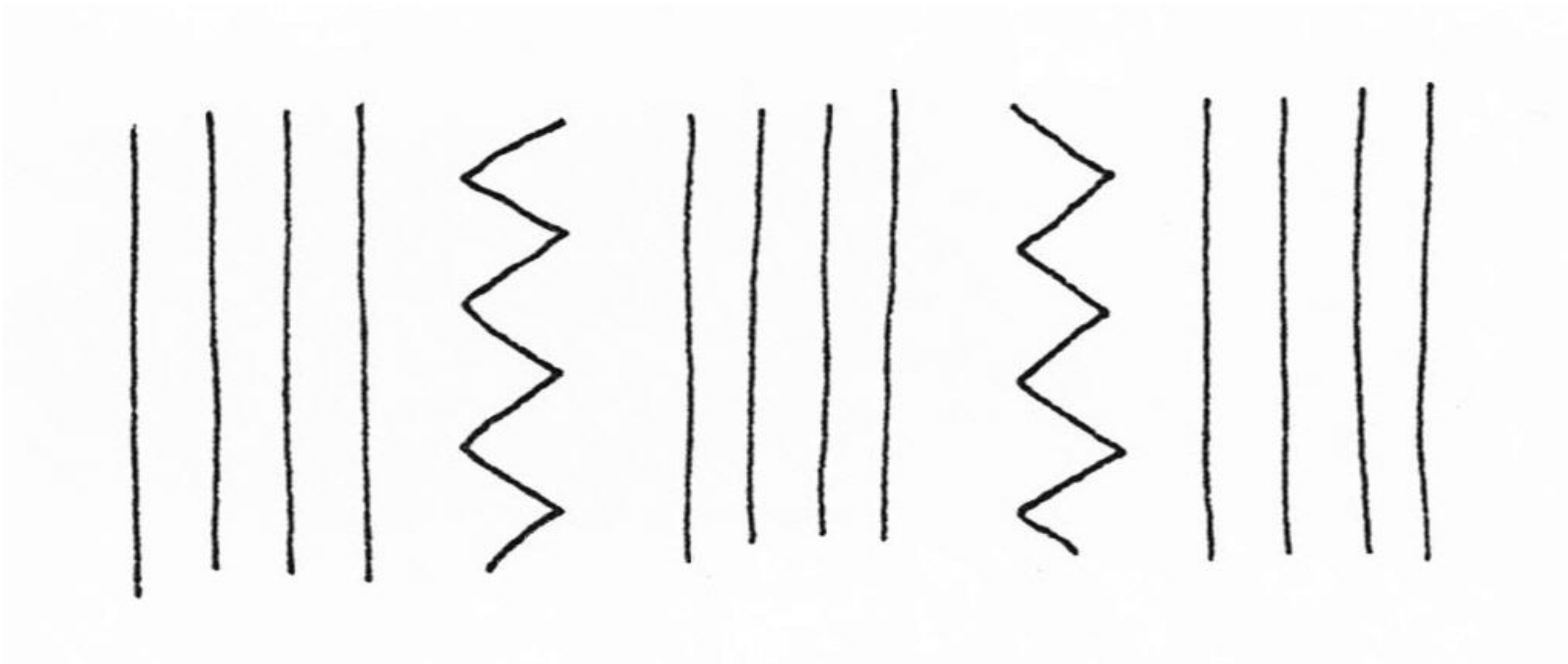


Figure 5.27: A Typical Incised Bell Decoration

THE DEVELOPMENT OF CARRYING FEATURES

The earliest instruments have an integrally cast loop whose position varies widely on the end blown instruments but is generally immediately adjacent to the tip bulb on the end-blows. Loops of this type are common on artefacts such as axes from the bronze-age and their manufacture presented a common problem in the formation of a suitable mould form. In order to form the cavity of the loop the mould halves would need to protrude adequately to core this out. See Figure 5.28

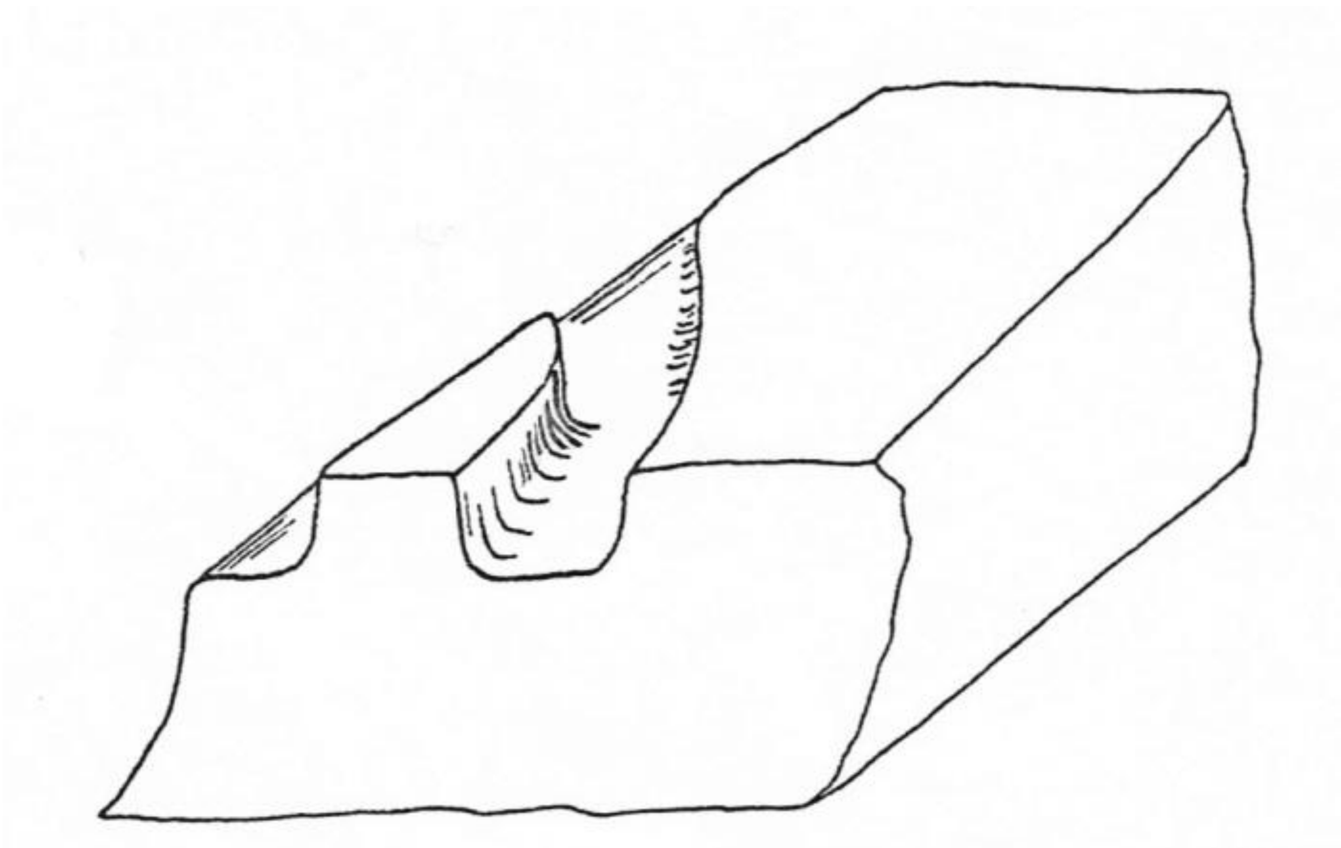


Figure 5.28: Creating an Integral Carrying Loop

Many instruments have examples of excessive flash in the loop cavity which subsequently had to be removed and on one instrument, SD35, this flash remains in position. (Plate 5.16a) Thus, this flash would have to have been removed before the loop could be used.

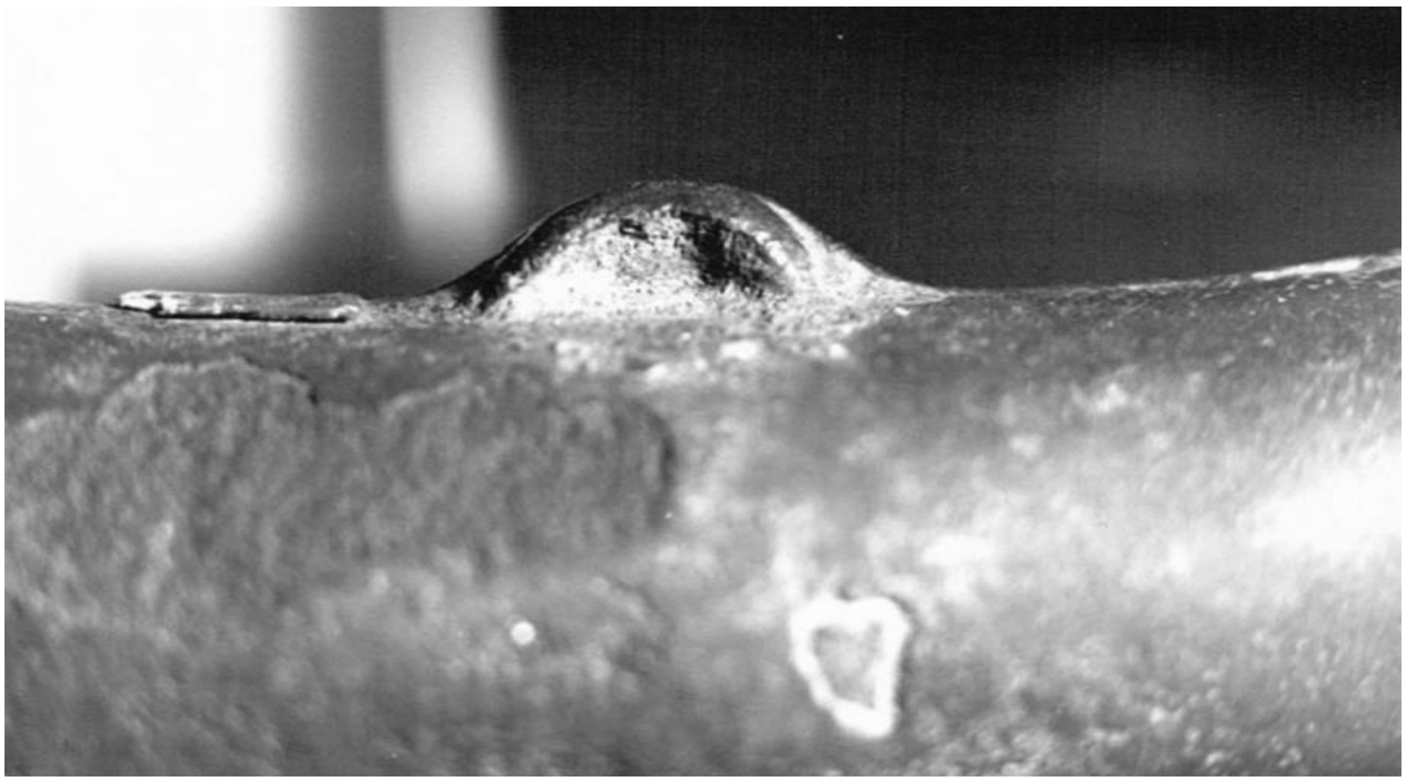


Plate 5.16a: An Uncleared Carrying Loop

On instrument SD36 this flash has been chipped away to clear the loop (Plate 5.16b), producing a relatively small hole with a jagged edge.

Plate 5.16b: A Cleared-out Carrying Loop

However, most other instruments have had the loop cleaned out much more effectively by either abrading out the flash or drilling it out. Evidence for abrasive cleaning is seen on instruments SD48, 14D and 14J, where the loop's aperture follows the form of the loop itself. Other instruments such as SD4A, 14F, 14G, 14L and 37A, have holes whose shape and bore form indicate that they are drilled out. (Plate 5.17a), below).

While the original cross-section of the loops was parallel-sided a development towards a more elegant waisted form is seen on SD14K and 30. On the latter the thickness of the loop is fairly consistent with other instruments but SD14K has a loop that is narrow at its centre (approx. 2*mm* wide) and splays out very elegantly where it meets the instrument tube (Plate 5.17a and 5.17b, below)

Plate 5.17: Carrying Loop Features

A further variety introduced at the tip of side-blown instruments was a larger loop of wider pitch and hence with a larger aperture, for example on SD4A. However, several side-blown instruments (e.g. SD14K and 49) have a tip that is fractured, probably as a result of an excessive load being put onto the loop. On two other instruments (14L and 37A) such a load has caused failure of the loop by pulling it out at the root, leaving behind two torn-out holes in the tip. (Plate 5.18a, below and Plate 5.19a, below)

Plate 5.18: Carrying Loop Features

This design of tip-loop was very susceptible to weakening due to a misplaced core during casting. Thus, were the core to be displaced longitudinally by the thickness of the tip end face, giving rise to a thin section at this tip, then the loop would be very inadequately fixed to the main body of the instrument. In addition to the problems experienced when a successful casting is made, the provision of a suitable pattern featuring an integral loop also presents problems.

When providing a ring mount of adequate size on a wooden pattern a weak section exists at the joint of the mount and the tube, where the woodsgrain flows across the thin section of this mount. (Figure 5.29, below) This weakness would most likely lead to the protruding part breaking off if pressed into the clay. The larger the loop, the more likely it is to break off and, hence the more attempts are made to provide a mount in other ways.

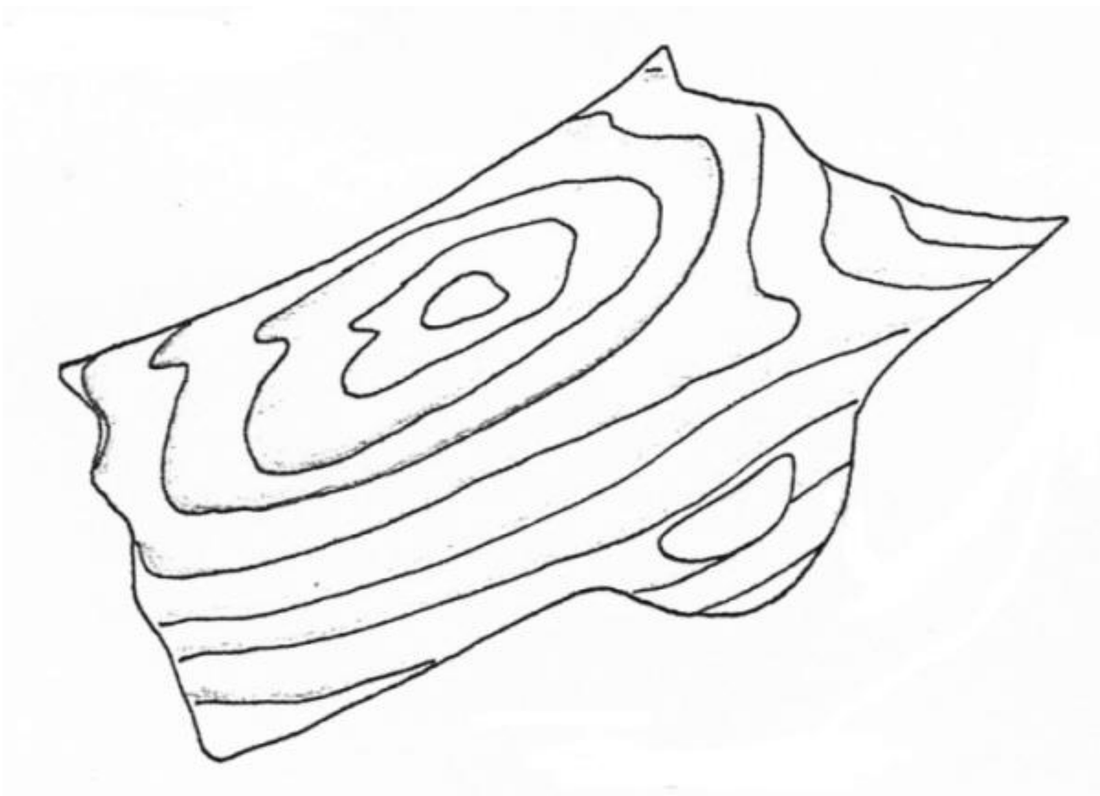


Figure 5.29: The Provision of a Loop on a Wooden Pattern

It is not possible to say in what order the attempts to provide better mounts were made, but one novel design broke away entirely from the established ways of making loops. On this the maker probably saw the loop-cavity infill as a type of core but one that was difficult to make and to maintain during casting. He thus conceived the idea of twisting the core through 90° so that its axis was parallel to that of the instrument. This produced a mount with a hole running along this axis. (Figure 5.30, below) It does not seem possible to explain this in any other way than by saying that it was a deliberately thought out and executed solution.

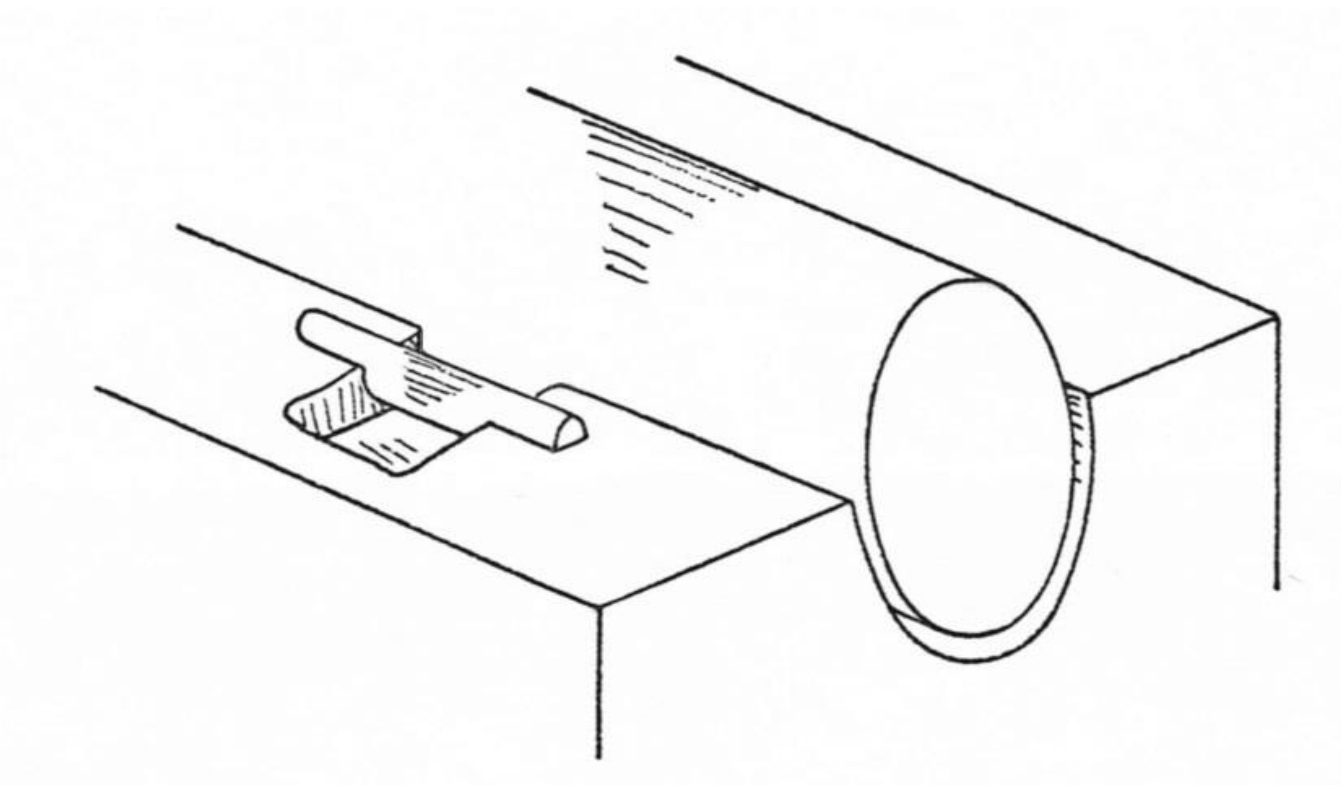


Figure 5.30: A Cored-out Carrying Loop

Only one example of this solution exists, however, on instrument SD14I on which the hole is clearly cored. It is too close to the tube surface to have been drilled and is much deeper, more parallel and rounder than other holes of this period. In addition, the majority of the bore has a clearly cast surface finish with only its two ends having been abraded back to radius it into the tube yard proper. (Plate 5.19b, below, Plate 5.20a, below)


Plate 5.19: Carrying Loop Features

In spite of the adequacy of this design in providing a solution to the problem, it was not adopted as a general solution. Perhaps it was too complex a coring job or perhaps the twisting of the aperture was not acceptable at the time. Nevertheless, the mount aperture parallel to the tube axis became a standard feature on later added mounts.


Plate 5.20: Carrying Loop Features

Future solutions seemed to concentrate on fabrication by the addition of preformed mounts. This can be seen in one form on instruments SD6C and 8 and 36B where a pre-cast ring-mount with an integrally cast root was cast into the tube or the spherical tip bulb. (Figure 5.31)

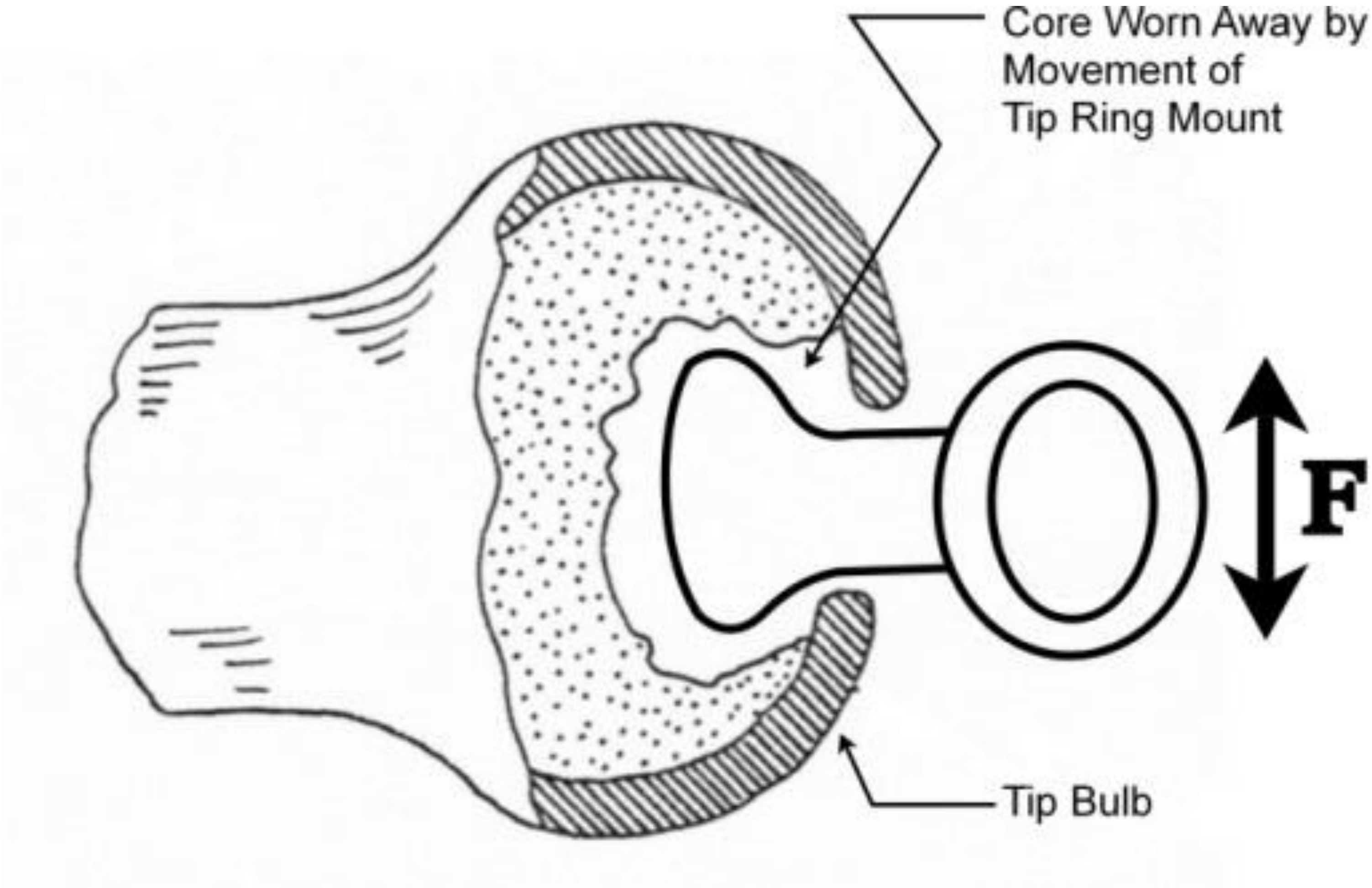


Figure 5.31: A Cast in Tip Ring Mount

As the mould/core assembly appears not to have been heated prior to assembly, the molten metal, on contacting the cold mount probably chilled and, failing to melt its surface layer did not produce a "welded" joint. Hence, when the mount is subjected to a force in direction "F" on Figure 5.31, this pivots on the thin wall section, the core offering little resistance to the movement. Eventually the movement wears away both the wall section and the core, leaving an enlarged hole. This situation, as illustrated on Figure 5.31, is seen on several instruments (e.g. SD6C) where the hole is still small enough to retain the mount. (Plate. 5.20b, above)

On instruments 14M and 7G the cast-in mount seems to have worked loose following considerable use which has worn through its base. This movement has worn away a hole in the tip which is still visible. However, the loose tip has been pushed down into the core and metal poured around this to re-fix it in the tip. (Plate 5.21a and Plate 5.21b, below)

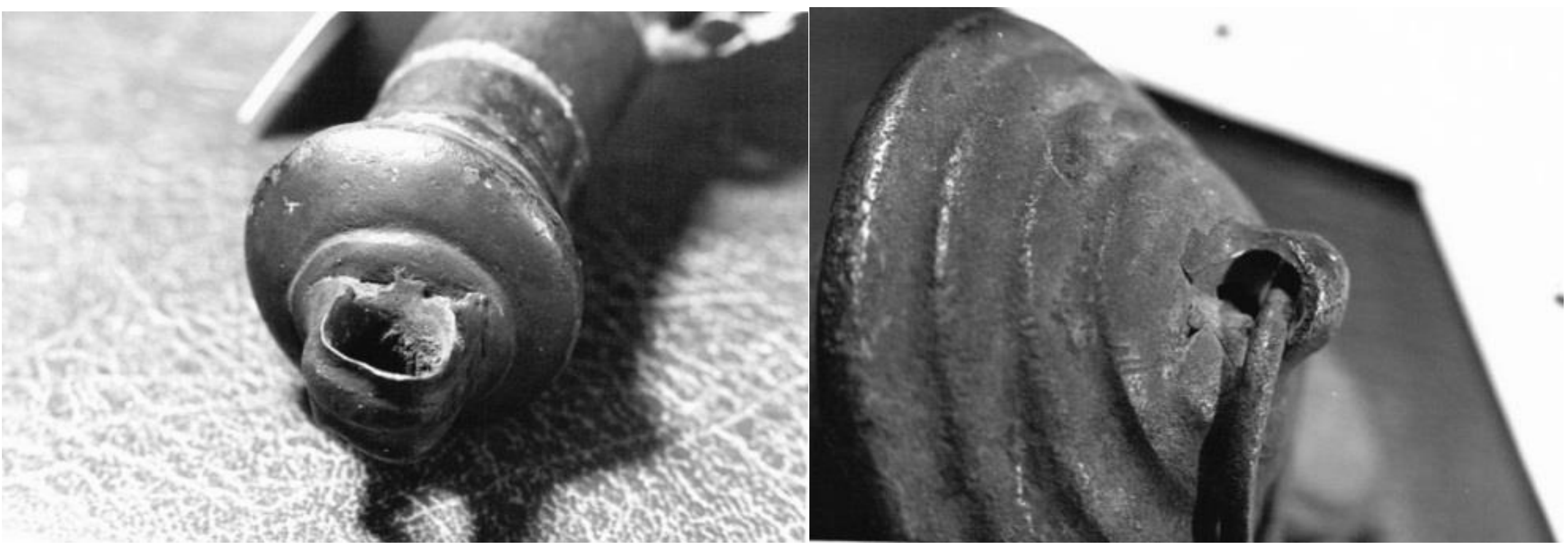


Plate 5.21: Tip End Carrying Loop Features

One important side-effect of the cast-in ring mount is that it provides a further means of supporting the core during the casting operation. Thus, the pre-cast ring would be set into the tip of the core during its manufacture, being adjusted to an appropriate depth i.e. allowing for the thickness of the metal tip. (Figure 5.32) A suitable depression is then made in the cope and drag to take the protruding ring-mount. The whole mould can then be assembled with the two mould halves supporting the tip mount/core assembly.

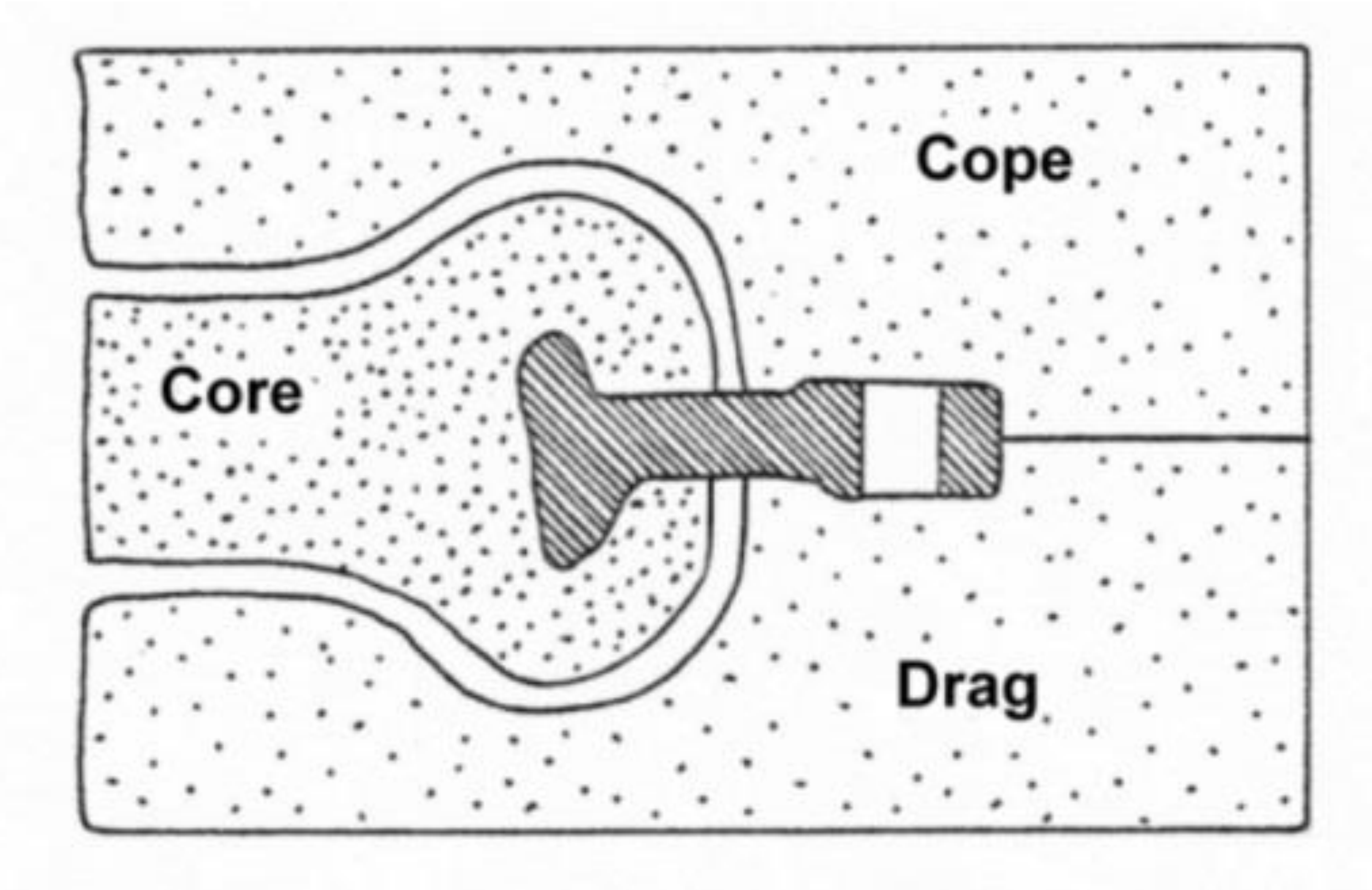


Figure 5.32: Casting in a Tip Ring Mount

A similar technique was utilised to fix the ring mount to the tube yard, this necessitating its fixture near to the tip of the horn where either a suitable wall thickness could be left or the root of the mount could be left in situ without blocking the tube. It may also be that the presence of the core in this zone was seen as further supporting the tip mount root, giving a positive reason for not removing it.

The breaking open of a mould is always an exciting affair being made so by the uncertainty of success. For this reason constant attempts were made to lessen the investment in each casting operation and to break down manufacture into prime-manufacture and assembly. Hence, the latest of the Irish horns were cast without ring mounts, such features being separately cast or wrought and then attached to the tube or tip.

One of the earliest attempts to affix a separately cast ring appears to be on SD36B on the tube, possibly as a repair. On this instrument a hole was made or possibly cast into the tube and a depression in the core excavated. Into this was poured molten metal, to form a blob on the tube wall and the pre-cast mount pressed into this. (Figure 5.33 and Plate 5.2a, above)

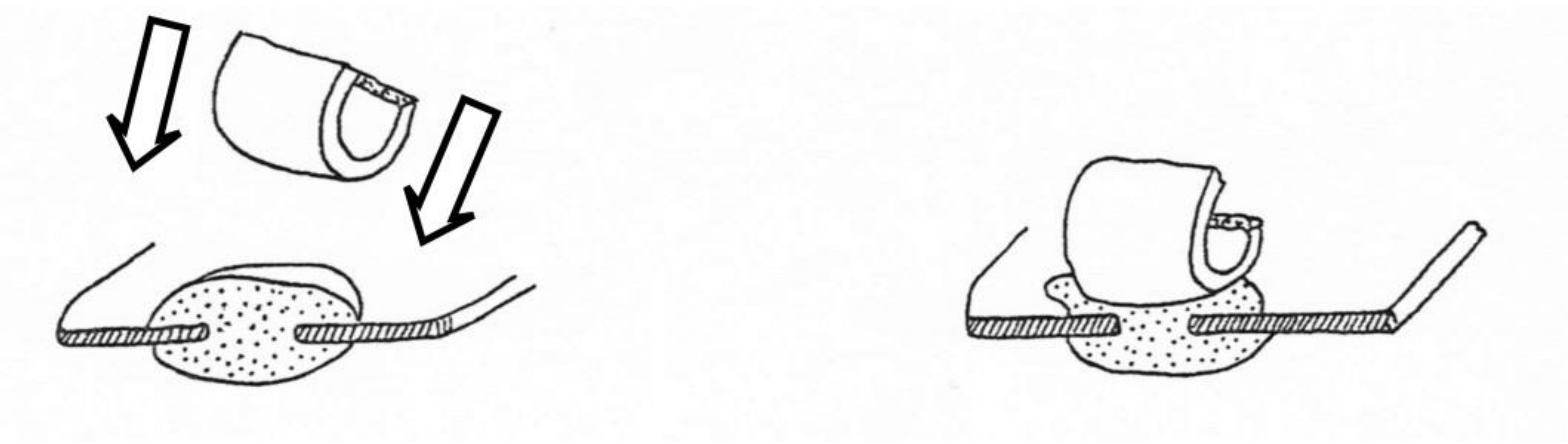


Figure 5.33: Attaching Tube Ring Mounts

Although the mount itself is now broken the area of previously-molten metal around it can be seen as well as metal that has been squashed out on pressing in the mount.

Around the mount itself (on 36B) there is no room for metal to have been poured in and this is in contrast with instruments such as SD7D and 29C where a pre-cast mount is clearly set in a pool of molten metal. (Plate 5.23(a), p. 272) This is most clearly seen on SD29C where a hole has been drilled in the tube wall and subsequently filled with molten metal. The edges of the drilled hole can still be seen as can several blow holes on the infilling material. Whether these came from gas escaping from the core or from burning away of tin is difficult to say. At some stage the mount was set into this material and remains in position although being set at an angle. Two other instruments, SD7B and 19B may have been joined in a similar way, but on these the metal has overflowed the hole and run onto the tube surface obscuring evidence that may have existed. (Plate 5.22(a), p.268._)

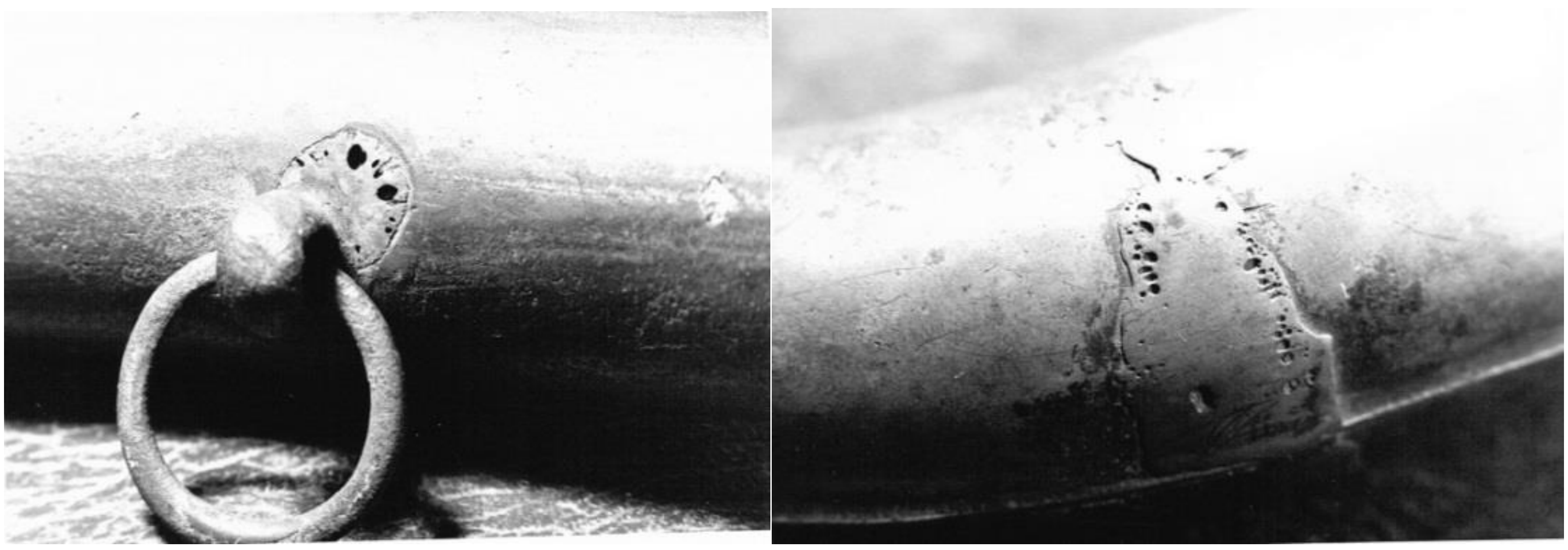


Plate 5.23: Attaching a Ring Mount and a Repair

Where they can be seen internally, the cast-on portions which serve to retain mounts are generally of fairly uniform form and have clearly been cut carefully into a core. On some instruments these are in the form of a blob of material somewhat oval in form approximately 10 *x* 15*mm*, on others they are kidney-shaped and on SD19B this consists of a uniform, neatly cast ring over approx. 270° of the bore.

Eight instruments (SD6C, 7G, 13, 16A-D and 19A) have mounts which are made from sheet and fixed to the tube by the use of added metal. The use of sheet in this way possibly represents a later development than the cast mounts, being used, presumably, when sheet became more readily available and, hence, providing an easier way of producing a mount than casting. That the mount itself is of sheet, is generally confirmed by its uniform section, signs of wrought work and in some cases, as for example SD19A and 16D the presence of the seam where the two edges of the sheet meet (Figure. 5.34). In addition on several mounts e.g. SD13 and 19A, the sheet has formed to a concave cross-section on folding over to form the mount. (See Figure 5.34 and Plate 5.22 a, above)

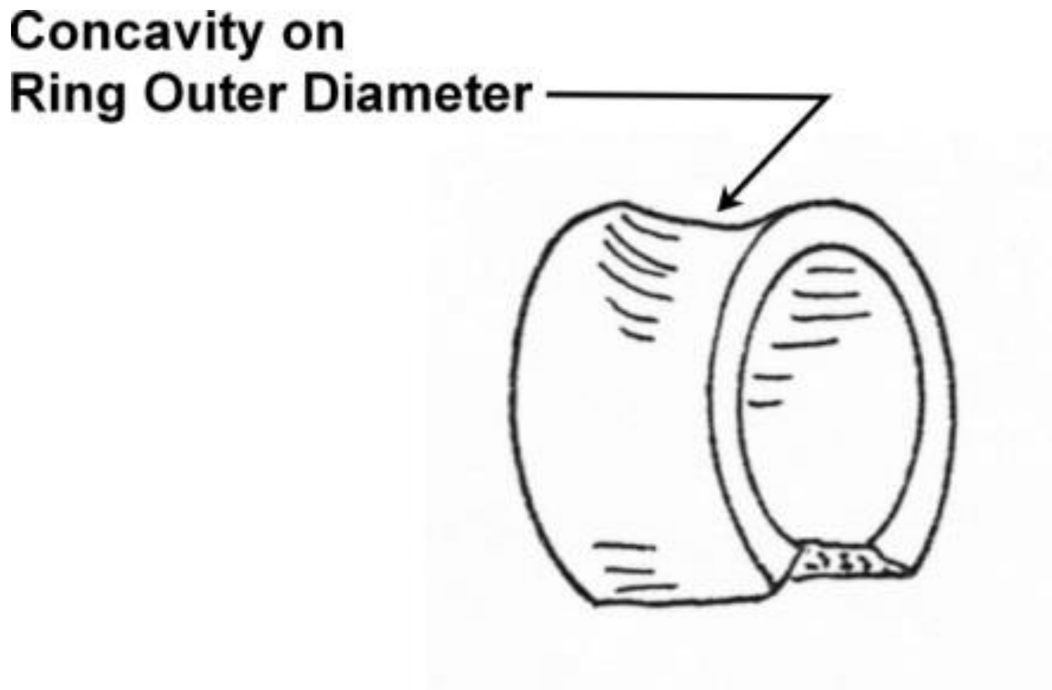


Figure 5.34: Sheet Metal Ring Mount Form

This cross-section is a typical deformation form for thick rectangular section material and is unsuitable for casting in a two piece mould. On instrument 19A, the added metal seems to have been poured through a hole in the centre of the mount probably into a cavity formed in the core. (Plate 5.22a, above) Where the metal was poured in a concave oval of lighter coloured material can be seen with clear sinking towards its centre. On this instrument the mount appears to be very loose and, hence was examined by the British Museum Research Department (Report in Appendix V). They considered that it had not been added but was cast in situ. However, around the mount are fillers of lighter-coloured material which has patinated in a different way from the tube itself and in the case of the tip mount, this adheres to the mount but has broken away from the tube surface. This interpretation does not conform to the opinion expressed in the British Museum report (Appendix V) but their comment on the interpretation of the X-ray photograph seems significant. The "lump of metal" that they identify is probably the rest of the poured-in material used to fix the ring mount to the tube. If this is the case, then the sequence of manufacture could have involved: manufacture tube yard; drill hole in tube where mount to be fixed; remove core to allow metal to flow in to produce a root for the mount; fix ring mount with pre-drilled hole in tube; pour in molten metal through hole in ring mount; (Plate 5.22a, above)

This could produce a root for the mount with a key similar to that used on the cast-in ring mounts (Figures 5.31/32) and the possibility of attaining a braze-type joint between the metal in this key, the tube yard and the ring mount.

One instrument, SD13, has a wrought tip-mount but its ends meet the tip at a steep angle, unlike SD19A where they meet tangentially. On SD13, the mount appears to disappear into the tip itself. It may be on this instrument, that keying-in of the mount, as well as stability during manufacture was attained by use of a bifurcated root attached to the mount itself. (Figure 5.35).

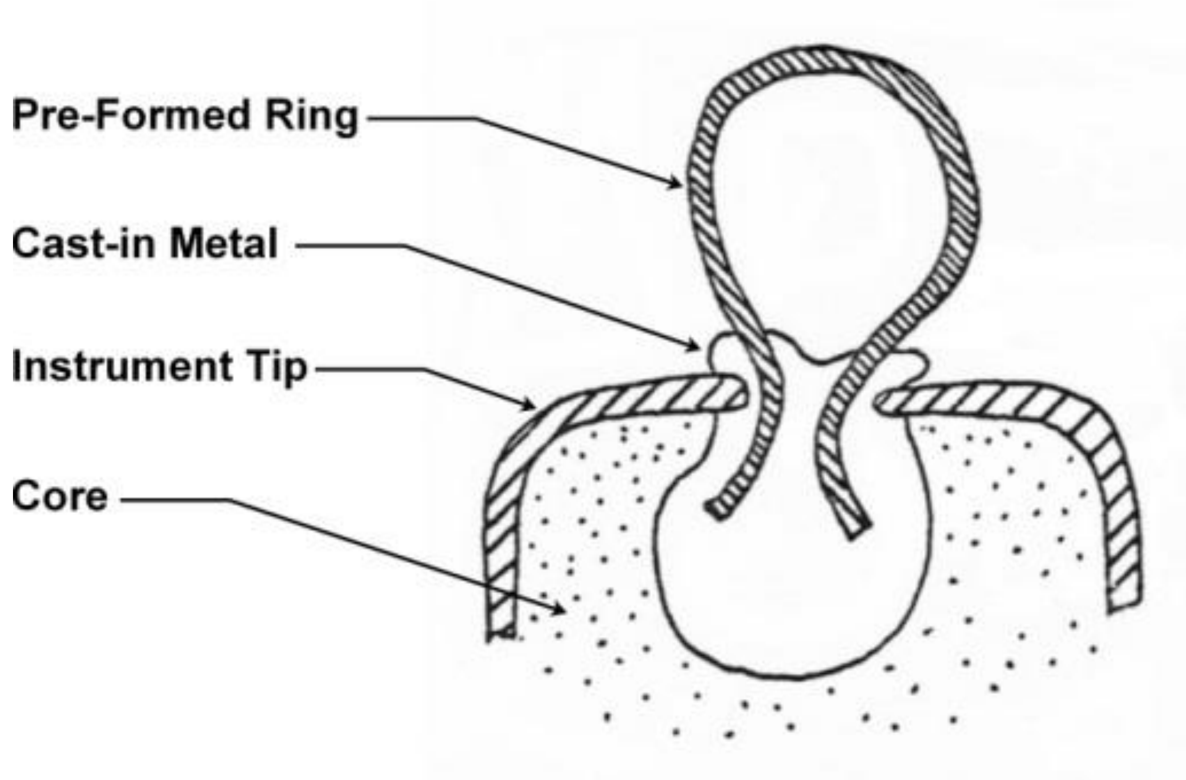


Figure 5.35: A Wrought Cast-in Ring Mount

Molten metal could then be poured around this to attach it firmly to the tip. Pouring in of metal around the mount would have been quite difficult to do neatly and it is possible that a pouring gate was provided to assist in this. Three other instruments also had holes drilled through the top of the mount probably to enable the metal to be poured through this and onto the joint area. On SD7G a blob of metal has run down the mount, presumably having been spilled during the casting-in process and, on instrument SD16D, this hole has been filled in with cast-on material. The provision of larger wrought mounts enabled bronze rings to be attached through these to the instrument. With these mounts the pre-formed ring could be fed through the mount prior to fixing it to the instrument itself. The earliest way of making such a ring would appear to have been to cast this in a two piece mould. However, only one instrument, SD7G, has a ring that still has evidence of a joint line internally, the others apparently having been fabricated and then joined together.

Evidence for this mode of manufacture is most clear on SD19A. Overall, the form of the ring is not round but becomes markedly straighter towards the join where a lighter coloured material is visible. Such a form is commonly obtained when folding metal around a mandrel, as the first formed part can be easily bent and follows the mandrel smoothly. Towards the joint, however, insufficient metal is available to lever the metal around and the ends of the rod then meet at an angle. Also in this case, the inner part of the rod tends not to meet and leaves witness of the join. Such a gap is clearly visible on the inside curve of the ring on SD19A.

On three of the Drumbest instruments, SD16A, B and D, evidence of a join in the rings can be seen. Here, however, this is in the form of a swelling in the tube diameter where material has been cast-on over the join. (Similar to that seen on Plate 5.23a, above) With these instruments the rings attained their largest size, clearly performing an aesthetic function as well as a functional one. Figure 5.36 gives the dimensions of these rings from 16B and 16D. These figures suggest that both rings were formed on a mandrel of approximately. 29.1*mm* bore from rod of approx. 5.5*mm* diameter. In the case of the SDl6B, the ring is round to within 0.27*mm* (4 stations) and on SDl6D to within ±0.05 mm (only two stations). In the former case this degree of roundness (±0.27 mm) would only be attainable by forming around a mandrel and this, in turn, could probably only be made by a generation process. The rod diameter used to make the ring on SD16B varies by 0.5 mm (4 stations) and that on SD16D by 0.81 mm (5 stations). This is of an order that could probably be judged by eye if done carefully but is probably towards the limit of visual perception. On instrument SD16D the tip ring is considerably larger than the tube ring (59*mm*(approx.) bore of 7*mm* diameter rod) and quite recognisably less round than the tube ring.

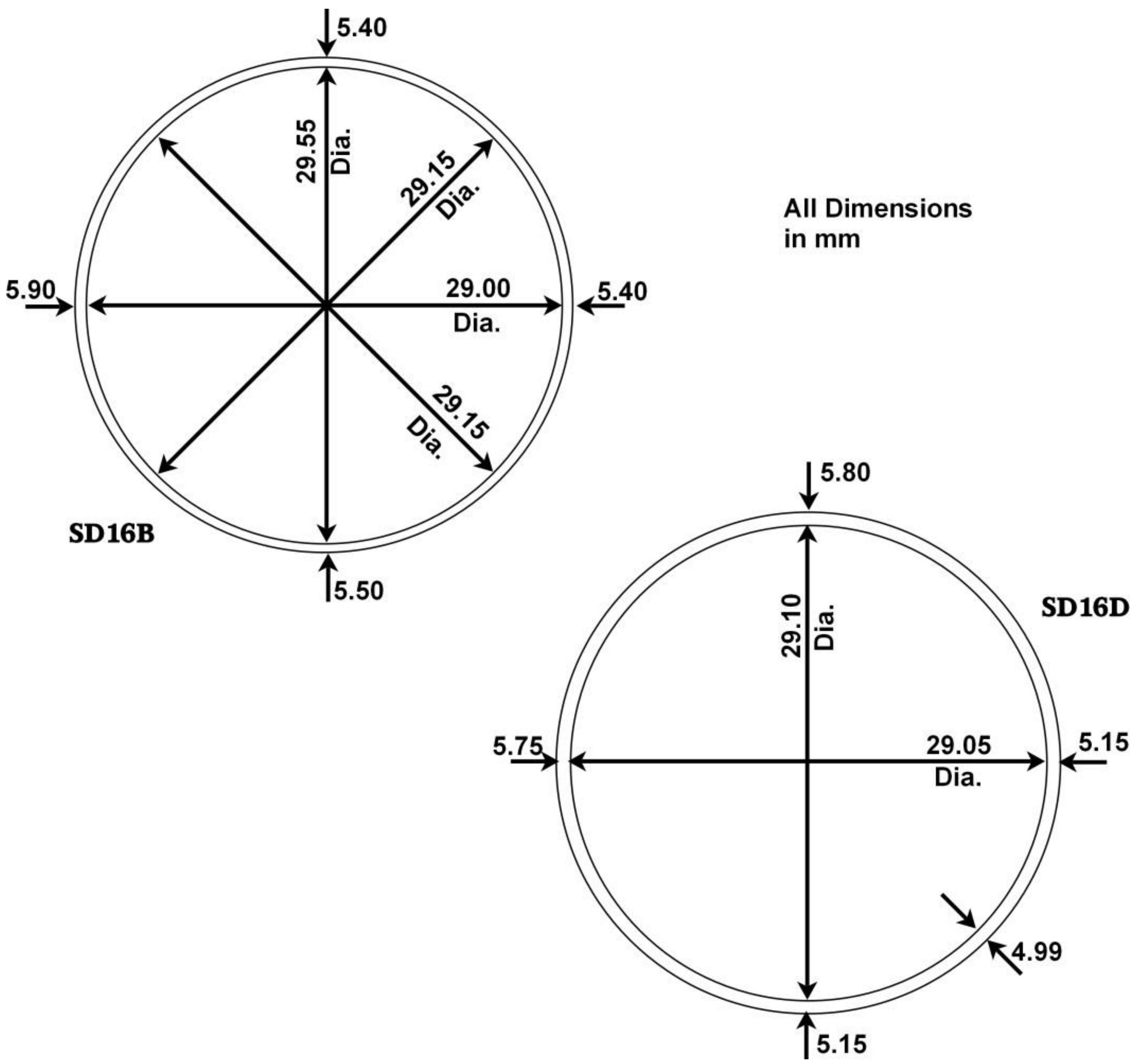


Figure 5.36: Dimensions of the Drumbest Carrying Rings

CASTING-ON PROCESSES

As instruments grew larger, the problems of casting larger sections naturally increased. To some extent, this was solved by improved manufacturing technology as witnessed by the large sections on side-blown instruments such as SD7B, 13 and 19A, but techniques were also developed for casting-on sections and joining by casting-on. In both these cases, a mould had to be made which incorporated the parts to be added to or joined together, as well as providing the cavity for casting into. This involves a deeper conceptual grasp of mould design than in lost wax casting where the material to be added is modelled onto the previous casting in wax, thus producing an analogue of what is finally required. When using a split-mould technique the cavity has to be carved out to the desired form in mirror image.

Casting-on was also used generally, to repair defective castings and those broken in use, to add on additional parts to instruments and apparently to modify instruments to suit changing needs in decoration etc. Repairs effected by casting-on vary greatly in their quality and effectiveness. On instruments SD29C and 43, for instance, the general quality of casting-on is poor with the added metal being poorly formed and, in particular causing considerable blockage of the bore. On two other instruments (SD14O and 13), broken tubes were repaired very effectively by casting-on. In the case of SD14O, at least two phases of casting-on can be recognised from the difference in colour of the two alloys used. (Plate 5.23b, above) The added metal here, however, is only 1-2*mm* at its thickest point and it seems probable here that the molten metal was simply poured over the tube. With the other instrument, a side-blown type, the tube failure occurred across the mouthpiece and a more elaborate joint was made. To do this, four holes were abraded through tube adjacent to the fracture and several other notches were made which did not break through. A core was then built up inside the tube and holes made in this to correspond with the holes in the tube. It is probable that a two-piece mould was then built up around the area to be cast, no evidence remaining to verify this although the cast-on material appears to be homogeneous. On pouring, a band around the tube was formed and metal flowed through the holes in the tube and over the rim of the mouthpiece aperture forming a lip. (Figure 5.37)

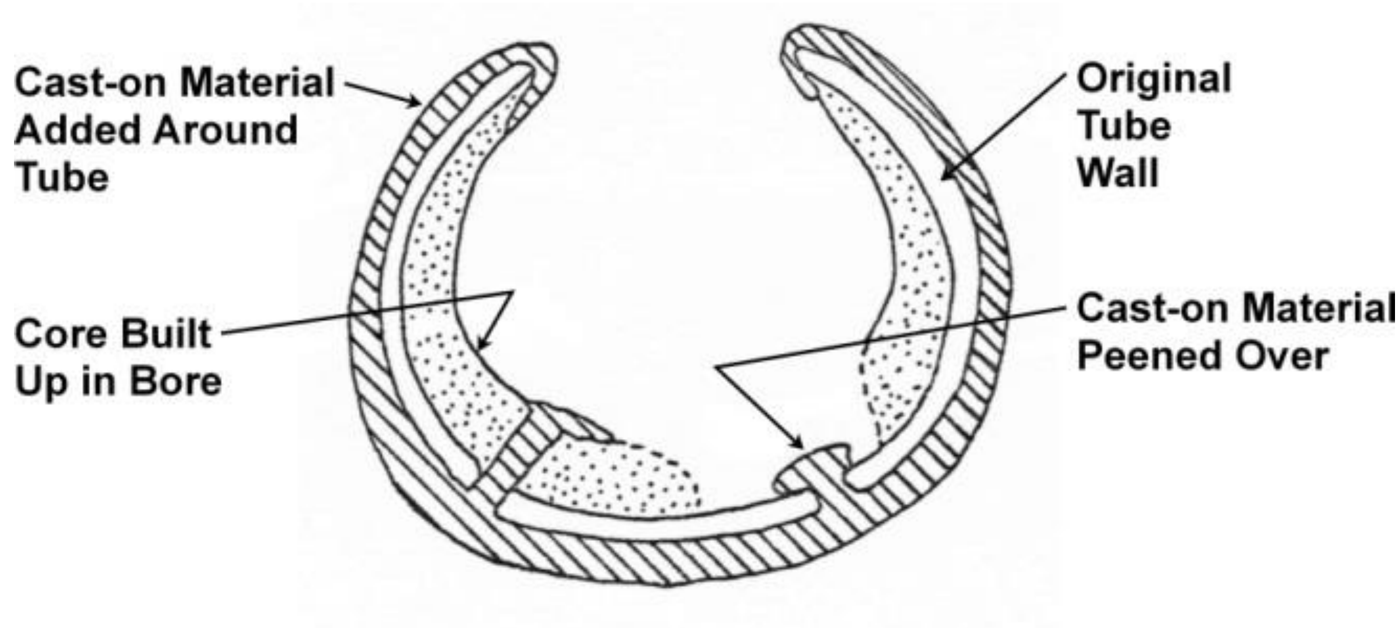


Figure 5.37: A Cast-on Tube Repair

The core was then removed and the metal that had flowed through the holes peened over to effect a tighter grip on the tube. (Plate 5.22b, above)

Evidence of the use of two piece moulds when casting-on is seen on SD14I, where a section of tube is cast-on over the original tube. The joint-line on this cast-on portion is clearly visible and is not coincident with the original joint-line. Over the top of this repair, was then cast-on a band which also has a clearly visible - an individual joint-line. (Plate 5.24a)

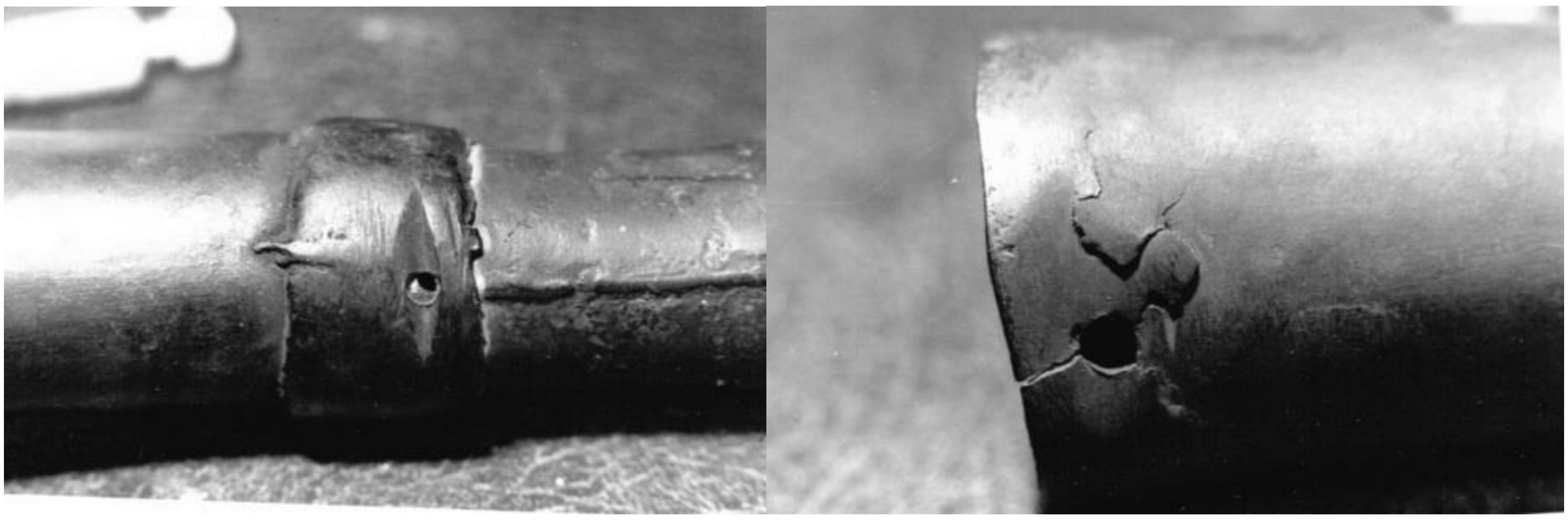


Plate 5.24: Post-Casting Work on Tubes

As a process in its own right, casting-on was developed to a high degree, as witnessed by the repair carried out to the mouthpiece of 16B. This was broken by fracturing off a segment around the rim - l6A is still in this condition - and a piece of bronze, clearly not the original piece, was set in by casting-in with molten bronze.

Many instruments have cast-on repairs at their bell end, presumably many of these restore the parts of tube broken off when removing the casting sprues. However, decorative features such as spikes and mouldings were also added by casting on, the former of these being discussed below. Rope moulding was cast-on onto the bell of SD4B along with 12 small decorative spikes. Instrument 14I was similarly added to at the bell but, in this case, the added material served to fill in four holes that were formerly present there. Subsequently two new holes were drilled through this cast-on material. (Plate 5.24b, above).

When casting-on, one of the major problems is the formation of a reasonable bore, i.e. the provision of a suitable core. This could be less of a problem when repair to a defective casting was being carried out as the core remains in situ. However, under other conditions, a core would have to be constructed specially to suit the area being repaired. Such a core seems to have been made in instruments SD22A and 43, where the bore is only roughly formed and metal has flowed over the end of the core to constrict the bore. On the latter of these instruments five pieces of tube had been bent over into the bore probably to hold the core in place during the casting-on operation.

Several instruments have had slots abraded on the surface to key in cast-on metal and SD13 had holes drilled to provide a key. It is not possible to say, however, whether or not particular attempts were made to clean surfaces or to apply fluxes to these prior to attempting to join metal to metal. The earliest reference to the use of fluxes is in Pliny[201] and the recipe given is long and involved. However, he is writing from a society which has a tradition of metal working passed on over 4000 years from the Middle East.[202] Unfortunately, we can claim no such continuity of technical development for Ireland and hence cannot assume that the knowledge from the Middle East was available to the Late Bronze-Age Irish craftsman. Indeed, as far as the joining of metal to metal goes, many cast-on features have a film of fine clay between the two metal surfaces (SD7B, 24D and 4L). The latter two of these instruments have only a fine film that can be seen but on SD7B two layers of clay, some 1-2*mm* thick are present. These lie between the instrument tube and two separately cast rings at the tip of this instrument and adjacent to the fracture which currently terminates it.

Casting-on was utilised on SD19A, a large type II side-blown horn to add on the tip cone. Its use on this instrument was very effective in that it is still intact and only reveals the joint between the tube and tip following close inspection. It is clear, therefore, that a technique of flow-welding had been developed which allowed the metal adjacent to the joint to be heated up to its melting point in order to achieve fusion of the metal. In the case of this joint, construction of the mould was probably facilitated by leaving in the core-print which was then carved to the desired shape and served as part of the core for the addition.

End-blown instruments, being longer than side-blown were more generally assembled by casting-on sections or joining sections by this process. Instrument SD14I, for instance, was made up from a tube and a bell joined by a cast-on boss to form what appears to be an integral instrument. Two other longer instruments, SD16A and 16B were made up from tube and bell parts cast together, but the level of craftsmanship on these is very high, of a different order from most of the simpler casting on.

The cast-on joints on these instruments are virtually identical and were clearly made by the same craftsman. They seem to have had four stages in manufacture as outlined on Figure 5.38, these stages being:

(i) casting of the tubes
(ii) casting—on of the raised mouldings around their tube end
(iii) assembly of the two tubes
(iv) casting-on of the thin wedge of material between the two tubes.

It is hard to explain why stages (i) and (ii) were done separately as it would seem that these could have been done in one casting operation to fuse together the two tubes.

[201] Pliny Liber XXXIII Chap. V, Sections 26, 28 and 29.
[202] (Maryon, 1938, 190)

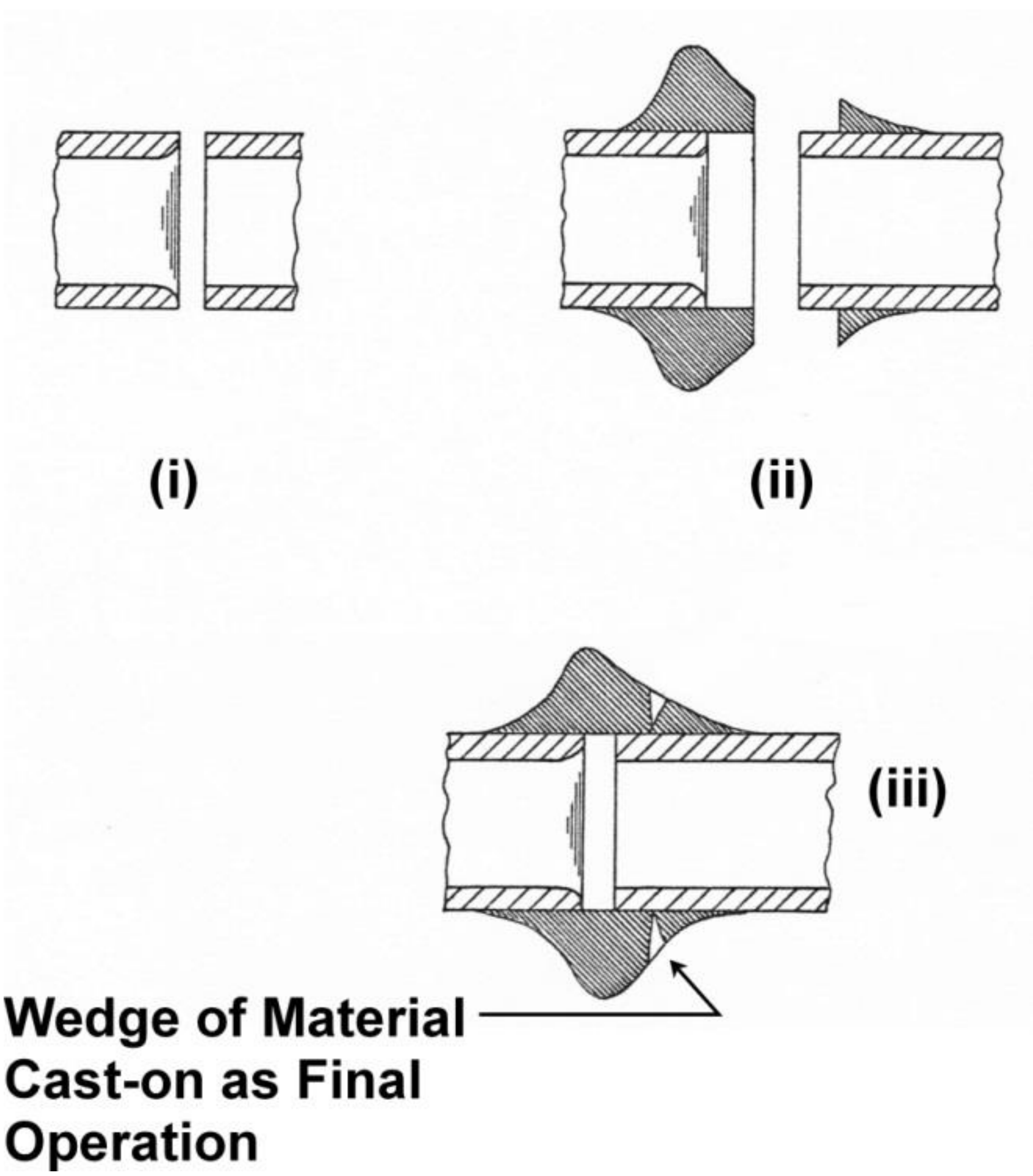


Figure 5.38: Joining together of the Drumbest End-Blow Instruments

THE PROVISION OF "SPIKES"

Most of the horns identified as type II instruments by Coles[203] (1963, 326 ff.) are decorated with prominent conical spikes. These are well developed on the later instruments and of a fairly regular form.

However, considerable variation in both form and method of manufacture exists throughout the instruments as a whole and several stages of development can be identified. Many instruments with spikes at their bell end also have holes drilled here, frequently downstream of the spikes and, in the case of SD7C, 26 and 27A the number of spikes and holes are the same and on the latter two instruments match up in position. There is, thus, a clear design relationship between holes and spikes on these. This relationship can be seen on instrument SD14A to be one of identity. On SD14A three holes were drilled at the bell end of the instrument spaced as for four. One of these remains in its drilled condition, a second has been infilled with bronze which bears signs of both hammering and abrasive working while the third still contains a bronze rod of

[203] Coles, 1963, 326 ff.

approximately 4.5*mm* diameter. This was set in by pouring molten metal around the rod while placed in the drilled hole. The rod and the viscous-looking cast-on material meet each other over most of their length at about 90°, i.e., the liquid metal did not wet the surface of the added rod and was cast too cool. Protruding from the tube surface by about 10*mm*, the outer end of the rod is peened-over somewhat.

Plate 5.25a: A Cast-on Spike

It appears, therefore, on this instrument, that the holes were provided as sockets to hold these rods while casting them in. A further possibility exists, of course, that a change of use of the holes occasioned their filling-in in this manner, A similar type of construction, i.e. casting-on, was utilised on instruments SD14F, 14K and 17A although, on these, the spikes are conical in form. On 14K, these are fairly sharp cones and their junction with the tube is obscured by a build-up of cast-on material. (Figure 5.39; Plate 5.25a, above) Similar features are seen on the large cauldrons such as those in both Dublin and Belfast museums. On these the spikes have generally been identified as rivets and this may, indeed, be part of the story. However, some casting-on has taken place around these features as witnessed by the deposits of cast material around the spikes themselves -as shown on Figure 5.39.

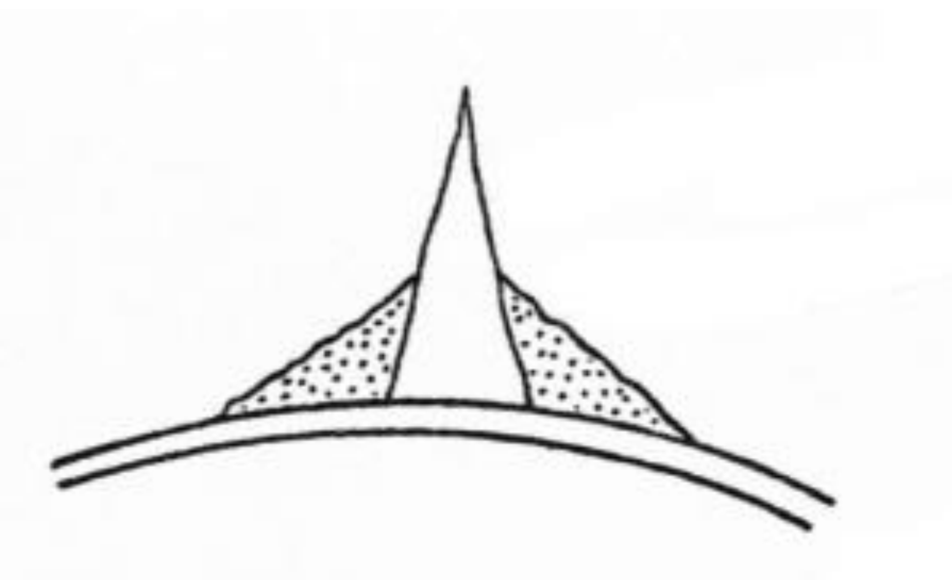


Figure 5.39: A Cast-On Spike on SD14K

The casting-on of small features such as spikes is technically quite difficult for, not only must the cast-on material be restrained to give the right form but it also contains little heat and is, therefore, very readily chilled by the metal with which it comes into contact. Such problems are eliminated when the spikes are cast integrally as was done on most of the later instruments. However, the earliest attempt to provide integral spikes seems to have formed these directly on the end face of the bell itself. These are seen on only one instrument where four rectangular "spikes" are spaced with each between the sprue junction and the joint-line and their end face is common with the instrument bell end. (Plate 5.10a, above) To form the mould cavity for these, material had been removed from the end face of the mould halves and the containing wall re-formed by the core butting up against the mould end face. See Figure 5.40

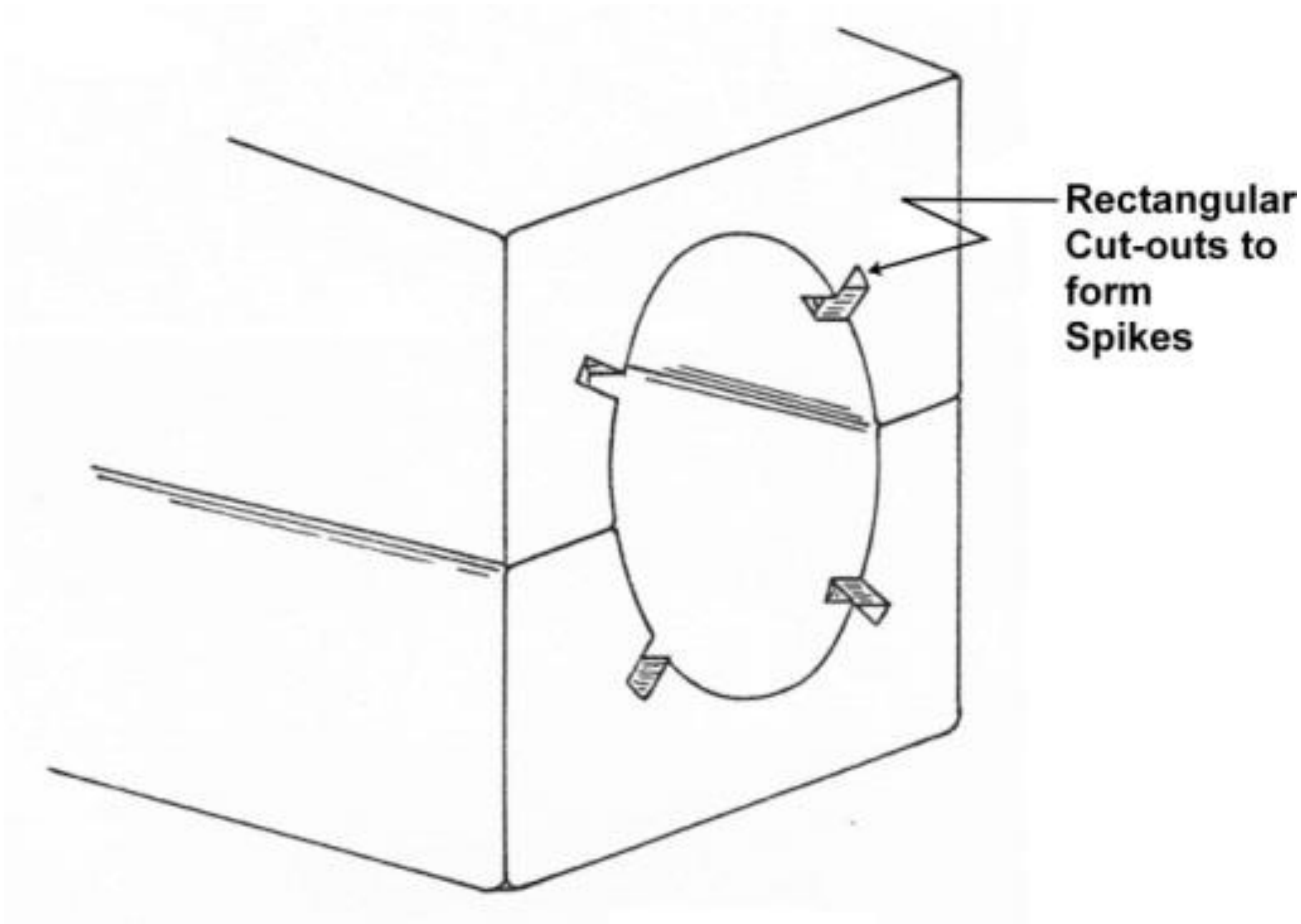


Figure 5.40: Forming the Spikes on a Bell End

Instrument SD14L has "spikes" spaced around the periphery of the bell in a similar way but these are generally set in by a millimetre or so from the instrument end face. Hence on this instrument, the "spikes" had been formed by pressing a cylindrical former into the mould to form these cylindrical features. It appears that a similar technique to that on SD14 had been employed in the construction of the mould and that the core print diameter was greater than that of the bore ·itself. This left a thin wall at the mould edge which in the case of one "spike" broke away, giving rise to one irregularly shaped feature. (Plate 5.26(a))

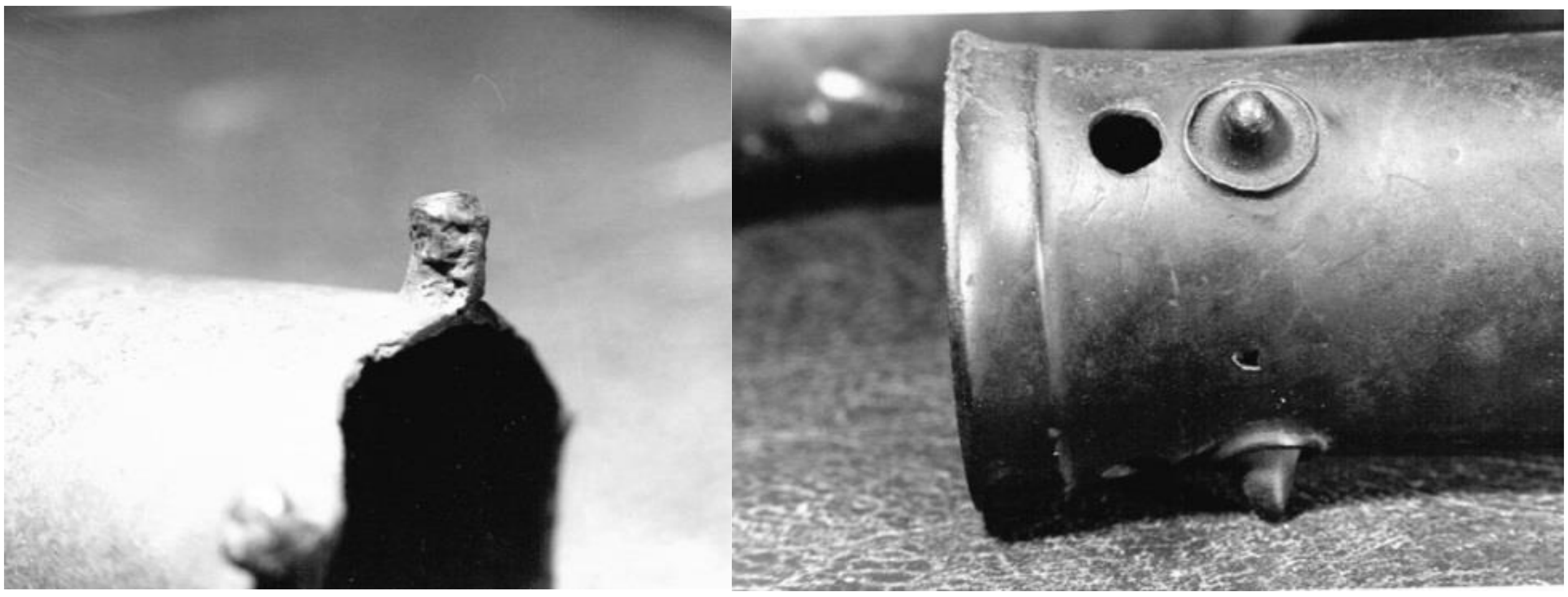


Plate 5.26: Tube 'Spikes'

Having formed the spikes in the mould in this manner, the way was clear for their "migration" upstream to the commonly found location a few centimetres from the instrument's bell edge. The restriction on the form of these "spikes" was also removed in that, whatever form could be pressed into the mould and then satisfactorily retracted could be used - and a conical form was ideal for this. Thus, many later instruments have conical, integrally cast, spikes spaced around their circumference, some of these having hollowing underneath them.

Once the technique for forming the spikes had been developed, the way lay open for the evolution of different forms of these. Many forms did develop from eye-shaped cross-sections on cones, through slightly spherical cones through to small domed or hemispherical shapes. Their most developed form seems to be that seen on instruments SD27A and 27B where a slightly spherical cone is surrounded by a raised concentric circle. (Plate 5.26b, above.)

On SD27A these spikes are present both at the bell end and the tip, this being the only instrument so decorated. This spike form is similar in some respects to decoration seen on bell discs of lurs from the Zeeland group (See Chapter 4, above). Viewed on its own, this form of spike appears to be the latest of the series and, the other advanced features on this instrument tend to re-enforce the view that this instrument is one of the latest made.

Many instruments contain holes which were provided for several purposes and in several ways, the commonest location for holes being at the bell-mouth where there are almost always four holes. Probably the earliest such apertures are on SD14F, where they appear to originate from clay plugs used to support the core during casting. (Plate 5.12 (a), above) Among the crudest holes is that seen on Plate 5.27a which was produced entirely by abrading through the tube, obtaining an ill-formed hole.

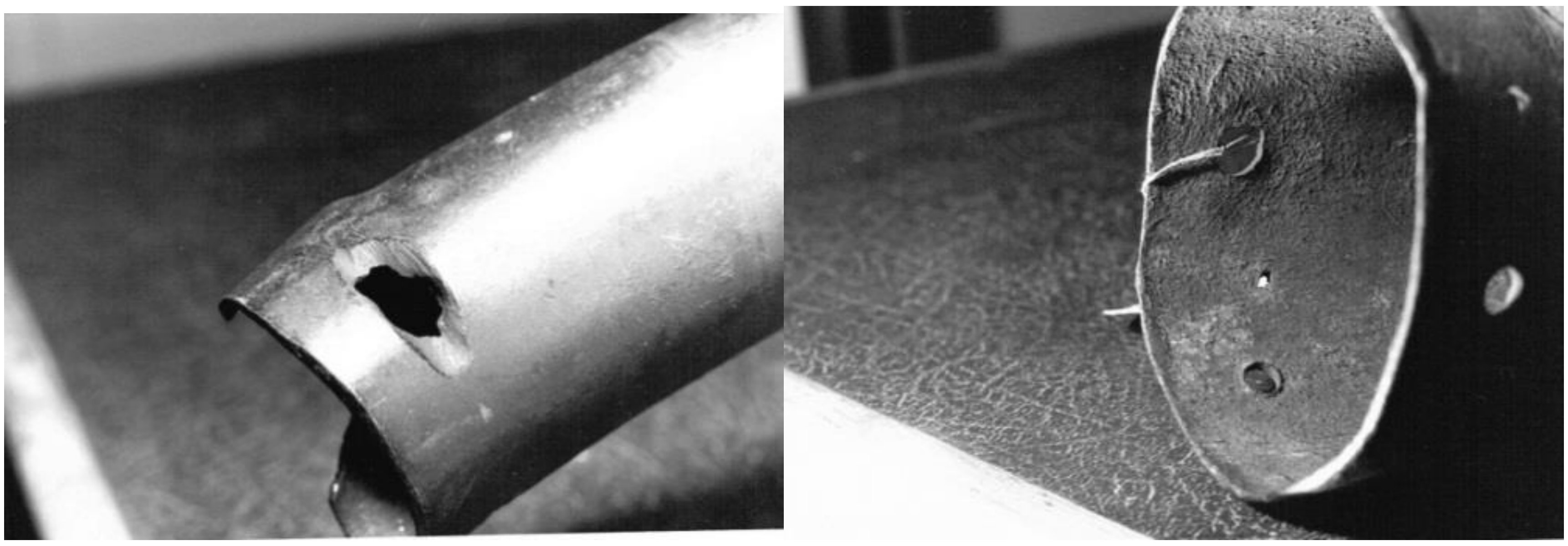


Plate 5.27: Post-Casting Work on Tubes

Many other instruments, however, (e.g. SD7D, 14A, 14I, 19B, 29D and 41) bear signs of having been notched prior to drilling. (Plate 5.24a and 5.24b, above) In the absence of a centre-punch and, particularly when faced with a brittle cast tube, abrading an initial breach in the tube wall would give a good lead-in for drilling.

There are many instruments which have holes of both slotted and unslotted types and the presence of the former may well tell something of the technology available for drilling holes, in particular the form of the drill bit itself as well as, in some instances something about the abilities of the actual craftsman working on that particular instrument. Many much earlier examples of holes made abrasively in this way exist, the earliest reference found in this study being of a hole in a shell of Turritella found in a Palaeolithic site at Sagvarjite in Georgia.[204]

Considerable pressure seems to have been applied when drilling holes in this material as many holes (in particular on SD7D and 1B) show very heavy burring-over on the bore. Only few show evidence of deliberate removal of these burrs SD7A having been abraded in the bore adjacent to the holes and those in SD17B having been roughly countersunk. Also on instrument SD29C, the hole made in the tube, to allow the tube-mount to be cast in, was fairly heavily countersunk, (Plate 5.23a, above) Holes were also used for keying cast- on material (e.g. SD13) and SD49 seems to have been prepared for a casting-on operation by drilling a series of holes around the edge of the broken tip but nothing further was then done on these. (Plate 5.28a, below.)

[204] Semenov, 1964, fig. 22.

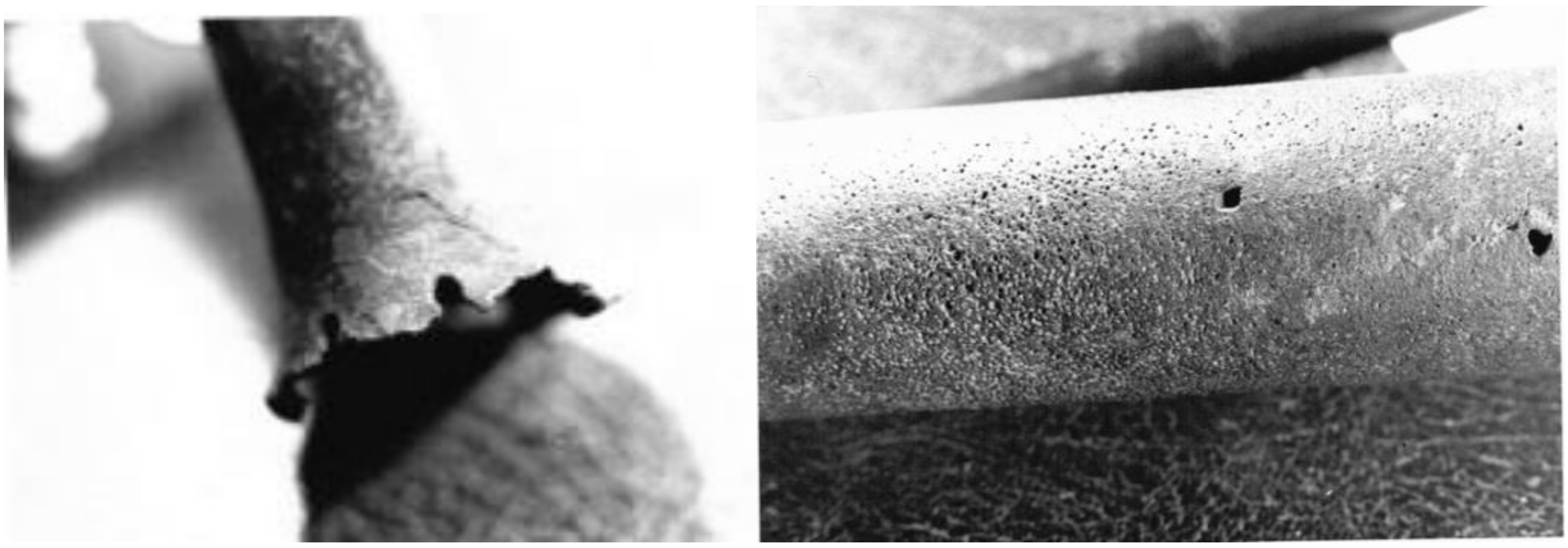


Plate 5.28: Post-Casting Work on a Tube and Tube Surface Finish

Many holes on these instruments are clearly very tri-lobed, the common morphological error to this day whereas others are clearly very round, one of the best examples being the hole drilled through a tube loop on SD14K. (Plate 5.17a, above) .

The diameters of holes on these instruments range from about 2*mm* to 7.5*mm* and are generally fairly consistent on an individual instrument, one glaring exception from this being SD43 where they vary from 5.8*mm* to 7.1*mm*. However, the diameters of holes measured on other instruments are (in mm):-

SSD7E	7.4	6.8	7.4	7.4
SD7G	5.3	5.4	5.3	5.4
SD7G	5.3	5.4	5.3	5.4
SD13	6.6	7.5	6.7	7.3
SD22B	5.2	5.7	5.2	4.4
SD41	5.0	5.2	5.0	obscured by casting on

These figures show a general repeatability to within about 0.7*mm* suggesting that, in each case, the holes were cut by the same tool, it was a fairly sophisticated cutting device and the maker was both able to and intent on cutting the holes to the same diameter. One of the key features of such a device would be the primary cutting faces of the drill-bit end. These would need to be sharp, formed at the same angle and in such a way that the point of the drill lay on the centre-line of its axis. Where this point lies off-centre, the outer cutting edge cannot follow the path defined by the drill centre and will extend a horizontal force on this, causing chattering and lobing of the hole. Thus on instrument 7G (dimensions above), the geometrical form of the drill tip must have been very carefully defined and produced, resulting in the production of eight holes all within ± 0.05*mm* of 5.35*mm* diameter. A strikingly well-drilled hole - drilled in a difficult position - is seen on SD14K where the tube-mounted loop has been drilled out to clear the flash (Plate 5.17, above).

Figure 5.41, below shows the hypothetical form of a drill tip, which could be made in a hard fine-grained material such as flint or quartzite and would derive sufficient central control from the tip form to allow a round and parallel hole to be drilled. The alternative process of abrading out a hole using a flat-ended drill and an abrasive would not produce holes round to the degree seen here, nor would it produce burrs of the size seen on many instruments.

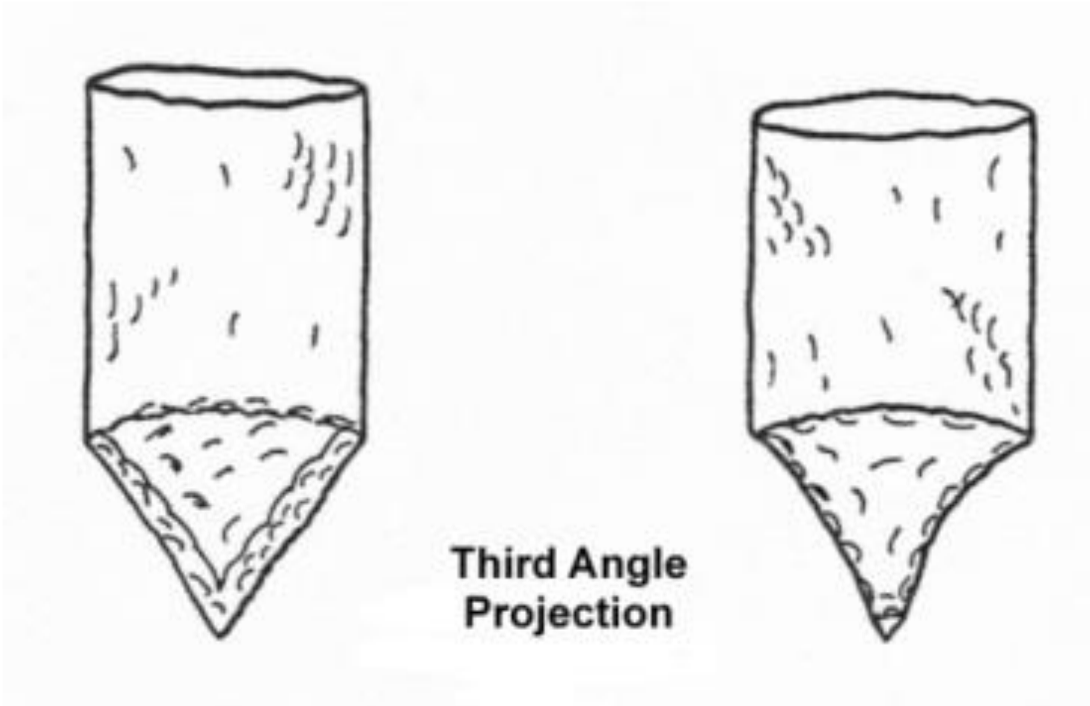


Figure 5.41: Possible Designs of the Drill Bit
Used to Drill Tube Walls

Several horns have portions of defective casting and in particular, miscasting occurs at the centre of the instrument curve. (Figure 5.4) Other typical casting failures are seen on SD1, where the whole tube is generally very porous. On SD29C, the areas of porosity are graded circumferentially with the obverse portion of the tube being more porous (Plate 5,3b, above). Several other instruments have blow holes over their surface, having been subjected to overheating since being cast (Plate 5.28b, above) and several show local pitting where overheated while fixing mounts. Generally, however, the casting quality is very good indicating that the maker had a fair knowledge of casting temperature requirements in order to cast the thin sections present on these instruments.

THE ORIGIN OF THE IRISH HORNS

Both the end-blown and side-blown instruments appear to have an origin in an animal horn, the side-blown having retained the animal-horn form with a short parallel addition at its tip while the end-blown was modified by addition of a more substantial tube yard. A horn from an animal of the bos genus has a hollow form when removed from the core that remains on the skull of the animal. At the tip, however, is a solid portion which extends some way down the horn and has a considerable effect on the use that can be made of the horn as a musical instrument. Use can be made of this tip of solid horn to fashion a mouthpiece as is seen on the shofar, the Iron-Age Scandinavian and many other instruments, it can be removed to present a clear bore but one which opens with a considerable diameter, much larger than the throat of a well-developed mouthpiece or it can be used to provide the end for a side-blown instrument with an aperture cut into the horn wall. The second route seems to be the one from which the Irish instruments evolved as none of the extant specimens has more than what could be described as a mouthsupport and all totally lack any developed throat. Starting from such a truncated horn, therefore, the end-blown instruments would evolve by the addition of a tube and the side-blown paradoxically by re-blocking the tube end and cutting an aperture downstream of this. It is the fact that the location of the blowing aperture is generally well downstream of the tip and the ubiquitous presence of a tip cone/bulb that would lead one to propose this sequence of development. No instruments have a tapered tip as a relic of pre-metal1ic forms as on virtually all other side- blown instruments reported in recent times. The early, pre-metal form of these end-blown instruments, therefore, would have been of a horn with the tip removed and a tube inserted into this. Then, in the case of the side-blown instruments, a blowing aperture was cut into this, while in the end-blown instruments the tube end could be utilised.

Very close ethnographic parallels are seen in the case of the side-blown instruments, in the Matto Grosso in Brazil. There a cow's horn has its tip removed and a bamboo cane inserted into the hole. It is then fastened with cord and sealed with wax. (Plate 5.30a, below, from Collaer[205].) Collaer describes several other uses of side-blown instruments many of which utilise bamboo as the blowing tube and comments (op. cit.) "It is a very remarkable fact that the actual tube of the trumpet is closed at the top end by the septum formed by the natural knot, although we would expect to find the mouthpiece there. The blow-hole is cut into the side-wall of the tube. The area of distribution of trumpets that are side-blown and held cross-wise extends basically across the Amazon and the country to the south of it.

Plate 5.30: Ethnographic Parallels to the Irish Horns

This seems to provide a very close parallel, furnishing a basic structural arrangement for both the side and end-blown instruments. It is probable, then, that the earliest instruments were of an end-blown type but whether these evolved in Ireland or elsewhere can only be guessed. The idea of an animal horn as musical instrument may have been

[205] Collaer, 1973, 166, fig. 93.

brought into Ireland i.e. a low level of design diffusion or indeed have originated there. It does seem clear, however, that the side-blown design evolved while the instrument was still being made in the original horn as the tip cone/bulb form would quite likely have developed differently had the point of divergence been from a bronze ancestor. A peculiar development then seems to have been strongly affected by the form of the tip-cone/bulb, as discussed below.

THE EVOLUTION OF SIDE-BLOWN INSTRUMENTS

The evolution of the side-blown instruments is discussed first as greater continuity of development can be seen on these. One of the earliest developments that took place had to be the plugging of the hole left by removal of the tip. This was probably done by the use of a bronze bung with a carrying loop identical to those on axes of the time. These loops are placed very close to the end of the bung which opens out in a wedge shape for convenience in wedging into the tube. Translated into bronze this type of instrument is seen in SD14O, 17A and 30. (Plate 5.1a, above, Plate 5.8b, above and Plate 5.25b, above) Adding a further loop on the tip cone (SD35) obviously gave a more-easily carried instrument, and the enlarging of this loop as on SD4B improved matters further. However, once the instrument had been established in bronze, the wedge form of the tip could be modified at will and forms such as SD17A, 30 and 36A emerged with a more rounded or bulbous tip along with SD14G, 14K and 14L i.e. with a similar smoother profile but having tip loops. Eventually, bulbous tips such as SD8 emerged. Parallel to these bulk changes in morphology the developments in chapletting took place although no obvious single train of events can be outlined. Some instruments, SDl6A, 16B and 16D, for instance, have what appear to be an early form of chaplets combined with a ring/ring mount combination supposed to be late in form. It is obvious from these and similar instruments that workshops were working quasi-independently·with only limited or occasional access to the developments which were taking place elsewhere.

The final developments which took place were connected with the large Type II side-blown instruments featuring holes and conical spikes. Being much longer than the northern instruments and having a much larger diameter, the manufacture of these instruments called for the largest castings of all to be produced. Their cores were made in several parts and several post-casting operations carried out to add rings and mounts to their tubes.

THE ORIGINAL FORM OF THE END- BLOWN INSTRUMENTS

Most end-blown instruments are found incomplete, unlike the side-blown and their original form is, therefore, more difficult to reconstruct. However, some early instruments such as SD14I appear to be complete suggesting a form for the early end-blown types. It lacks a clearly formed mouth-support but the end-face of the tip is, in parts, finished off normal to the tube's axis. (Figure 5.42).

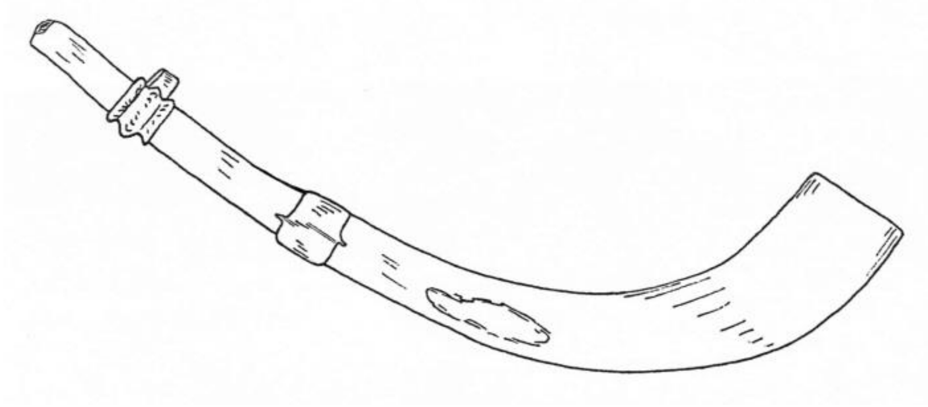


Figure 5.42: The Form of Instrument SD14L

Although only 0.54 metres long, it is made up of three parts joined by means of two cast-on bands. Like all the other instruments from this province, it lacks any evidence of ever having had a developed mouthpiece and would, therefore, only ever have produced three tones - its first, second and third formants. The latter of these it would doubtless only do with difficulty.

As the ability to cast longer sections was developed, no doubt the tube yard section of the instruments themselves were made longer. Aesthetic considerations may have been principally responsible for such increases, although where an upper formant was only marginally obtainable on an instrument, a few centimeters on its length could make a noticeable difference.

TYPE II END-BLOWN INSTRUMENTS

One other instrument similar to SD14I is known and is made up from SD9D and 9E. This however, is clearly of a type II form and is made up of bell and tube yards. No information is available about the archaic mode of joining of the two yards as these are now soldered together. Its overall length is approximately 0.66*m* long[206] and is, thus, some 120*mm* longer than SD14I. As on 14I, its end-face appears to terminate as a straight tube with no provision for a mouthpipe or tube yard extension piece. Further increases in length of the tube yard seem to have been accommodated by the manufacture of a separate tube yard which was presumably fixed to the mouthsupport and bell portion on final assembly. These tubes have four holes at both ends where these fit into both mouthpipe and bell yard sockets and were probably pegged into position using wooden pegs. One pair of tube and bell yards SD7E/7D have four holes drilled in their mating portion, which were produced selectively on assembly to take the pegs which would locate and retain them. None of the sockets or bell ends are round or smooth enough for their mating fit to be airtight and it would, thus, be necessary to seal this joint by means of some suitable material. For this a wax or resin impregnated piece of cloth could be used to wrap around the joint to make it air-tight. The presence of such wrapping material was reported on several finds, although, on none of these, were instruments in an assembled condition, and no such material has survived to the present day.

One instrument, SD14B has three holes - drilled as for four - at its tip apparently for fixing as described above. However, these holes are drilled through thicker sections of tube, where the wall has been locally thickened by making indentations on the core. (Figure

[206] Coles, 1967, 115.

5.43) These features seem designed to locate the tube and the wear on their internal diameter suggests that they have, indeed been in contact with this. While so assembled, the two tubes would be held fairly rigidly by the point-contact of the small bore protrusions and at the same time have an annular space between these that could be filled with resin or wax to seal the two parts together.

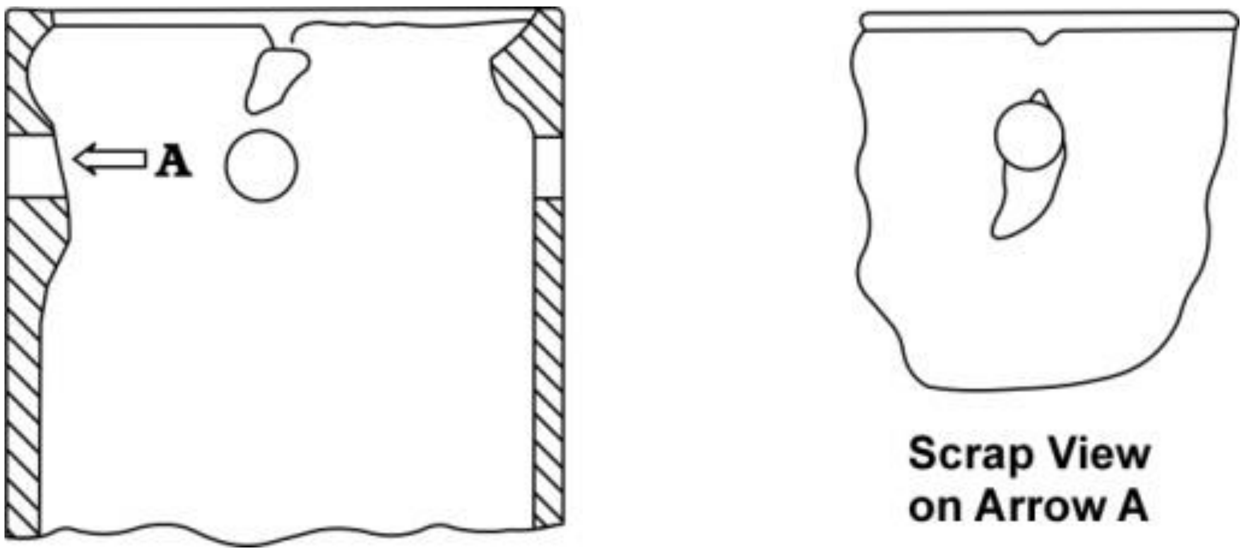


Figure 5.43: Local Wall Thickening

Type II tubes that have been found, have reduced diameters at both ends and one would expect these to have been fixed to other features at both ends. However, no separate blowing features have been found and it is only possible to guess that they were originally similar in form to that seen on instruments SD16C and 16D.

However, as the length and, therefore, the weight of the instrument increased, the attitude in which it was played probably changed too. While SD14I could well have been held out horizontally, this would not be so for some of the longer instruments. At least, they could not have been held in such a way for long periods. Thus the longer of these instruments have tube yards with ends that turn through a small angle, allowing the instrument to curve downwards thus making it easier to support.

Such a change may have been introduced while the straight tube yards, such as SD19B were in use. In this case, the changed form could have been accommodated in a crooked mouthpipe. However, it seems to have been built into later tube yards as these have both ends turned through an angle. (Figure 5.44)

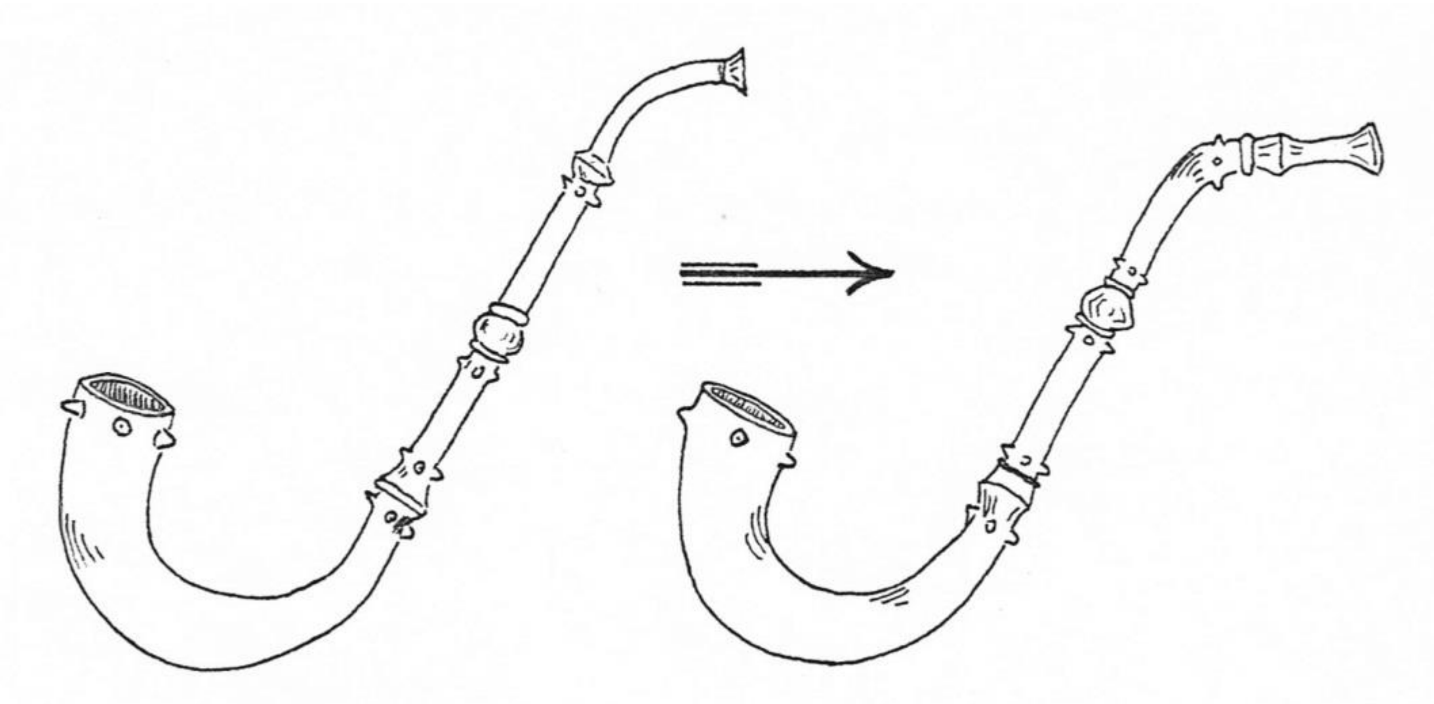


Figure 5.44: Development of End-Blow Instrument Morphology

Type II bell yards were universally joined to the tube yard by inserting the small diameter end of the tube into the tip of the bell yard. Sometimes these tips are plain with a bore running smoothly into that of the bell while on other occasions the bells are provided with sockets at their tip, into which their respective tubes fit. Later varieties were also decorated with conical spikes here, and, on the instruments from Macroom, by a re-enforced band. (Plate 5,26b, above) Their overall form is always very curved, their bell-yard centreline describing a semicircle, and in their assembled form they would appear as in Figure 5.44, above.

TYPE I END-BLOWN INSTRUMENTS

Like the type II instruments, the tube yards of the Type I instruments became progressively longer but differed in detail of construction. On these instruments, the bell-yards had at their tip a small diameter portion that was, presumably, designed to fit in a corresponding socket on the mating part. Several double-socketed junction pieces have been found that mate with these bells and, presumably with tube yard or mouthpipe. However, no parts that mate with these junction pieces have been found, and the presumed original form of such parts can only be conjectured. The most advanced form of Type I instruments was attained in instruments SD16A and 16B. (Plate 5.29, at the beginning of this chapter). Bell and tube yard were cast-on together on this instrument to produce an instrument with an overall length of about 0.72*m*. A slight curvature was added to the tube yard, giving a very faint ‘S‘ shape to the instrument overall. At the end of this tube a mouth support was cast integrally and provided a rim of about 31*mm* diameter. On 16B the four notes listed in Coles[207] F3, D#4, C5 and F5 can be sounded, but the instrument also sounds a very resonant F2, when played with a very relaxed embouchure such as would be used on a variable tone-colour instrument. What is more surprising however, is that the blowing aperture seems well suited to blowing in this mode and during tests on this instrument one member of the museum staff came into the room to see who was playing "a didjeridu."

One other complete type I end-blown instrument is illustrated in MacWhite[208], although the whereabouts of this latter instrument is no longer known. The instruments are slightly 'S'-shaped somewhat after the shape of a modern alto saxophone and would, most probably, be played in the same attitude, i.e. in front of the player. From the form of these complete instruments, it would seem that mouthpipes and mouthsupports would have been provided for the other Irish horns although no such parts remain today.

THE MUSIC OF THE HORNS

The end-blown instruments are, as discussed above, metal analogues of an animal horn and a tube. As such they have a common heritage - with the vast number of other PVAs and one view of their use tends to be conditioned by the usage patterns of these other instruments. The side-blown instruments, however, have resemblances to some contemporary and recent side-blown instruments but none with archaeological material.

[207] Coles, 1963, 339, fig. 6.
[208] MacWhite, 1944, Fig. 4b.

Even when compared with the recent material, fundamental differences can be found which could lead to a conclusion that their usage differed from that of this material. However, both the side-blown and end-blown instruments were clearly used together, a common find association being one of each and the use proposed for one instrument should, therefore, reflect the use of the other. For this reason the side-blown instruments, being harder to interpret are considered first in an attempt to avoid the danger of drawing simplistic parallels.

As on the present-day and recent side-blown horns, the Irish Bronze- Age instruments have their blowing aperture some way from the instrument tip. This enables one hand to grasp this portion of the tube and to pull the instrument towards the player's face in order to maintain a seal around the lips. In this way the ancient instruments are similar to many modern ones. However, the morphology of the blowing apertures of the Irish instruments is simple being a large oval hole formed in the tube wall. This contrasts with those of other side-blown instruments which are generally much smaller and are built out from the bore with a considerable radius leading into the aperture. Figure 5.45 shows the mouth aperture of a small (approx. 260*mm* long) side-blown ivory horn from East Africa (Author's collection).

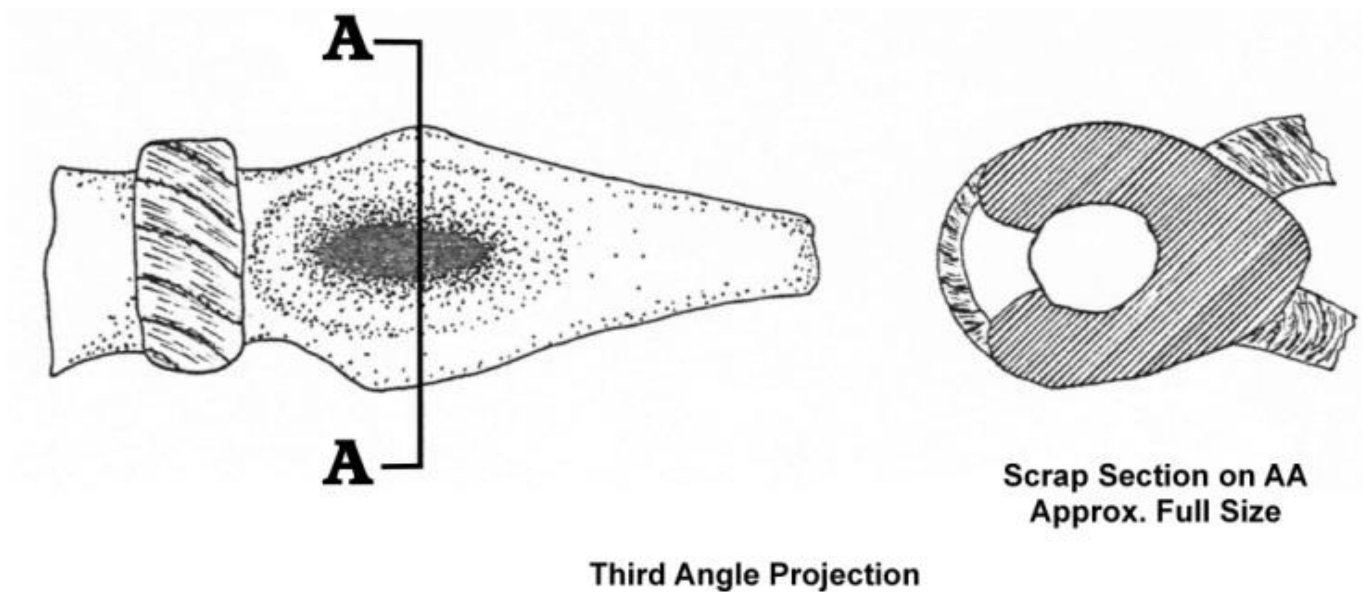


Figure 5.45: Side-Blown Instrument Blowing Apertures

Obviously, this general form can be accommodated in the thick ivory wall of the horn, but, nevertheless, the actual blowing apertures of ivory instruments are always smaller than those seen on the Irish horns. Similar mouthpieces are seen on analogues made of wood both in Africa and Asia. One is clearly visible on p. 20 no. 72 of Collaer, 1968, although it is not clear what material this is made from.

Also widespread in its use, both in time and geographical extent is the shell trumpet. Known from prehistoric times to the present, it exists in both end-blown and side-blown varieties. On this latter, however, the aperture provided is generally round, and small enough to give considerable support to the lips. (Figure 5.46) Similar to this, is the aperture of a composite end-blown trumpet again with a circular blowing aperture. (Figure 5.46b)

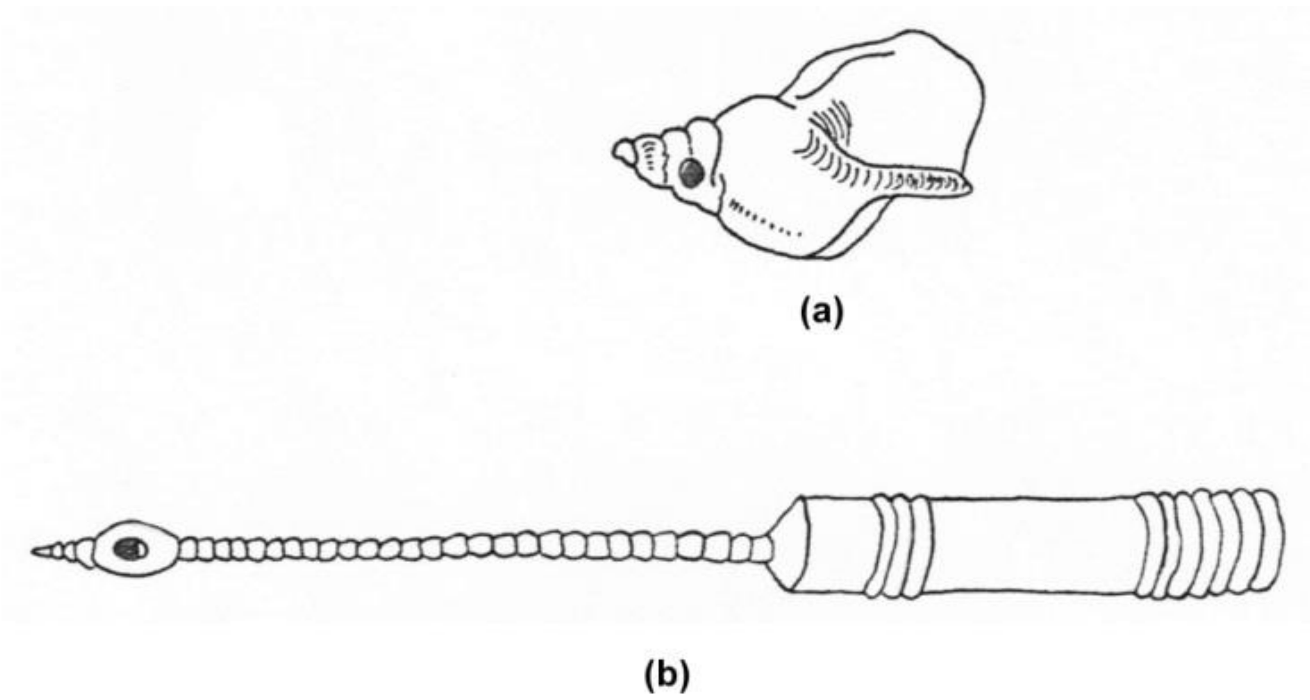


Figure 5.46: Side-Blown Instrument Blowing Apertures

With the use of metal to manufacture horns, the design restrictions placed on the mouth aperture arose principally from the technology employed. Hence, the aperture can be tailored largely to suit the organological requirements of the instrument. Such "metal instruments" commonly found represented on bronzes from Benin are representations of ivory horns and, on none of those found can the form of the mouth aperture be seen. The only metal side-blown horn found for this study is a specimen which was bought from an

Asian crafts shop in Dublin by the author. This was lost-wax cast in brass, is highly ornamented with integrally-cast decoration and has small jingles attached to the outer radius. It is illustrated on plate 5.31, below). On this, the mouth aperture is parallel-sided with semi-circular ends. It measures 50*mm* by 15*mm* and because of the small diameter of the tube at this point - c. 15 mm - occupies the whole of the circumference of the instrument inner-radius at that point. This mouth-aperture is, therefore, of a form very similar to those on the Irish horns although it is only about half their linear size (or one quarter of their area.) (Plate 5.11a, above, 5.22b, above and Plate 5.29a, above.)

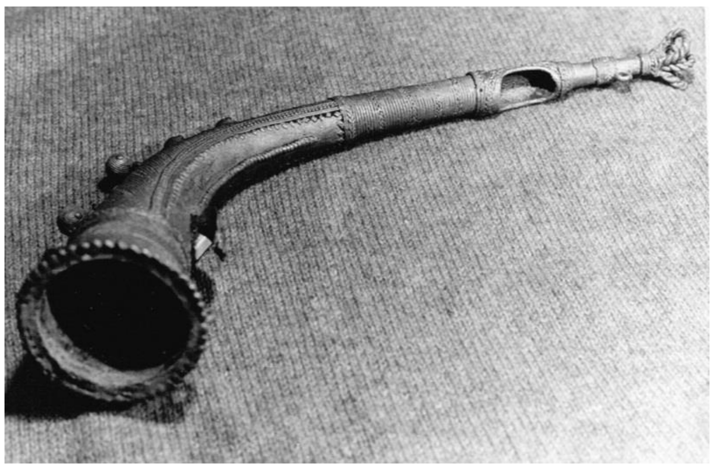


Plate 5.31

There are no references, iconographic or literary to the use of the Irish Bronze-Age instruments and one must, therefore, rely on the evidence of the extant material itself to recreate their original form. The possibilities are, that the instruments were used as they are now seen or that some device was fixed to the mouthpiece to reduce the aperture size, producing an instrument more like the side-blowns seen today. However, should the maker of the time have wished to produce an instrument with a smaller aperture, he could readily have done so by reducing the size of the core portion that formed this. This would have required very little modification to his detailed manufacturing procedure and not entail operations that were outside his abilities.

Two instruments, SD4B and 36A, have mouth apertures that are more elaborate than the simple holes on the rest of the instruments. (Plate 5.11a, above) The significance of this feature is discussed later.

On the other hand, a thicker mouthsupport may have been required and again this could have been cast integrally. In this case, though, a rather heavy instrument would have been produced and such a mouth aperture form would more likely have been provided by use of an added part, probably in wood. No such parts have been found, and it would be most unlikely that, had they been used, all of them would have perished. This is particularly so under the conditions of many finds in Ireland where acidic peat conditions have preserved wooden artefacts well. A further possibility that exists, of course, is that the mouth aperture fittings were removed while the instrument was not in use. In several parts of the world taboos exist on the touching or, in some cases, even the seeing of trumpet/horn mouthpieces by other than the priest or shaman and, in many cases particularly not by women. Such a ritual could have been observed in Ireland in the late Bronze Age and could account for the lack of mouth aperture parts. This taboo was clearly not practiced when the Drumbest end-blown instruments, SD16A and 16B, were made as these have integral mouthpieces not separable from the instrument. Even were it to be so that the parts were hidden on other instruments, however, it would seem likely that some evidence of such parts would have been found somewhere in Ireland, indeed the act of hiding could have accomplished the first necessary stage of survival.

Undoubtedly, on the ivory and wooden instruments, the thickened section around the mouthpiece (Figure 5.45) does provide considerable lip support. However, its major function may well be more in strengthening the tube section at the point where the mouth aperture is cut out. Clearly, on an instrument such as the small brass end-blown horn described above, 50% of the sectional strength is lost where the mouth aperture is cut out. This is equally true with the Irish Bronze-Age horns although, generally speaking, the mouth apertures occupy a smaller part of the instrument circumference. Nevertheless this section is the weakest on the tube yard and is the point where most tube yard failures have occurred. In fact, two instruments, SD13 and SD14O have been repaired at this point by casting-on thus thickening up the section here. From this evidence, therefore, it would appear likely, that, had a thicker section been required in the area of the mouth support it would have been produced by casting integral with the remainder of the tube.

What is more critical to the performer than the thickness of section at this point or, indeed, the size of the radius around its edges, is the size of the mouth aperture throat. As both side-blown and end-blown instruments appear to have been used together, the player called upon to blow a side-blown would almost certainly have tried blowing an end-blown. Thus, in the case of the Drumbest instrument, a player using an oval side-blown mouth support of 47*mm* by 25*mm* (SD16D) would have blown the round end-blown mouthpiece of 50*mm* diameter of the two end blown instruments (SD16A and 16B). He would, therefore, have been aware of the greater support given by the smaller mouthpiece and, presumably, wished to affect the design of future instruments to facilitate blowing. A further function of the mouthpieces examined on side-blown instruments of recent origin, is to provide an aperture that is more readily sealed by the lips. Thus, where the instrument tubes are essentially curved, the built-up mouthpiece presents a flat face to the lips upon which the lips can seal. This could have been readily accommodated by a change of tube form to flatten the area of the mouth aperture. Even if extra parts were to be added to this, a flat tube surface at this point would have made it easier to effect a seal here. The feature present on the mouth aperture of SD4B does nothing to ease this problem of sealing but appears to be designed to produce a form to which the lips can seal. This suggests that, in this case, at least, no other parts would be added to this instrument to facilitate its use.

However, assuming that the use of ethnographic parallels is a valid procedure in attempting to reconstruct a mouth aperture assembly, it should be possible to make some assessment of what could have been used. Figure 5.47 shows a possible assembly in which a wooden (or other material) part builds up over the mouth aperture, restricting its size and providing some measure of support for the lips. Clearly, such a part would give support to the lips in a similar way to the blowing apertures of recent side-blown instruments. However, it would be difficult to make, and require fastening very rigidly to the tube. In addition the metal aperture would not need to be of the same form as that in the added part, a square shape being easier to match up to. Nor would the blowing apertures on the horns themselves need to be so carefully radiused as they are on all the instruments examined. (Plate 5.9b, above)

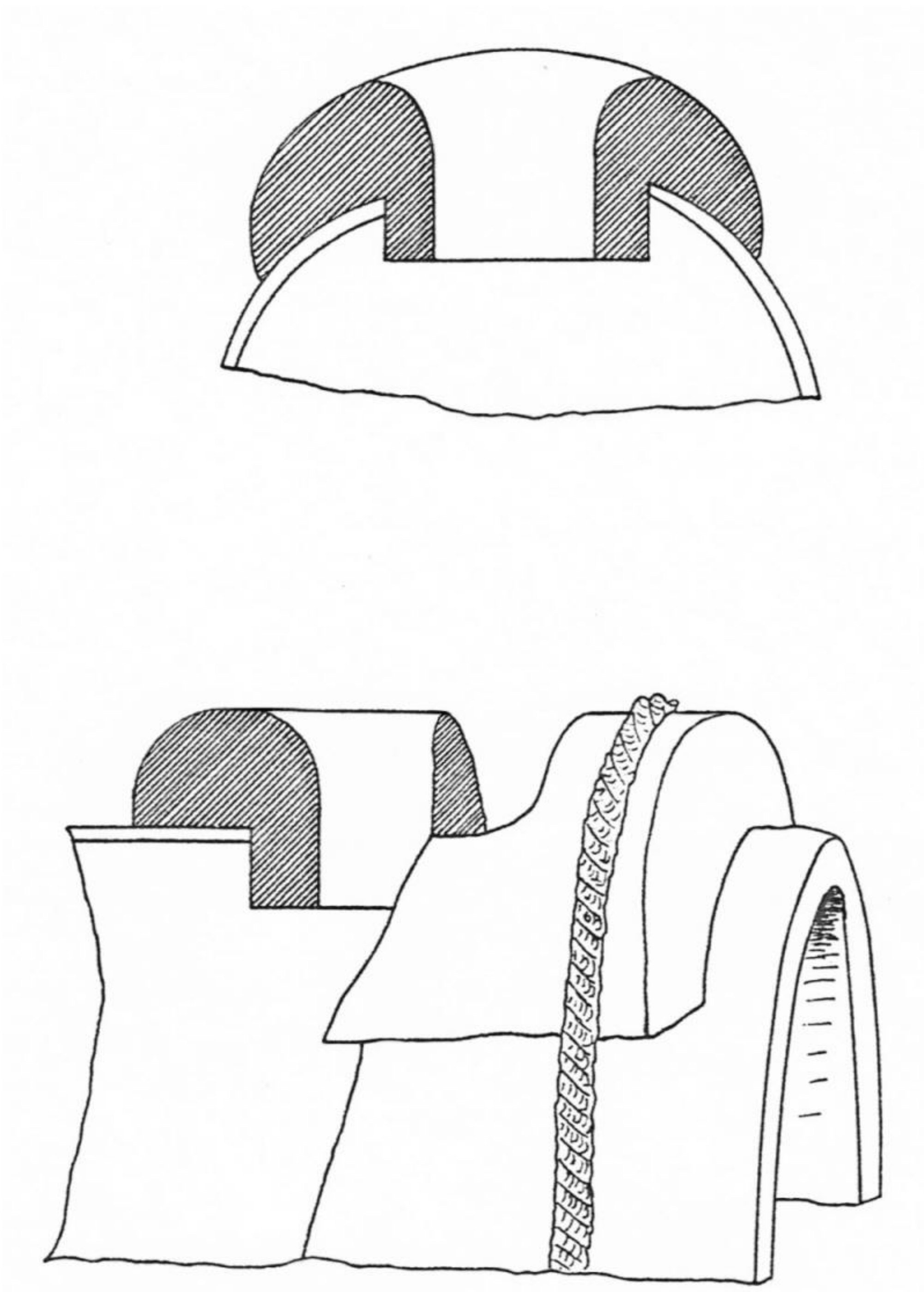


Figure 5.47: A Possible Design of an Additional Mouthpiece
For a Side-Blown Horn

If separable mouth support parts were to be provided on these instruments, then their sound output would be comparable with that from other recent end-blown instruments. However, if these instruments are to be considered as complete with the mouth apertures that they now have, then comparisons with ethnographically reported side-blown instruments are not possible. Only were one able to find organologically similar material would a direct comparison be possible, and no such material has been found in this study. A different approach to the problem could be taken by considering the basic attributes of a side-blown horn and freeing these from the morphological constrains imposed by specific designs seen in the Bronze-age material. Thus, these horns could be described as having a large, generally oval, mouth aperture with no throat leading to a tube that has an unusually large diameter compared with its length when considering PVAs in general. Having thus re-defined the instrument form, it can be seen to be similar to a member of the variable tone-colour sub-group of PVAs. (See Chapter 1)

Thus, the end-blown instruments as they stand now are capable of producing two notes with a moderately experienced player, i.e. their first and second formants, approximately one octave apart. With the addition of extra parts to the blowing aperture, which restrict lip vibration, they become capable of producing the second formant only. It can be said with certainty, therefore, that, with these instruments, the bronze age player had available the means of performing after the manner of variable tone-colour instruments as they are now played.

The possibility remains strong, therefore that both the end and the side-blown instruments were used as variable tone-colour instruments to provide a basis for ritual singing or chanting with possible simple idiophone accompaniment. Of the present day use of instruments such as these - the didjeridus·-Jones[209] says that it is, (as these horns from Ireland) a simple sound producing device:

> *"Yet in the hands of accomplished players the result is amazing in its subtlety and complexity. .... The function of the didgeridoo is to provide a constant drone on a deep note, somewhere between D flat and G below the bass clef. This drone is not a simple held note, but is broken up into a great variety of rhythmic patterns and accents by the skilful use of the tongue and cheeks. Nor is it constant in timbre, for many different tone-colours are achieved by altering the shape of the mouth cavity and the position of the tongue and by shutting off various parts of the anatomy which act as resonating chambers for the human voice. The variety of sounds thus produced is impossible to describe in words, and must be heard to be believed.*
>
> *It is not, however, in the manipulation of this droned fundamental, nor in the slight rise and fall of pitch used to accent a rhythm, that the greatest skill of the didjeridoo player lies, but in his use of two entirely different notes, which are alternated in rapid succession to form complex and fascinating cross-rhythms. These two notes are not haphazardly chosen, but invariably are pitched a major tenth apart, the upper note being the first overtone ....*
>
> *......Instead of snatching quick breaths at irregular intervals as do these players of the Bunggal songs, the didjeridoo-men of the western or "Lira" style favour a method of drawing in air through the nose while blowing from the cheeks, like a glass-blower. An endless fundamental tone can be produced in this way for any length of time, without undue fatigue. But these players have discovered an ingenious means of varying the timbre of this note by singing the overtone (i.e., the tenth) instead of blowing it. The two sound waves of the blown fundamental and the vocalised overtone combine in the tube to form beats, and a reedy, vibrant chord results,*
>
> *forming a rhythmic pulsation with the pure fundamental. One cannot detect the sound of the voice itself even when one is very close to the player."*

From this picture of instrumental usage today, it is possible to gain some insight into the potential musical life of bronze-age Ireland. These horns are neither simple to make nor simple to play and both these activities must have resulted from several generations of artisans, technical or musical, and have been deeply rooted in society. As the author has discovered in two years of learning to play the didjeridu it is not an art to be easily

[209] Jones, 1957, 8.

mastered. Jones[210] tells that "Like the songmen, didgeridoo-players are trained from an early age and devote their life to their profession." Good players often become celebrities and go on *Grand tours* around the district". Unfortunately, due cognizance is not taken of this fact when instruments such as these Bronze-Age horns are blown at gatherings of men of letters. The instrument is but one part of a whole and, devoid of accompanying song or chant, the appropriate ritual to surround its use and, above all, the atmosphere, a performance on a single horn becomes clinical and inappropriate.

Thus, bronze-age society in Ireland may well have utilised song and chant, as do the present-day aboriginals of Australia, and accompanied this on pairs of horns, possibly one end and one side-blown, along with simple idiophones. The blowers of these instruments may have been ritually-pure individuals or simply experts in performance. Whatever, their religious status, however, they would most likely be experts. Each horn represented an enormous investment in time - and bronze - and such an investment would be unlikely to have been spent unwisely. From the occurrence of both side and end-blown instruments, it would seem that the smallest group of players to perform together would be two and the differing tonal characteristics of these two types would clearly enhance their performance. Whether the Drumbest find of four instruments signifies a larger group of performers is hard to say but while the doubling of the instruments in this way could lead to the development of complex rhythmic and harmonic patterns all one can be sure of is that it would increase the volume.

In Australia many styles of didjeridu playing exist in different areas while the basic technique for sounding the instrument is common throughout the country[211]. This results from the fact that the didjeridu is essentially very simple from a technical point of view and the variety in performance comes from variations in blowing technique. This is not so with the Irish horns, however, as the instruments themselves are technically quite complex and show variation, from north-east to south-west, both in design and manufacture. Nevertheless, these instruments are unique to Ireland and, thus, have a fundamental commonality throughout the island with the organological variety being relatively superficial This was probably also the pattern in the musical performance with the fundamental basis of the music being determined by the side-blown/end-blown combinations of horns and the variety arising from the differences north-east to south-west in size of the horns, size and shape of the blowing apertures and the technique utilised in sounding them.

Undoubtedly, interchange of ideas did take place between the two cultural areas as witnessed by several similarities in developmental trends such as the morphology of instruments and the methods of attaching mounts to tubes. In the same way musical elements of performance must have migrated between one culture and another to produce a pattern very similar to that seen in Australia, of varied local schools of performance. The Irish bronze-age horns are indigenously developed and unique in the archaeological record, as would have been the schools of performance that grew up to use them. No trace remained of their use in the iron age although the large Celtic riveted horns seem to have continued the tradition of using large-bored PVAs without constricted bore mouthpieces.

[210] Jones, 1957 p. 8.
[211] Jones, 1967.

CHAPTER 6

CELTIC INSTRUMENTS[212]

Evidence of Celtic instrumental usage during the later part of the La Tène culture comes from iconographic material (Roman and Celtic), a small quantity of extant fragmentary material and Greek and Roman documentary evidence.

Although the Celts are considered to have utilised only two types of PVA, the evidence gathered in this study suggests the - use of at least five types. However, the evidence for the existence and use of these varies greatly and is outlined below.

1 CARNYX

The name of this instrument is known from Greek and Roman writings and physical evidence existed in the form of a carnyx found in Lincolnshire (since destroyed) and four other fragments found in Europe. A considerable body of iconographic evidence also exists in the form of Roman reliefs and Celtic coins.

[212] It has to be said that I would no longer call these 'Celtic' but refer to them as Pre-Imperial Native Iron Age. It's not nearly as catchy as a simple 'Celtic' but much more accurate.

2. CELTIC Lituus

These have no literary references but four complete specimens exist along with a fragmentary instrument and two previously reported specimens which are now missing. Of the two iconographic references only one is in a clear Celtic context, the other being less clearly assignable.

3. CELTIC Tuba

This is known only from one iconographic reference and two extant specimens.

4. CELTIC CURVED HORN

These also have no literary references but physical evidence exists in the form of three almost complete specimens and two fragments. One iconographic reference occurs on a Roman battle standard and an excellent representation of two instruments exists on a Graeco/Roman statue.

5. WIDE - BELLED INSTRUMENT

This is known only from one iconographic reference, IC78.

6. CLAY HORNS

Known only from Numancia in Spain.

1. CARNYX

Of the six instrument types, the carnyx is most clearly identifiable as Celtic. According to Prof. A.J. Beattie[213], the name is referred to as Karnon "The form is given by Hesychius (DR 3) with the meaning of 'trumpet' and assigned to the Galations." It is also cited by Eustathius (DR2) where he writes of it being blown "upwards and into. "Both describe it as a trumpet with an animal "bell" or mouth, with a leaden tube and assign it to the Celts and the Galatians, Polibius (DR17) in the 2nd century BC describes Celtic war trumpets, using the phrase Bucina and Salpinx, either indicating two types of trumpet or more likely glossing an unfamiliar word by adding "and trumpeters". Diodorus Siculus (DR9) a century later and in a similar context refers to trumpets "peculiar and such as barbarians use" but neither employs the word "carnyx."

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[213] quoted in Piggott, 1959,19.

The Carnyx appears on numerous Celtic coins (17 located in this study), generally in the right hand of a Celtic warrior or otherwise generally displayed in a vertical position. It is also displayed on Roman iconographic material (7 references) where it appears as war trophies, and on one N. European cauldron (IC49). Only one complete example has ever been found (SD213) but this was melted down as an archaeological experiment in the 18th century.[214] Four fragments have been found which are generally identified as parts of carnyces; (SD207, 208, 214 and 215).

THE FORM AND USAGE OF THE CARNYX

The general form of the instrument is distinctive and well defined by the evidence as having a parallel to slightly-tapered tube yard with a curved conical bell section which passes through a decorative animals-headed bell termination, boars and stylised bird heads being the commonest terminations. Characteristically seen along the outer radius of the bell, is a mane which runs between two prominent vertical ears and then down the bell yard for almost its entire length. (See Figure 6.1)

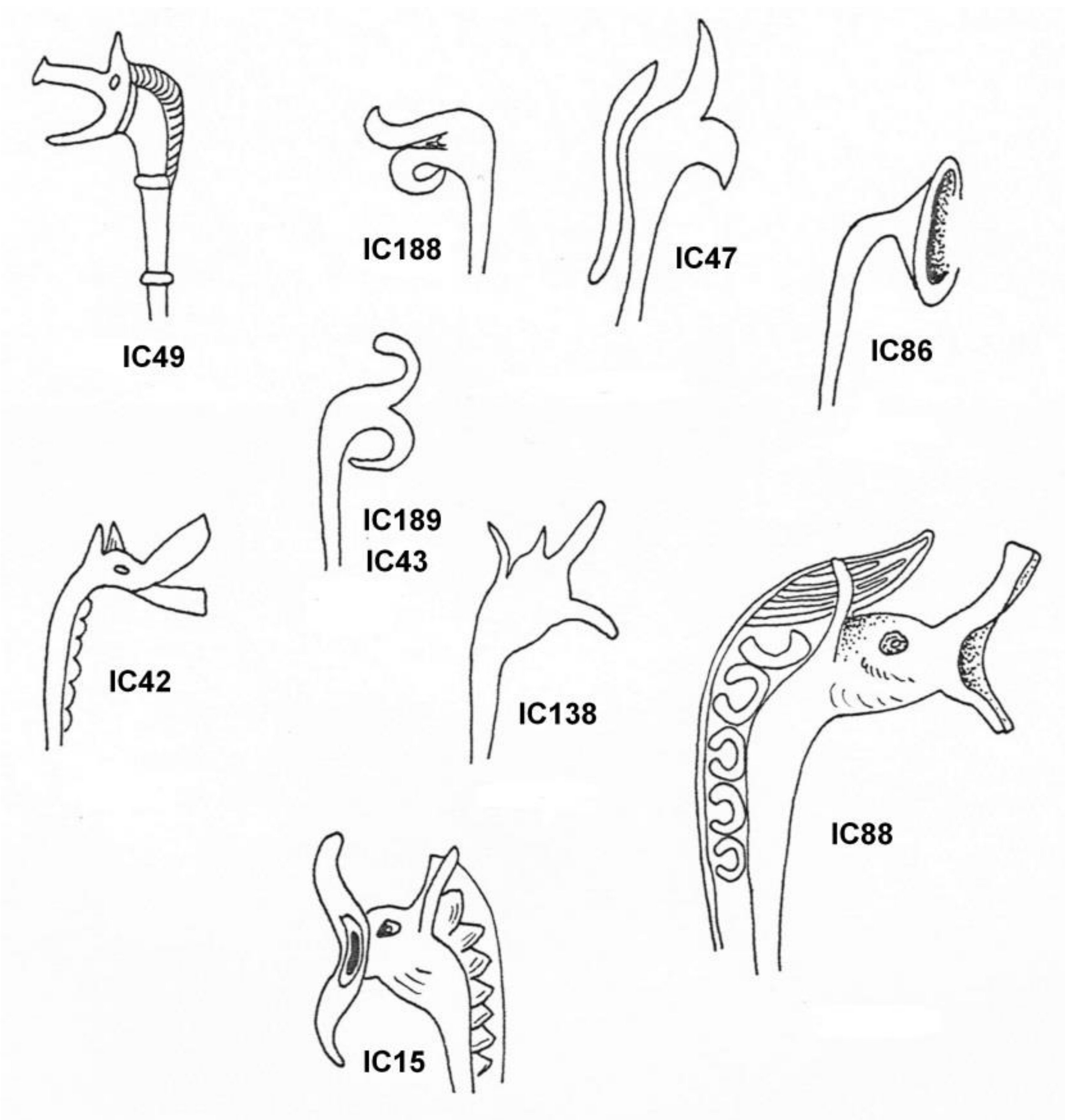


Figure 6.1: Some Designs of Carnyx Heads

[214] Pearson, 1796.

Two illustrations, IC49 and IC109, show the instruments grouped in threes and this may be indicative of a pattern of instrumental use in threes. Were this so, it would show a close parallel with the Roman military instrumental use of the period (see Chapter 3).

Although it has generally been proposed that the carnyx is blown with the tube yard horizontal[215] the evidence for their having been played vertically seems stronger. The Gundestrup cauldron (IC49) depicts three players blowing carnyces in a vertical position as does, probably more conclusively, an illustration of a Gallic soldier on the Triumphal Arch at Orange (IC5).[216] Here the instrument is clearly held at a steep angle pointing upwards but the animal head is pointing to the rear of the player. This may be confirmed as a probable configuration by the termination of the instrument from Trajan's column (IC 88),(Plate, 2.4b, above) which appears to have an oblique termination to the mouthpipe, open in the same direction as the bell mouth. A similar shaped oblique termination was drawn by the illustrator of the Tattersall Ferry carnyx (SD213) in 1796 when this find was published[217]. However, the mouthpipe is disarticulated from the bell yard and no angular relationship can be defined.

The vertical blowing position could be accommodated by an oblique termination of the tube-yard or by provision of an aperture as on the side blown horns or the Roman statuette (SR2). (See Chapter 3) Morphologically, the bell terminations are similar in that their axis is horizontal when the instrument is held vertically as on most depictions. Were the instruments to be held horizontally, then the carefully-made terminations would scarcely be seen and the visual effect lost totally. One Roman iconographic representation (IC109) shows trophies of war with groups of carnyces, there being about one carnyx to each sword suggesting that each warrior would have an instrument. Were this so, then their instruments could hardly have been played facing forward without a considerable spacing between individual players and also a considerable risk of injury to the face and particularly the lips. Also any instruments played vertically would present a waving sea of ferocious bellowing animal heads projecting their sound over the heads of the advancing army towards the enemy. Polibius (DR17) said of the carnyx that, "together with the shouts of the whole army in concert, (they) made a clamour so terrible and loud, that every surrounding echo was awakened, and all the adjacent country seemed to join in the horrible din." As the Celts also carried animal-headed standards into battle the incorporation of an animal head into their instrument would serve a dual role, providing it could be seen.

The provision of attachments on the animal head portion of the instruments is a further indication that their output was not intended to be "musical" in the modern sense of the word. The Deskford boars head, for instance, contained, according to the account of its finding,[218] a moving wooden tongue attached to a spring. No doubt, such a device would add to the intimidating effect when these instruments were used en masse as described by the Romans (DR9 and 17).

If this interpretation of instrumental usage is correct then it seems unlikely that any attempt would be made to co-ordinate the "musical" output of the instruments during a battle. Individual instruments, either carnyces or of the other types may have been used

[215] Behn, 1954, Abb.l88.
[216] Moreau, 1958, Taf. 2.
[217] Phillips, 1934, pl. xxi.
[218] Smith, 1867.

before the onset of mass blowing as a signal instrument but once the main body of instruments had been sounded it is unlikely that any commands could be communicated by sound. The volume of sound might also serve to mask musical commands given to the opponents and thus reduce the efficiency of their organisation.

From the remaining illustration of the only carnyx found, at Tattershall Ferry, some idea of the dimensions of the instrument can be determined although one cannot be sure that this instrument was complete. The remaining part appears to have been approximately 1.27*m* long with an air passage of about 1.31*m* long varying from 14*mm* to 72*mm* diameter at the bell. Iconographic evidence suggests that the instrument was made up of three yards plus the bell yard termination and the longest instrument depicted, (IC189) scales about 1.2*m* in length. This would suggest that SD213 was complete and was about the standard length for a carnyx.

MANUFACTURE OF THE INSTRUMENT

An account of the Tattershall Ferry carnyx (SD213) before its destruction tells that it was made of hammered sheet bronze "about one twentieth of an inch thick, "the seam being made "by means of solder clumsily applied." This solder the author identified as tin. The fragment of carnyx SD215 from the Schwabische Oberland is also of sheet. However, the gauge of this material is much thinner, reportedly 0.2*mm*[219] and the instrument tube is made up of two pieces riveted together. See Figure 6.2 (From Piggott, 1959, Figure 2)

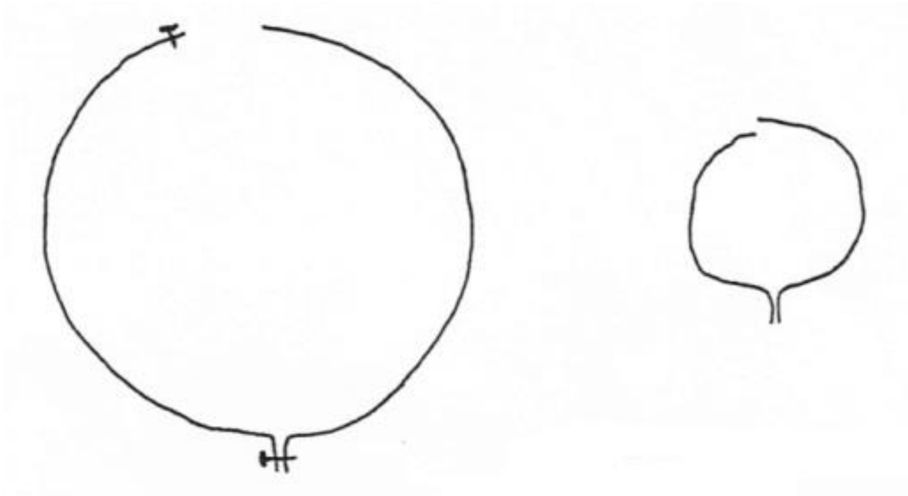


Figure 6,2: Construction Details of the Dürnau Carnyx Fragment

A further example of sheet metal work riveted together is also reported in Piggott's 1959 paper and this he identifies as an animal head termination for a carnyx. This boar's head found at Deskford in Banffshire[220] has a "roughly circular hole" of about 2½ inches (62*mm*) diameter through which a bell yard could pass to mount the head at the bell of the instrument.[221]

[219] Piggott, 1959, 28.
[220] op. cit. pl. VIII.
[221] op. cit. p. 25.

Manufacture from sheet would enable a lighter weight instrument to be produced than would casting, as the sectional thickness produced by casting would probably need to be in the region of three times this thickness in order to obtain satisfactory flow of the metal into the fine mould cavity during pouring. In addition, the wrought material would react to impact by bending rather than fracturing as would a larger-grained (and probably porous) bronze, a feature to be greatly desired in the battle situation. The carnyx appears to have derived its form from an instrument made up of a parallel or near parallel tube-yard with a bell termination turning through approximately 90°. Its ancestral form is thus shared with the Bronze Age Irish Horns, the Etruscan and early Roman Lituus and other instruments such as those from Mari. From where the line of descent branched, it is not possible to say, but it is possible that a familial relationship with the Etruscan and early Roman instruments did exist, (See below) as the Celts did have contacts with both these groups. In addition, the technical processes of manufacture appear similar in that they are both made from wrought material formed into tube and bell and apparently soldered. However, instrumental usage is different in that all iconographic references show the Etruscan and Roman use of the lituus in a horizontal attitude, i.e. pointing forward in front of the player in contrast to the vertical usage of the carnyx, although one reference shows a lituus being used as a side-blown instrument. (Plate 7.1a, below)

Some documentary references are difficult to interpret as the authors tended to use specific instrumental names in a generic sense, frequently applying the name of an instrument present in their culture to a different instrument in another culture. This is seen in the reference by Diodorus Siculus, DR9, to presumably salpinges as being used by the Celtic Gauls. The evidence for use of the salpinx, however, points to a very restricted usage of this instrument both in space and time, and the quotation is usually translated in a general sense as "trumpets," although it most probably refers to carnyces.

THE CELTIC Lituus

This study encompasses instruments of the Roman period and, thus, includes several, previously known Roman Litui.[222] However, as the study of these progressed it became apparent that these were not Roman instruments but, most probably of Celtic origin. These four extant instruments, SD203, 240, 241 and 242 and two fragments SD204 and 248 were examined while two previously reported instruments (SD232 and 244) remain unlocated to date.

EVIDENCE FOR ITS CELTIC ORIGIN

Previously having been described as Roman Litui, these instruments are of somewhat similar form to this instrument in that they are made up from a straight tube-yard with a curving bell. However, the curvature of the bell on the Etruscan/Roman instruments is greater, generally turning through about 180° compared with 90° on the Celtic Lituus. (See Chapter 3, Figure 6.3, below and Plate 6,1, below)

[222] Klar, 1971, 305.

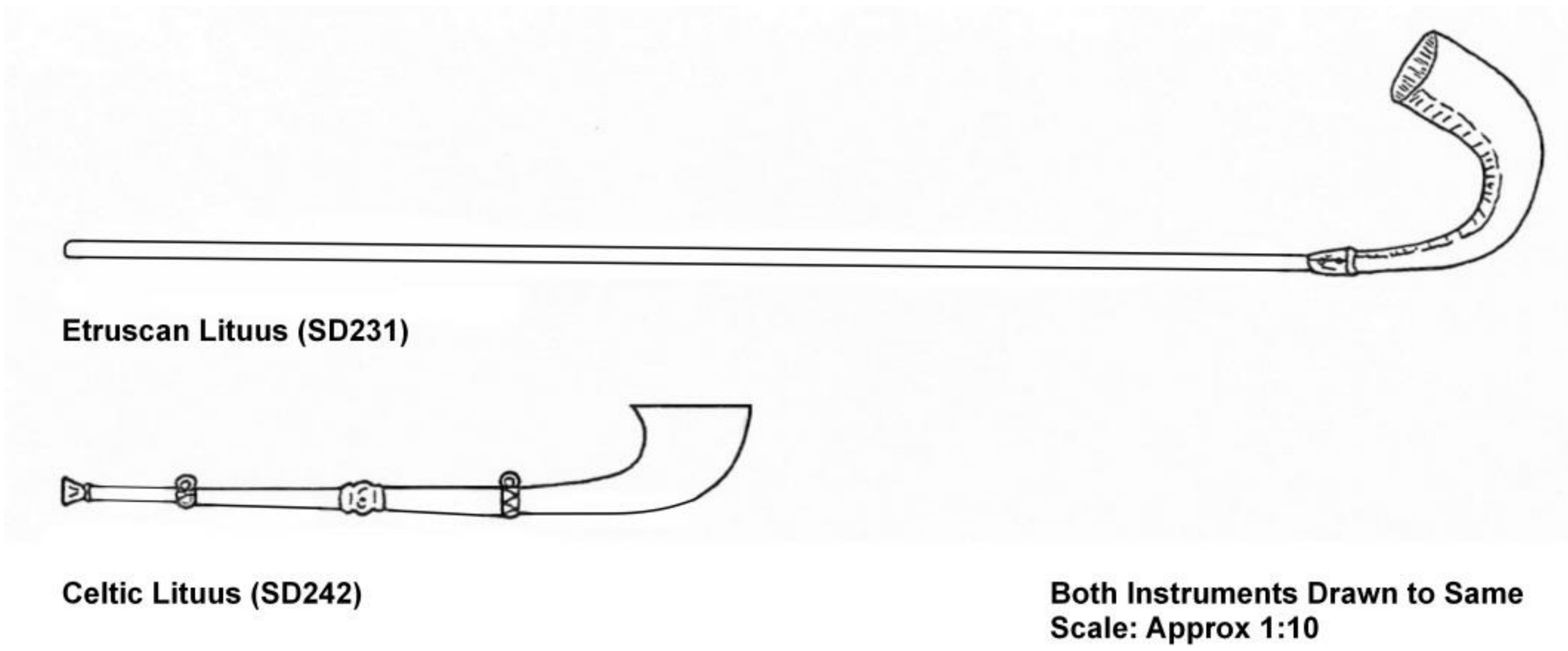
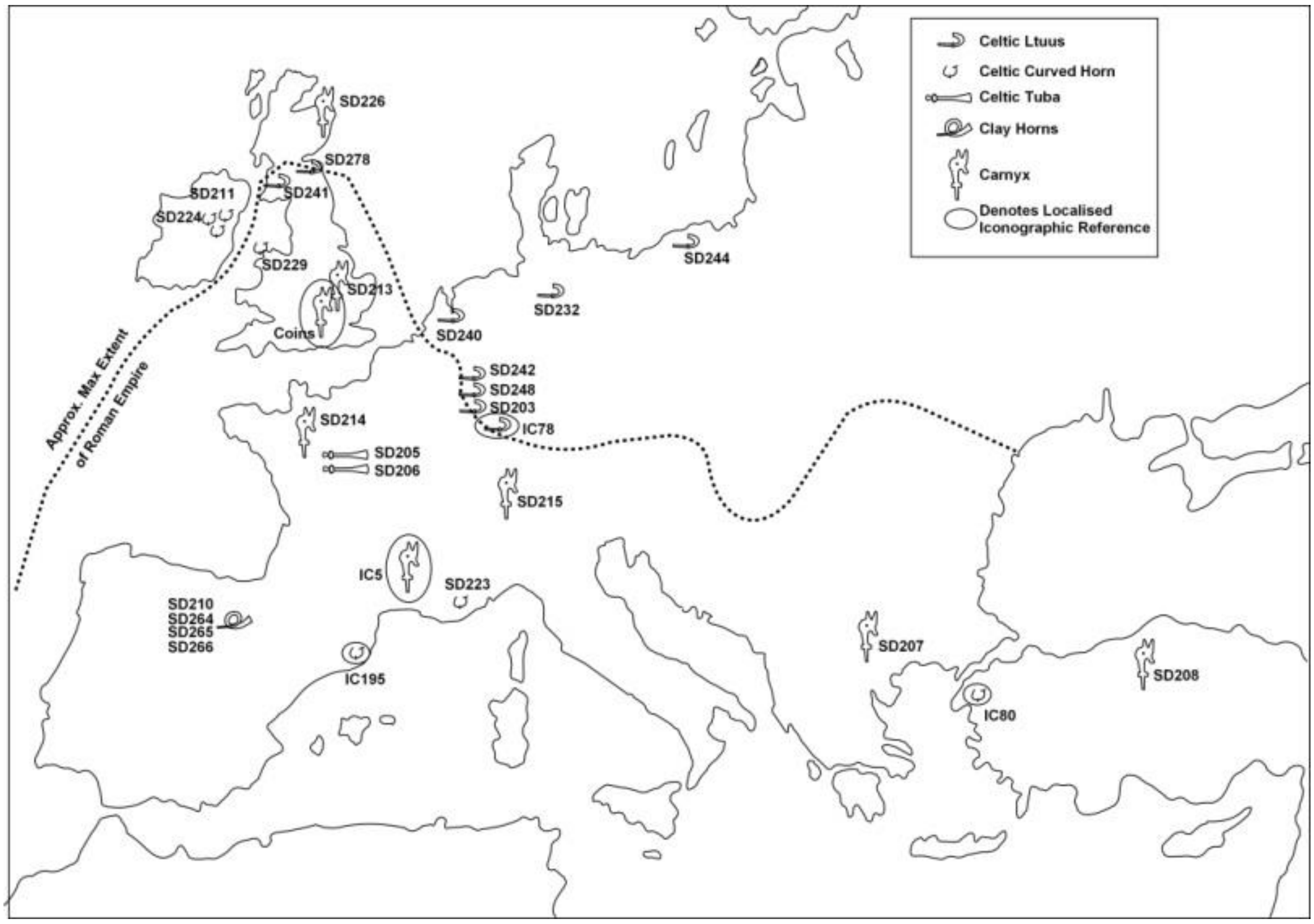


Figure 6.3: The Form of the Etruscan and Celtic Litui

In addition, the Roman instruments are about 1.6*m* long compared with the Celtic instruments' length of 0.68 to 0.70*m*. All the instruments studied are of cast construction, albeit differing in the type of casting used, while the Roman instruments are manufactured from sheet.

The instruments here referred to as Celtic Litui are found only on the periphery of the Roman world or well outside this, in the area occupied, during the Iron Age, by the Celts. See Map 6.1, below. In addition, two instruments and two fragments were found in the Rhine, this deposition in water being typical of the Celtic tradition of depositing votive objects in water. Roman writers frequently mention the use of the lituus prior to about 200 AD but no references to the use of this instrument in the later Imperial period other than those of historians, were found during the course of this study; Similarly with the Etruscan and Roman iconographic references, a decrease in the number of illustrations is seen at the beginning of the Imperial period, the latest illustration of a lituus being in AD 70.



Map 6.1: The Findspots of Celtic Instruments

Most significant of the evidence for the Celtic origin of these instruments is IC78, a Roman silver battle standard found at Kastell Niederbieber in Germany. This standard depicts Caracalla subjugating the lands of the Rhine and displays Celtic and Germanic trophies along with a subjugated personification of the Rhine. Among the trophies are a Celtic lituus and a possible Celtic tube. (Plate 2.5a, above). It is clear that these instruments are among the trophies and are not Roman but belong to the subjugated Celtic tribes.

The only instrument of this form referred to in any Southern European context is IC24 (Plate 3.1a), above) on a Situla from 5/4 century BC Italy. However, the bell form of this instrument is markedly flared and seems to bear more relationship to the eastern instruments, e.g. IC35 (Tak-i-Bostan)[223] than those from the north.

MORPHOLOGY OF THE INSTRUMENTS

All the instruments of this group are of conical form throughout with the bell end of the instrument turning through approximately 90° which, presumably, when played pointed upwards. Those measured vary from 612 to 769*mm* in length, although the two instruments not yet located are reportedly longer than this. Their bell diameters vary from about 109 to 111*mm*, but are by no means as uniform as these figures suggest, SD203 for instance, varying by about 10*mm* in diameter at different azimuths and SD240 having a

[223] Behn 1954, Abb. 107.

bell aperture better described as octagonal than round, the dimension 104*mm* for its bell being the A/F (across-the-flats).

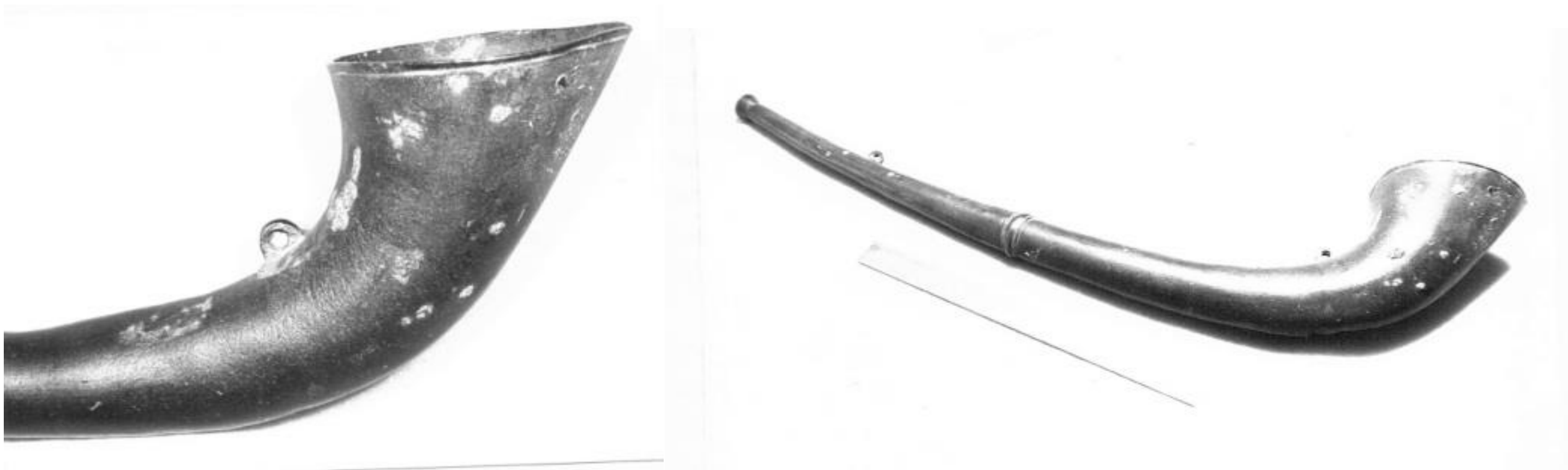


Plate 6.1: Morphology of the Celtic Lituus

Of all the features on instruments of this group, the most characteristic is the mouthpiece with its small throat. (Plate 6·3a lower and (b),·p. 325. (As with many other features, SD240 differs markedly in this respect.)

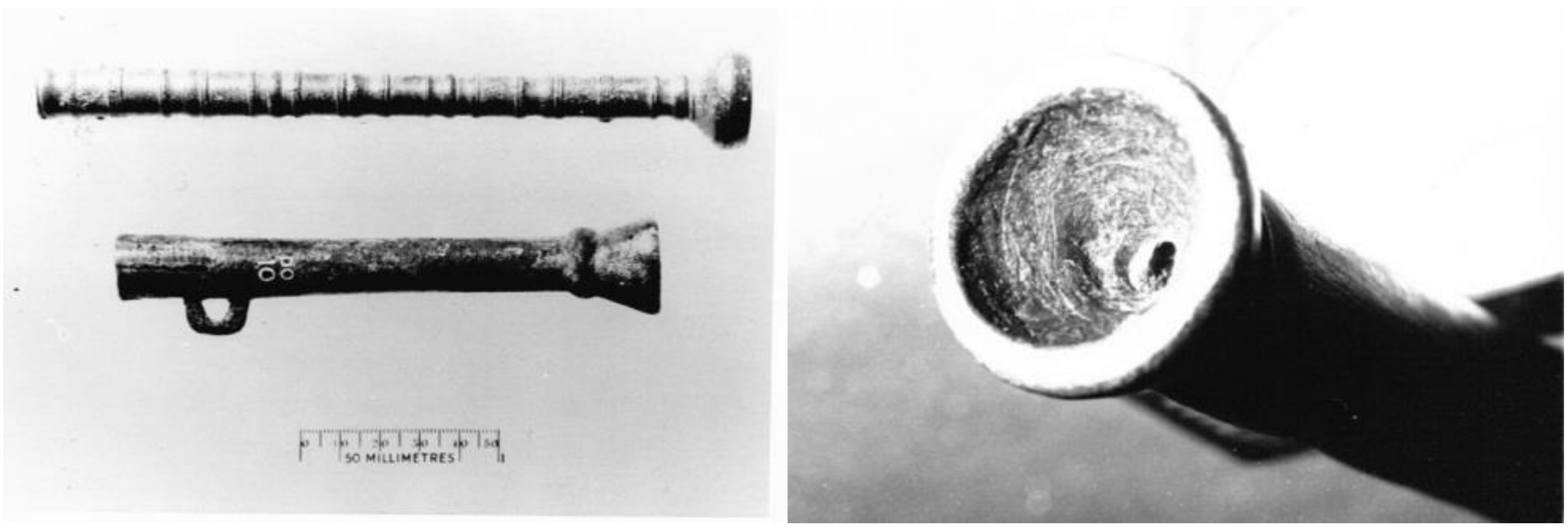


Plate 6.3: Celtic and Roman Mouthpieces

The small diameter of the throats, from 3.5 to 5 mm, does much to improve the blowing characteristics of the instruments as discussed in Chapter 1. Fig.6.4 illustrates the cross-sections of several mouthpieces and also shows the clearly defined rapidly expanding back-bore of these instruments. The good match of the mouth- piece to the bore morphology is particularly noticeable on SD203 which sounds its formants with the greatest of ease.

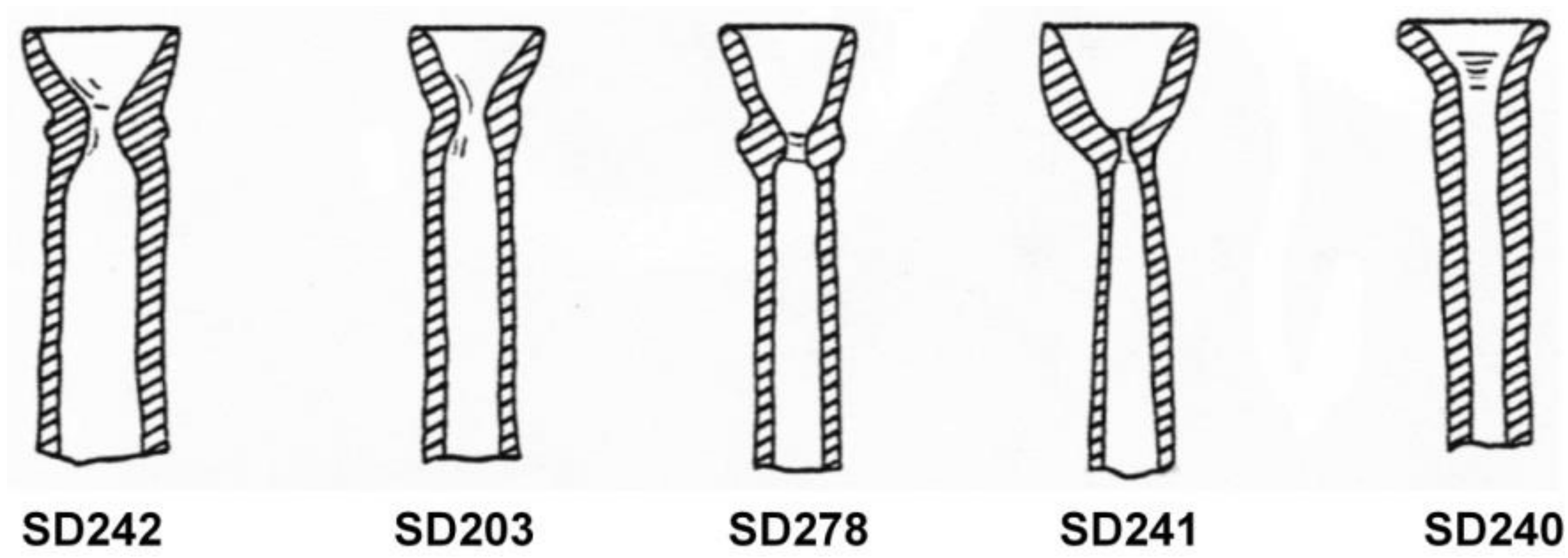


Figure 6.4: Mouthpieces of Celtic Liui

MANUFACTURE OF THE INSTRUMENTS

All the instruments studied are cast, although SD240 has several wrought pieces added and SD241 has a central band which is wrought and probably modern. The major difference in technique is that SD203 and 242 are lost-wax cast, SD204 and 241 are definitely, and SD240 and 248 possibly, cast in a two part mould. Plate 6.1, above, provides an overall view of SD203 and a detailed view of its bell.

This application of different manufacturing techniques to produce to a design seems to be common on Celtic material and is discussed further below. SD242 is lost-wax cast in one single piece. However, the workmanship on the casting is poor and the tube section has failed at one point rendering the instrument unplayable. This is the only instrument integrally cast, however, the others having been made in several pieces. The basic symmetry of these instruments is based on a ring roughly halfway between the mouthpiece and bell. On SD241, this ring appears to have been cast on, presumably joining together the two parts which were cast separately. Subsequently the joint failed as a modern brass ring holds the two parts of the instrument together, this having been soldered in position. SD240 has a similar central feature but this is placed on a 120*mm* (approx.) central tube yard which links the mouthpipe and bell yards.

On instruments SD203 and SD242, the central bands are clearly vestigial and remained to serve an aesthetic function. on these, the bands are 12 and 13*mm* wide with a central raised spherical portion and two circumferential grooves around each end. However, on SD203, this band is integrally cast with the bell yard, whose end forms a socket into which the adjacent yard fits.

When examined, this instrument (SD203) was in one piece and the presence of a joint between the mouthpipe and bell yard had not previously been detected. However, the slope of the tube changed fairly abruptly at two points and close inspection showed the presence of a fine joint gap at one of these. Subsequently, the instrument separated into two parts during examination and the presence of one of the joints was confirmed. The Museum later carried out an X-ray examination of the instrument on my behalf and this confirmed the presence of a second joint. See Plate 6.3, below.

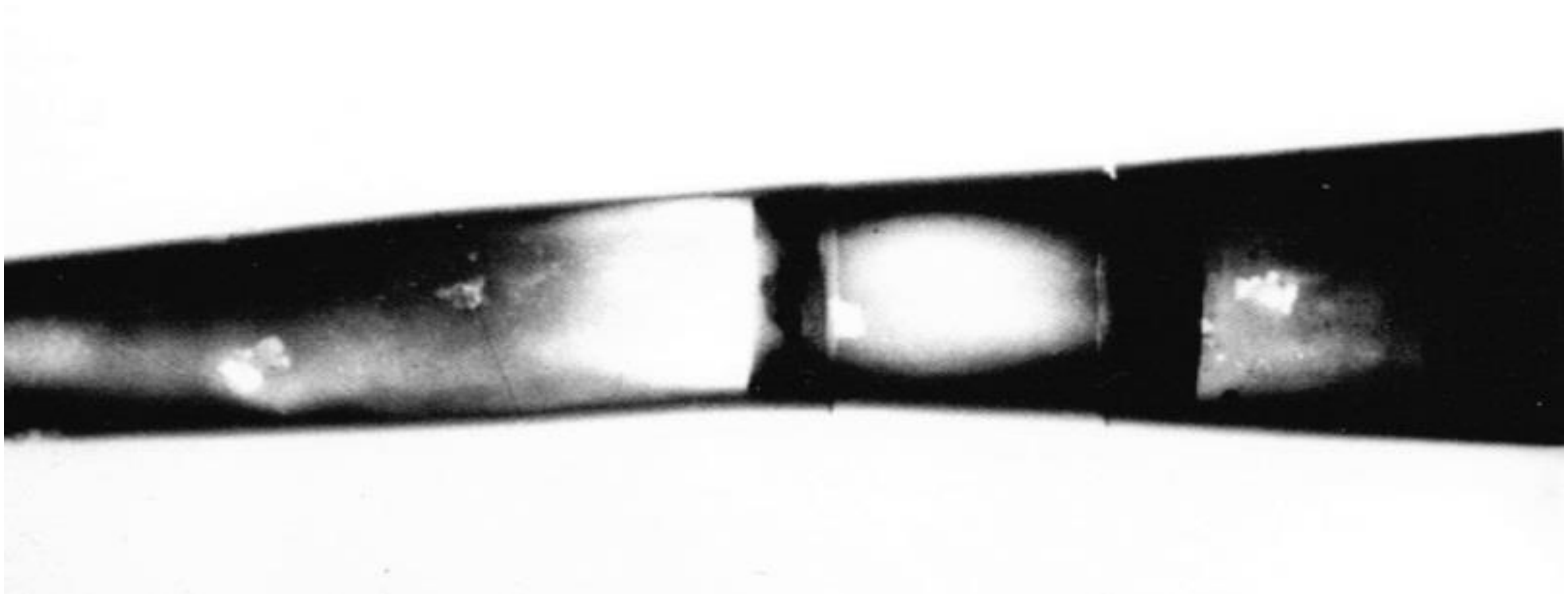


Plate 6.2: The Junction Piece of SD203

Thus, the instrument was made up of mouthpipe and bell yards which were joined by a 25*mm* long central junction piece whose ends fitted into the sockets on these two yards. (See Figure 6.5, below)

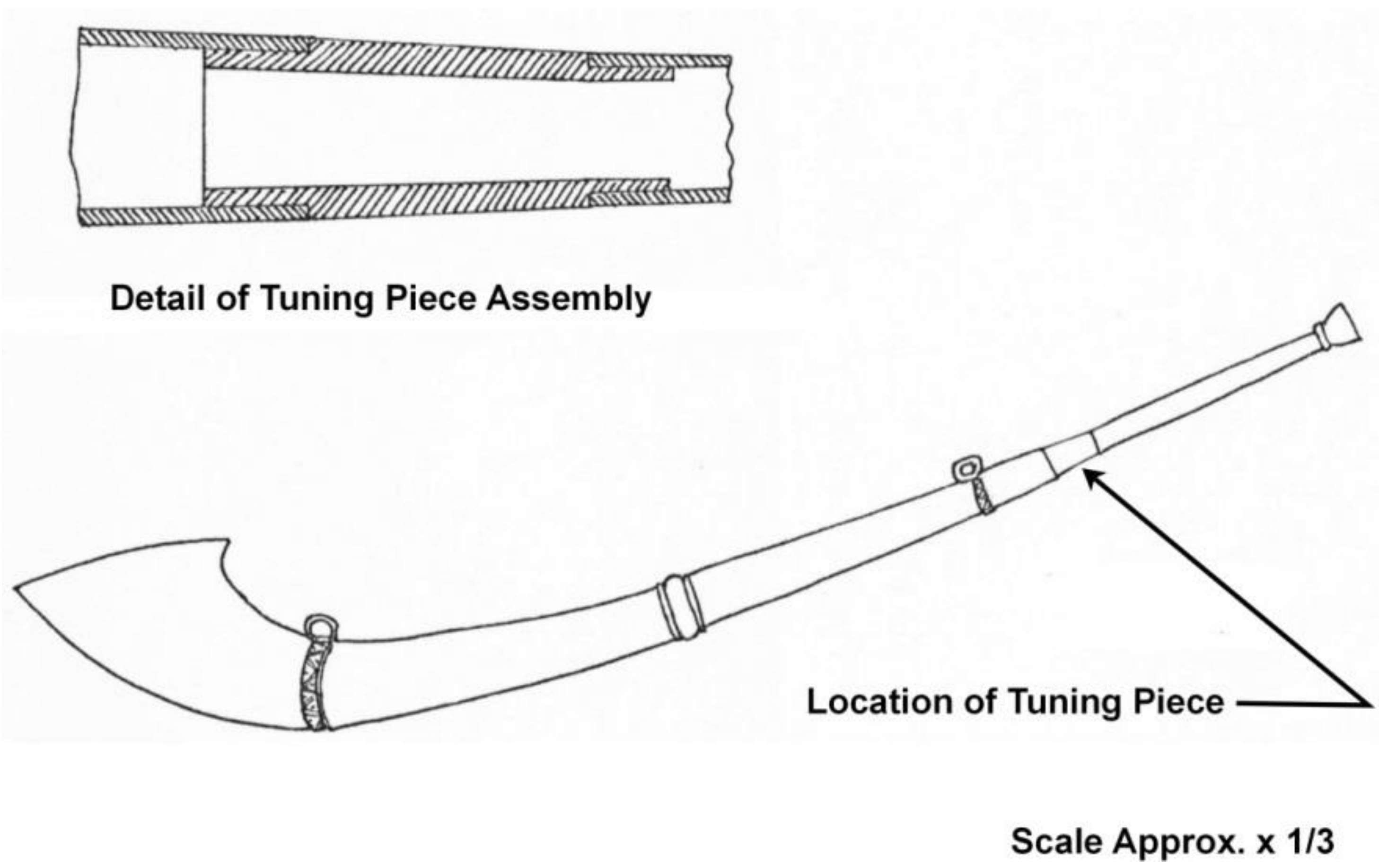


Figure 6.5: The Junction Piece of SD203

On the end of this junction piece which could be examined, its outer form is reduced to a circle of diameter 18.6 ±0.5*mm* over a length of 8*mm*. On this portion of tube is a layer of soft silver-coloured material possibly tin or more complex solder. This material was applied to the joint surfaces prior to assembly as witnessed by the presence of globules in the area between the 18.6 mm diameter and the shoulder which abuts it. On assembly, these were deformed somewhat and they, together with the irregularities in similar material on the shoulder prevent the two pieces of tube from butting perfectly, leaving a slight gap at this joint. The surface of the applied metal showed no signs of having been scored by repeated assembly and it seems probable that this disassembly was the first since original manufacture.

Externally, the profile of the walls of all three adjacent parts of tube which meet blend smoothly one to the other, in spite of their visibly different slopes. In the area where these meet there is no obvious sign of abrasive working to flow one contour into the other and the slopes on each individual piece seem consistent throughout their length.

THE FUNCTION OF THE JUNCTION-PIECE

It is clear from the smooth flow of contours from this junction-piece to the adjacent tubes and of the fit of its ends into the other yards, that it was made deliberately to suit this instrument. It is also clear that the piece was soldered into position, the solder on the mouthpipe/junction-piece joint being visible on the X-ray photograph. (Plate 6.2a, above). Thus, the instrument would be considered complete, and permanently so, following final assembly. The joint did not, therefore, provide a means of detaching the mouthpiece as on many Roman instruments, as the joint had been soldered. This was not an afterthought as, even with the 1.2 to 2.0*mm* thick solder coating the fit of junction piece to bell-yard was still loose and the length of mating diameter too short to provide an adequate support on its own. It is similarly difficult to justify the use of a junction-piece on technical grounds, as the addition of 25 *mm* of tube to either the mouthpipe or bell yard would not appear to have been beyond the maker's ability. Nor would it have been too difficult for him to have provided the male part of the joint on the mouthpipe and avoid the necessity of adding a separate junction piece.

One cannot deny the possibility that the maker was joining together parts from two different instruments i.e. mouthpipe and a bell-yard both of which terminated in sockets, although instruments from one particular industry have been found in this study to retain characteristics such as maleness and femaleness of joints in a very conservative way. Thus, although the two parts from different instruments might not fit, their incompatibility would be one of size only.

The conicity of the junction-piece differs visibly from those of the two adjacent yards (See Figure 6.5), that of the mouthpipe and bell yards being 17.5*mrad* and 20.1*mrad* respectively and that of the junction piece 58.4*mrad*. This difference in slope is much greater than the variation seen on either mouthpipe or bell-yards and the diametral match from junction-piece to adjacent yards is "perfect" from a visual perception point-of-view. Hence, the maker would clearly have been able to produce a nearer match of slope had he so wished.

In order to "correct" the slope of the junction piece to match the adjacent tubes it would need to be made approximately twice as long as it is now is, i.e. with the same end diameters. It would, thus, increase the length of the assembled instrument by about 25*mm* and lower its pitch between one half and a whole tone. Thus, it seems hard to explain the deliberate presence of this junction-piece other than as a fine adjustment to the instrument length to obtain the pitch required. Such a provision would not be unreasonable on a short instrument such as these, where it is the overall form of enclosed air-cavity which determines the precise regime of oscillation and small variations both of length and diameter could give rise to considerable pitch variation. Assuming that a mean value of such tuning pieces has a slope that matches the overall instrument, its length would be about 50*mm*. Hence the "correction" applied by means of these tuning pieces may well have been of the order of ±25*mm*.

THE USE OF THE CELTIC LITUUS

As with most PVAs a first assumption as to their use is almost invariably as a signal instrument and, in the case of these instruments this would seem to be a reasonable assumption. However, the combination of mouthpiece and instrument proper is such that the tube's formants are easily elicited and are harmonically related. If used for signalling, therefore, their usage is likely to have been more sophisticated than simply blasting out one or two simple notes.

The major factor influencing one's view of the instrument's usage is that feature that has here been identified as a tuning-piece. At the very least, this indicates that instruments were designed to be played alongside other similar instruments. A possible usage is, therefore, of instruments in pairs, and, under these conditions, instruments of fixed pitch matched to each other, would be required. No evidence of pairs of instruments has been found although with such a small sample of evidence for these instruments this does not seem surprising.

A further possibility is that the instruments were made to be used with one or other of the Celtic instruments as seen on IC78. If this were so then the maker would require a standard of pitch to which he could make his instruments. He could thus, make the mouthpipe and bell yards to his standard design and then select a tuning-piece to suit, or perhaps make one longer or shorter. Whatever the true case is, the presence of this tuning-piece indicates that the maker possessed an understanding of the problems of tuning and had built a correction into his design.

THE CELTIC TUBA

This instrument has been discussed in Chapter 2.

THE CELTIC CURVED HORN

This instrument is known mainly from the five extant instruments or fragments, three others possibly having been lost, and only one problematical iconographic reference

(IC195) and one representation on a statue (SR16). One possible precursor or related instrument exists, manufactured in wood (SD251).

A group of four instruments were found in a bog at Loughnashade in 1798) Stuart[224] and Wilde[225] 1861 identify the instrument now in the National Museum at Dublin as one of these. This identification (of SD211) has been accepted in this study. The whereabouts of the other three instruments found at this time are no longer known.

A further instrument (SD225) was found in 1809, again in peat, at Ardbrin in County Down, (Bell, 1815) and this is known to be that in the National Museum, Dublin. Two other fragments are known, one from Rosscrea (SD224) (definite findspot not known) and one from Llyn Cerrig in Anglesey (SD229), found in 1943. In the Deutsche Museum in Munich is one other instrument, (SD223) in a moderately poor state of preservation, which was bought by the Museum in 1910 from a dealer, and is said to have been found at Nice. The other major piece of evidence of this instrument is on the statue of the dying Gaul (SR16) where two complete instruments of this type are shown.

MORPHOLOGY OF THE INSTRUMENTS

All these instruments have a large diameter tube yard, 20-30*mm* diameter, curved into a roughly semi-circular form approximately 1.0 to 1.5*m* in length. Their bell-yards then open out to 80-100*mm* diameter at the bell end. These yards are made of wrought material folded to form a tube and then curved to the appropriate shape. On the north-western instruments, the seam on the tube is sealed by riveting in a strip inside the tube while on Munich the seaming strip is on the outside of the tube and is, presumably brazed in position. Unfortunately this instrument is covered with a heavy deposit of resin and copper salts and neither the nature of the fixing technique used nor the roundness of the tube can be determined.

Three instruments, Rosscrea, Llynn Cerrig and Loughnashade, have bosses at the ends of their tube yards, the latter of these being wrought while the other two are cast. No boss was found with Ardbrin or Munich and none can be seen on the two instruments shown on SR16.

These latter instruments, however, do appear to have a rim around their bell end, the only other instrument with any bell-end feature, being Loughnashade. On this, a separate bell-disc was found which although it matched the bell yard exit diameter, retained no traces of the fixing arrangement by which the two were previously joined.

No evidence of the use of mouthpieces was found in this study and none can be seen on either of the two instruments on SR16.

THE MANUFACTURE OF CELTIC LONG HORNS

[224] Stuart 1819.
[225] Wilde 1861.

Being made from sheet, all these instruments, would have required a considerable quantity of this as a basic raw material. That used varied in thickness from 0.85 to 1.4 mm (Ardbrin) and 0.28 to 0.81 mm (Loughnashade). The major variation in sheet thickness is along the _ length of the instrument suggesting that the sheet was made from a long ingot of material by flowing the metal outwards, normal to the axis of the final tube. See Figure 6.6.

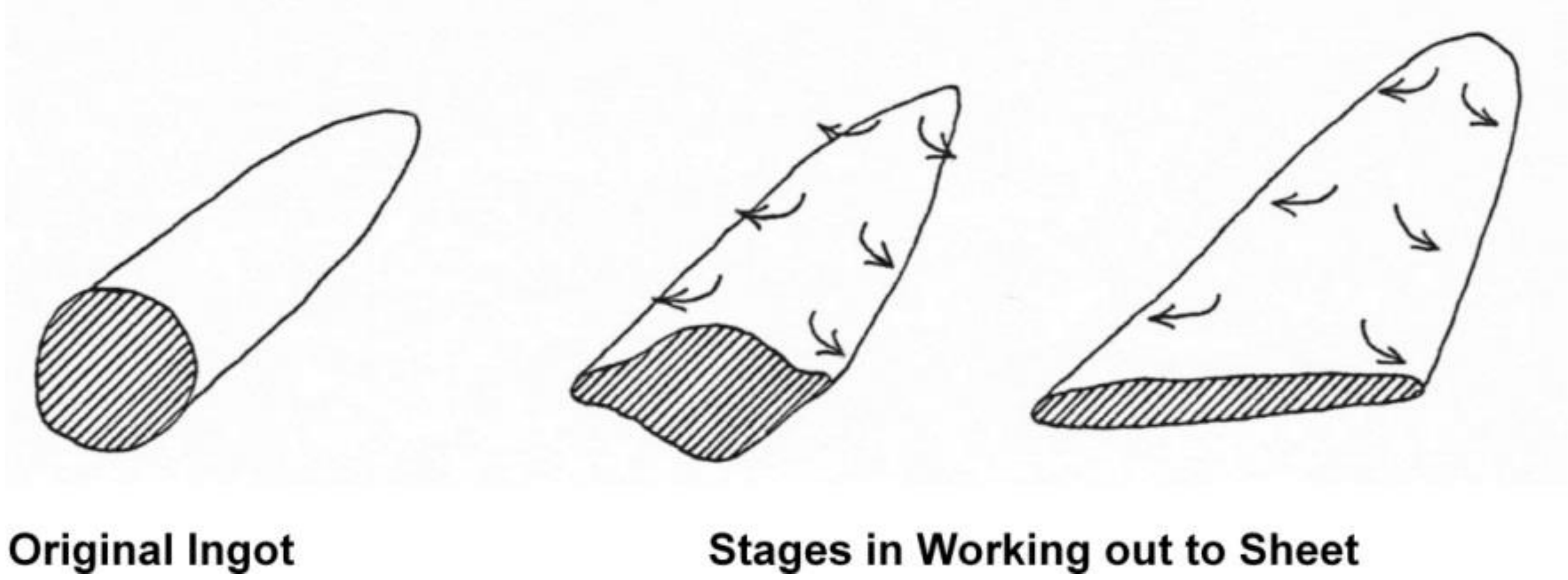


Figure 6.6: Making Sheet to Form an Instrument Tube

Measurements taken on the bell of Loughnashade show the result of this mode of working where the bell end is 0.58±0.10 mm thick whereas 10*mm* upstream of this it is 0.31 ±0.10*mm* thick. Similarly at the tip of this bell yard the end is 0.68 ±0.04*mm* thick and 10 mm downstream. of this 0.74 ±0.07*mm* thick. These latter two figures result from only four measurement stations and thus, are only a guide to the general picture. Figure 6.7 shows the distribution of measurements from which these figures were computed.

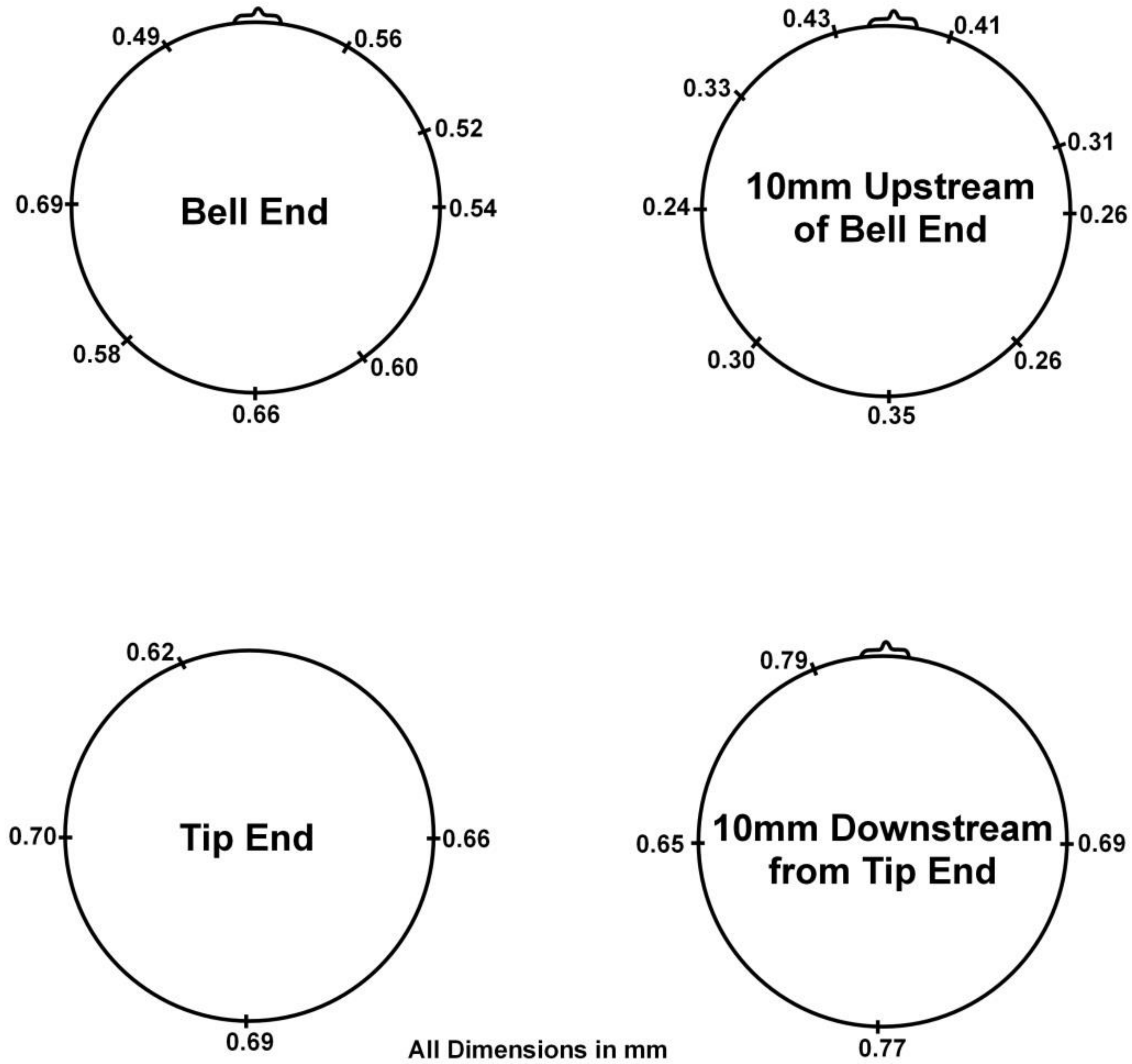


Figure 6.7: Wall Thicknesses of the Loughnashade Horn

It was not possible to measure the material thickness over the whole instrument surface and it is probable that this varies somewhat, away from the edges where measurements could be made.

The largest piece used on any of these instruments was in the construction of the bell yard of Ardbrin, where a piece of sheet 1.49*m* by 0.28*m* was required. Following the cutting out to size, this material would be formed into a tube and sealed. In the case of the riveted instruments, the first operation in providing the seal would be to mark out the axial centre-line for the rivet holes. On the bell-yard of Ardbrin, the scribed line through the centres of the rivet holes is visible over most of the instrument and it seems probable that this would be drawn with the developed sheet flat, i.e. before forming into a tube. The line, which is still clearly visible, was obviously scribed using a straight-edge, the straightness of this being discussed below.

Having defined the centre-line for the rivets the maker then had to space these along the tube, alternating across the seam. (Plate 6.4a/b) Several pitches of these rivets were measured, on Ardbrin, and their spacing of 4.67 mm was found to be consistent to within ±0.25 mm. This limit is clearly tighter than can be attained by simply centre-punching the holes using a visual assessment of spacing and points to the use of some mechanical lay-out technique. No signs are visible, on the riveted seam, of marking out by means of compasses and with this technique anyway, one would tend to get a build-up of errors from both the marking-out and punching operations.

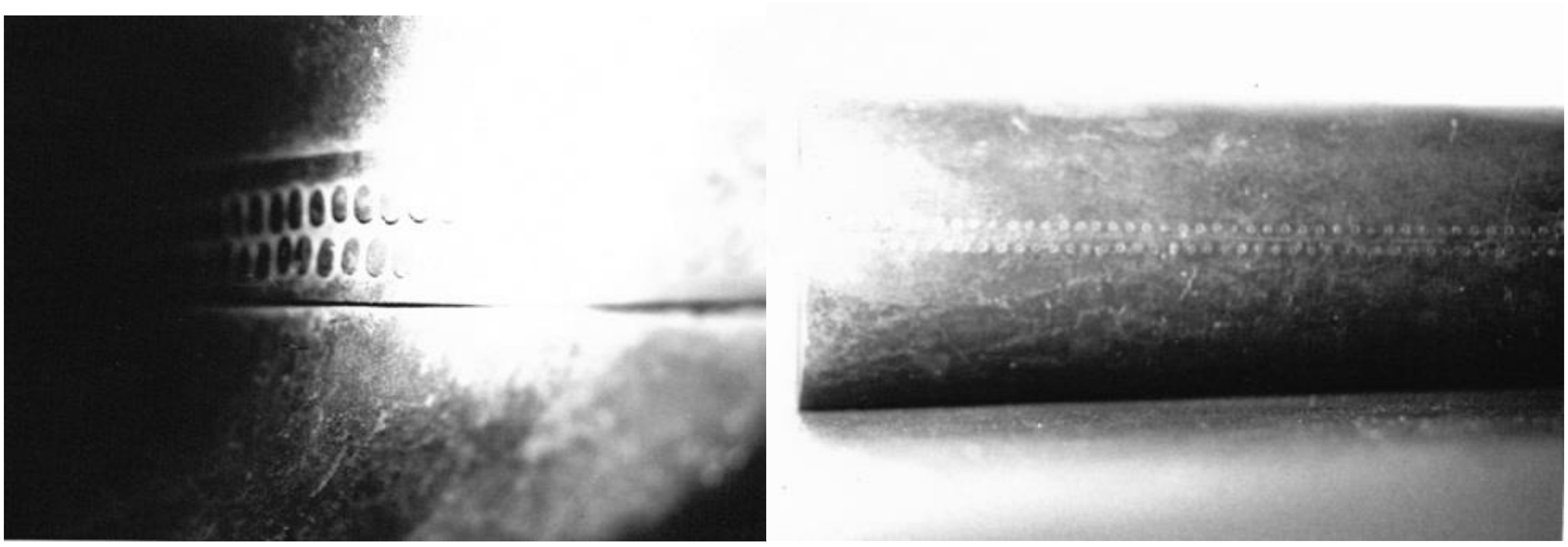


Plate 6.4: The Riveted Seam on The Ardbrin Horn

Thus it is possible that the technique employed by modern craftsmen was used, i.e. the fastening together of two punches one of which located in the previous hole while the other punched the next. Whether or not this was so, very great care was expended in the location of the rivet holes. Drilling of these holes must have been carried out equally carefully to avoid running-off of the marked spot. Only one hole is now vacant and can be inspected, this being on Ardbrin. It is well drilled with a diameter of 1.35*mm* and is countersunk on the outside of the instrument to a diameter of 1.70*mm*. Such a hole form when filled by a rivet formed in situ, and abraded flush to the outer surface of the tube would give a head nip of only 0.175*mm*.

The internal riveting strip (IRS) would also require drilling and it would seem unlikely that this was done before its assembly in the tube. Thus, the first hole could be drilled in the IRS and this riveted in place as the tube is formed round. The next hole could then be drilled, deburred and that section of tube riveted in place. After each such operation, the tube would need to be formed over another rivet pitch and the drilling and riveting carried progressively down the tube. On the inside of the instrument tube the rivet heads are flattened against the tube bore and, being about 4*mm* diameter, these almost touch each other here. These heads would need to have been formed prior to assembly of the seam, as a head of 4 mm diameter could not be formed from 1.3*mm* diameter wire without several stages of annealing between the forming operation. Figure 6.8, drawn to scale, shows the extent to which the metal forming the rivet head on the bore of the instrument is required to flow during manufacture of this rivet. (See Plate 6.4a, above)

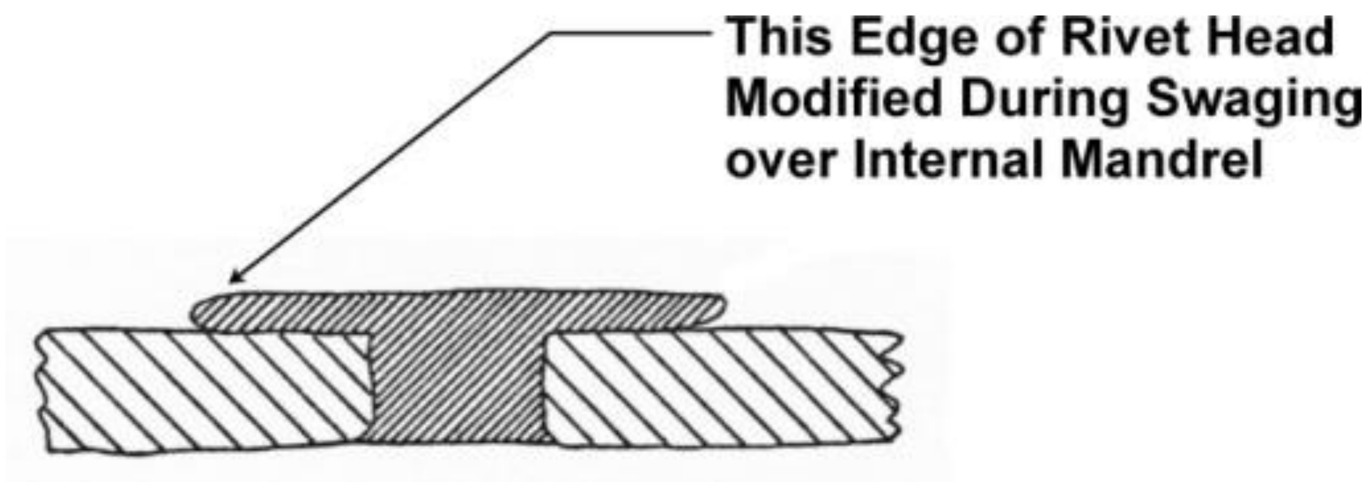


Figure 6.8: Form of Swaged-over Rivet

One key feature when riveting is the close fit between the rivet shank and the sides of the enclosing hole. Where excessive clearance exists, especially with fine rivets such as the ones used on these instruments, the shank tends to bend while the head is being formed. With the advent of wire drawing, the means to produce a uniform wire became available from which rivets could be formed. Whether or not drawn wire was used to form these rivets cannot be stated categorically but draw-plates are known from a late bronze-age hoard from lsleham in Cambridgeshire.[226]

Although each individual rivet is quite small, having used perhaps 3-4*mm* of wire, the rivets together would have consumed some 2.5 m of wire. This is a considerable quantity of 1.5*mm* diameter wire which, judging by the good fit of the rivets in the holes was manufactured to a high degree of roundness. It seems likely, therefore, that the wire to produce these rivets would have been drawn.

While the first few rivets could be fed through the drilled holes reasonably easily, this process would become increasingly difficult as the tube length increased. These later rivets would thus, have to be fed through from the point where the tube is being slowly closed up and, once through the tube wall and IRS, be held hard against the wall with a suitable mandrel.

A more-elaborate technique was used to manufacture the seam on Llyn Cerrig instrument, where the two ends of the tube meet in an interlocking wavy line. See Figure 6.9. Where the edge of the tube material extends over the seam centre-line, the sheet has been thinned by flowing the metal over this, leaving the tube wall thinner at this point. The mating edge of the seam, which had previously been chamfered on its inner edge was then worked down to form a neat seam. See Figure 6.9. A similar technique for producing riveted seams was used on the Cork Horns found in 1909 during excavations in Cork. (See O'Kelly, 1961, 5)

[226] Britton, 1960.

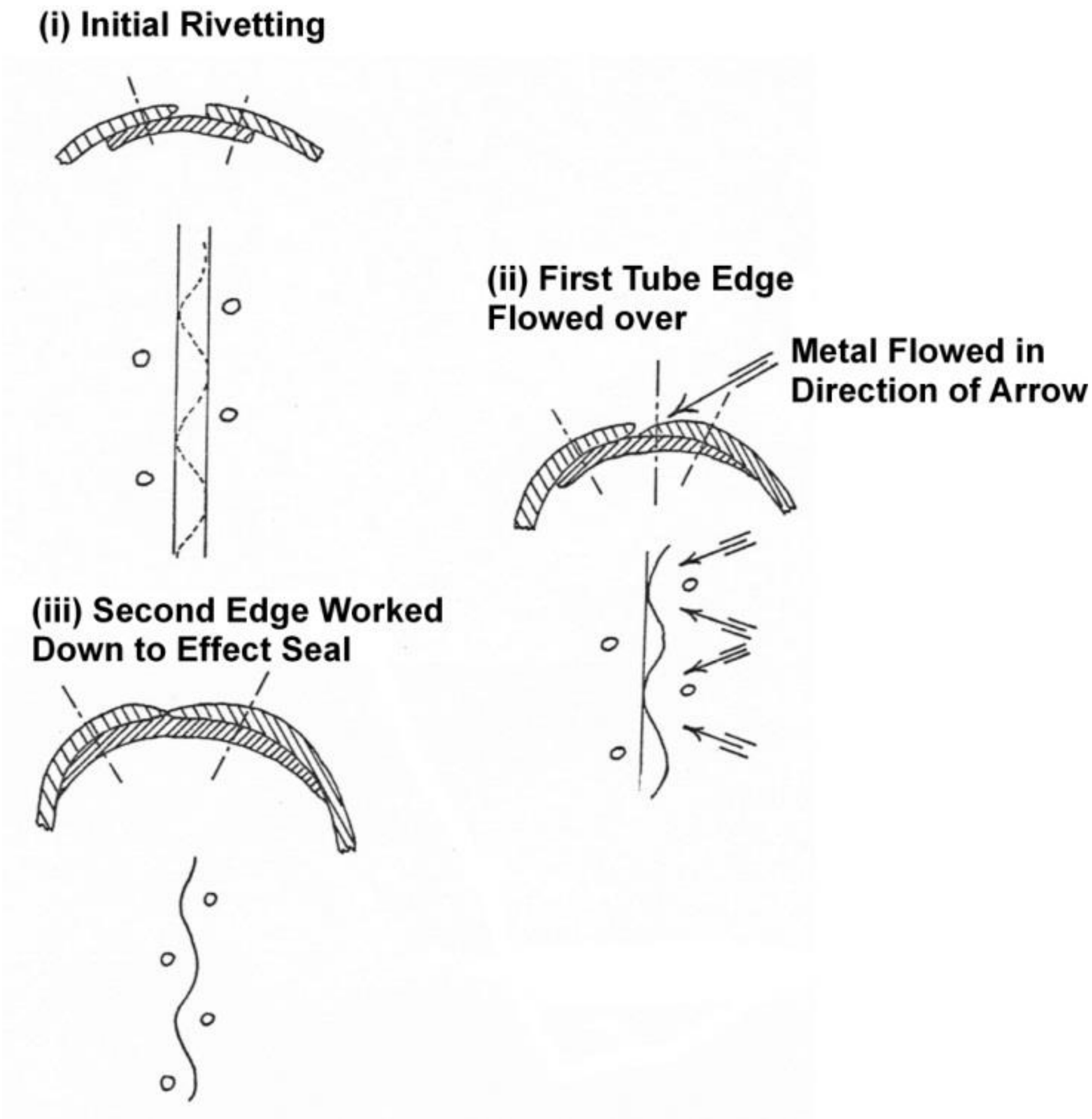


Figure 6.9: Forming the seam on the Llyn Cerrig Instrument

All the Celtic Curved Horns examined have parallel tube yards. In the case of Ardbrin this yard is 22.0*mm* diameter (mean of 52 readings at 8 stations) with a maximum variation of +0.26*mm* and -0.22*mm*. At individual stations, the tube is round to within ±0.29*mm*, in spite of this quality of the tube "roundness" being the first to suffer when the instrument is dropped, banged or otherwise mishandled.

The figures for roundness quoted above are indicative of considerable precision in the forming process both at the stage of cutting out and forming it into a tube. When cutting out the material to form a parallel tube to ±0.24π*mm* (mean error) a rectangular sheet would be required which has parallel sides, themselves uniform to within about 0.24π*mm* (0.75*mm*). This figure of 0.75*mm*, the maximum allowable variation from parallelism is itself the product of the two operations; marking out and cutting to this mark. A relaxation of this tight dimensional requirement is discussed below.

As mentioned above, an accurate straight edge would be needed for the marking-out but no evidence was found as to the mode of shaping the sheet. If parallelism alone is the criterion, then the absolute dimension of the strip width would not be critical and a go/no-go gauge would be suitable for dimensional control.

Having manufactured sheet to the required shape, it then has to be formed into a tube. Although this can be done by folding around a fairly crude mandrel, such a process would not enable a tube to be produced to within ±0.24*mm* roundness. Such a dimensional requirement can only be met by the use of a mandrel of equal or greater roundness. In addition, such a mandrel would need to be of a sufficiently hard material that it can withstand the blow of a hammer used to form the metal. When making hollow objects a hard wood is generally usable for forming metal. However, when the metal itself contains internal projections, such as rivet heads, wood of even the hardest type is no longer suitable. The point pressure from the rivet heads impresses these into the wooden surface of the mandrel and this can then no longer be removed from the formed tube. It seems, therefore, that a metal mandrel was used in the manufacture of these tubes, of a metal that was hard enough to stand the pressure of the rivet heads. Such a metal, however, had to be formed into a circular cross-section with roundness of at least $\pm 0.24mm$. Of the methods available for producing such a mandrel, the most likely to have been used seems to be that of generating, probably by turning on a lathe. A further benefit from having a round and hard mandrel, is that, where the tube diameter is slightly less than this mandrel, working of the tube walls over it will stretch the material, producing a tube diameter that conforms closely in size and roundness to that of the mandrel.

A secondary effect which results from this working over a hard mandrel is that the rivet heads themselves, are both curved to suit this mandrel and thin out at their edges to run smoothly into the bore, (Plate 6.5b, p. 340)

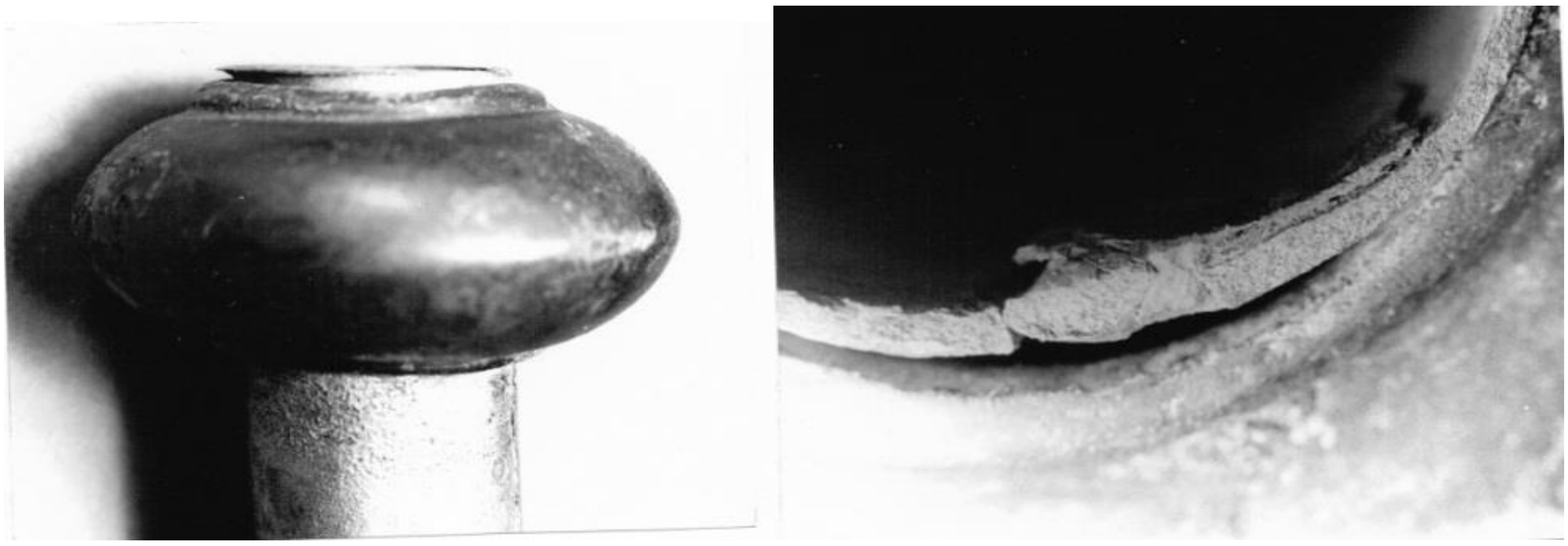


Plate 6.5: A Cross -Section Through a Rivet

There is a bit of a cheat added here in 2012 when I originally scanned in the thesis as the reproduction of Plate 6.5a was not as good as that in the original thesis which was a photograph

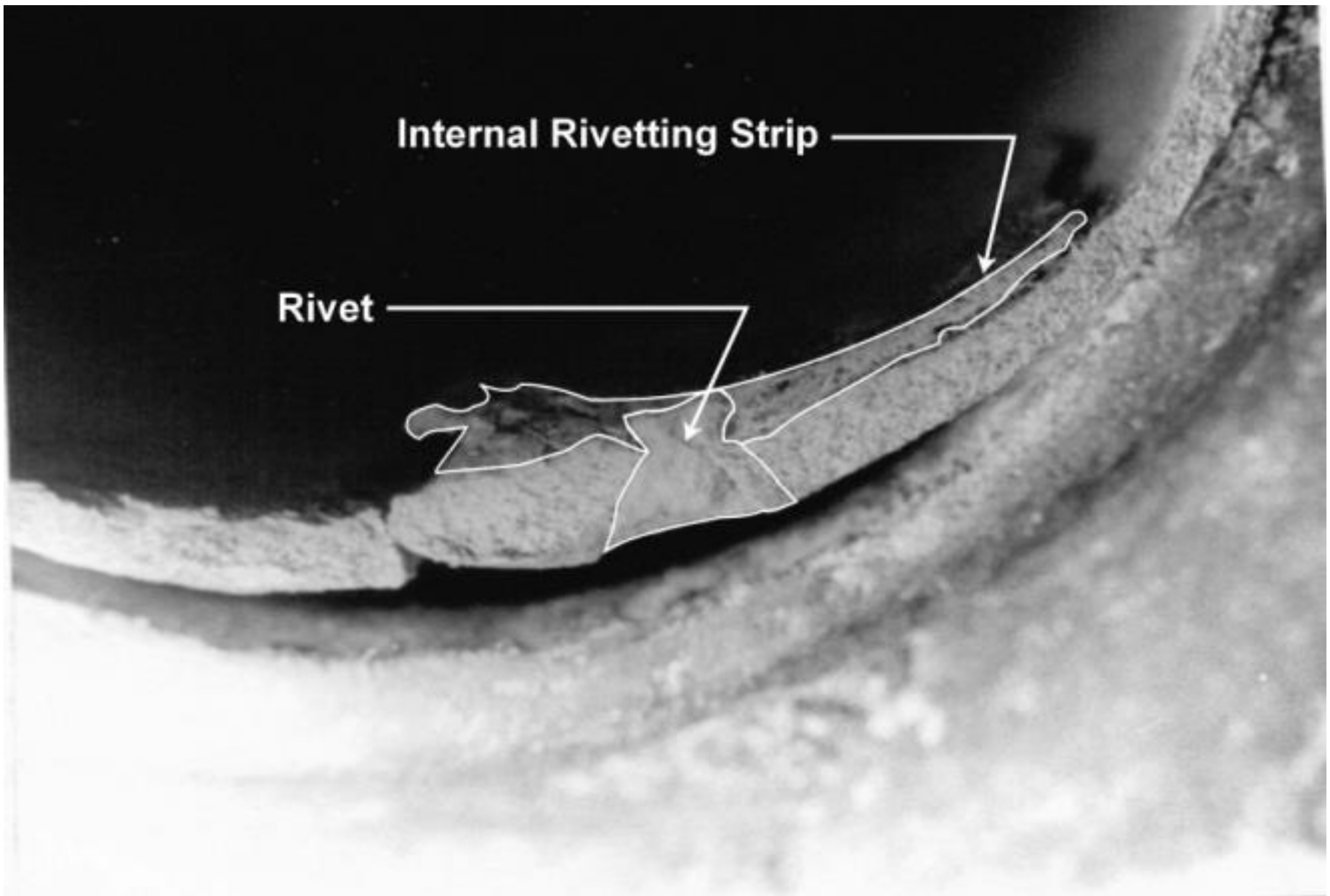


Plate 6.5bb The Rivet Shape Outlined

This effect is very marked on all the instruments examined indicating quite clearly that a hard metal mandrel was used in this operation. (Plate 6.5bb, above.) This photograph show the edge of the tube and it is apparent from the sectioned rivet visible here that this has been abraded back since the tube was originally riveted. The wedge shape of the rivet at this point results from the drilling of the original rivet hole obliquely and not normal to the tube wall. Also visible on this plate is the thinned-down edge of the sheet adjacent to the rivet hole.

MANUFACTURE OF THE BELL YARD

This group of instruments has bell yards which are basically conical in form. Thus, the manufacture of these yards would first involve the production of a sheet of material of the appropriate shape, i.e. the developed surface of the cone. With a long narrow-angled cone such as these bells, the frustrum of a cone would provide a near approximation to this developed surface. The major error would be visible on the bell end of the instrument, where the end face would be inclined at an angle to the normal to its long axis. This excess material could then be removed by abrasive working.

On Ardbrin the bell yard is not truly conical but it is uniformly hollow from the best cone by about 11*mm* over its 1.489*m* length. This variation, however, is not random but reaches a peak at 0.77*mm* from the instrument tip and varies smoothly back to zero either side of this. In order to investigate the nature of this relationship, the values of x (distance from bell yard tip) and y (diameter of bell yard) were tabulated and values of log y calculated.

The values of log *x* and *y* were subjected to a straight line regression analysis and yielded a goodness-of-fit correlation (r) = 0.9988. Thus, the analysis was statistically valid and showed that the values of x and y were related by the equation $y = x^{(0.0043)} + 19.80$ i.e. the bell yard had an exponential form with a relatively slow rate of flare. Although this form of expansion of the bell yard is more effective both in terms of propagation of the instrument sound output and of producing harmonically related formants it does not seem too likely that this feature of the exponential bell was well understood at this time. On the other hand, whereas the flare on an exponential bell with a more pronounced flare can readily be seen, the degree of flare on this instrument is so small as to be scarcely noticeable.

The forming of this yard would be no less difficult than that of the tube yard as the taper of the bell would require a mandrel of the same shape as the bell to be made were the same technique to if be used. It was not possible to measure the form of the bell yard to the same extent as on the tube but the indication from measurements taken are that this is round to within ±1.0*mm* at its least round point.

Following manufacture of the yards, these would need to be curved to the desired shape. Whatever the technique used on these instruments, it seems to have left behind little surviving evidence. A modern smith faced with this task would fill the tube with a low melting point metal such as lead, or one of the modern commercial alloys, which can flow as the tube is formed. However, on a tube with two rows of rivet heads along the seam, the molten metal being poured in would have wet the tube/rivet interface as these were heated up to the appropriate melting point, and probably flowed into this rivet head/tube interface under capillary action. Such a layer of material would, subsequently, be difficult to remove and would probably remain when the bulk of the infilling material was removed. Inspection of the bore using fibre-optic inspection equipment revealed no such deposit nor traces of the corrosion products of lead in any form.

The other alternative for filling the tube during bending, which is also still used today, is sand or similar granular material. This is also able to flow, taking up the change of shape of the bore, but needs to be packed tightly into the tube during working and to be retained there. With a small diameter tube wooden bungs can be wedged into their ends and can be made to seal better if these ends are given a slight conicity. On both ends of the tube yards and the tip-end of the bell yard are, in fact belled out, the tube yard ends over the first 100*mm* of their length and the bell yard end over the first 40*mm*. This belling out could, thus, have been to facilitate sealing-in of the packing material as well as to accept the adjacent yard or feature. See Figure 6.10.

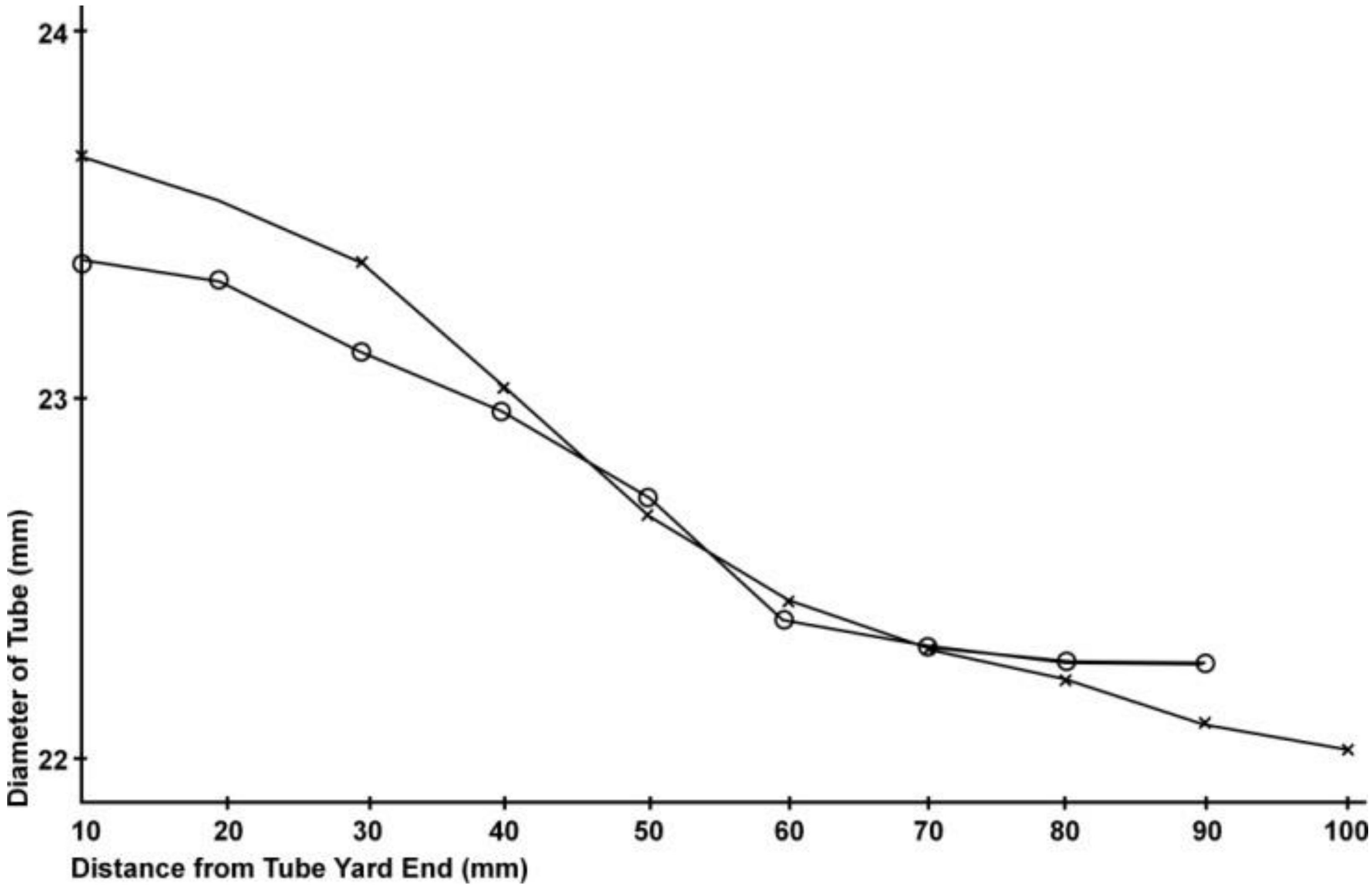


Figure 6.10: Instrument Tube Diameters

No signs of distortion of the bell yard are visible at the instrument bell end, however. Nevertheless, this instrument must have been packed to facilitate bending, and the technical skill called for in this operation was considerable. On the outer curve of the instrument, the tube surface was thinned during this operation but, on the inner surface, where the riveted seam lay, the metal was actually thickened during the process. Had this not been so, then the accommodation to the new form would have been made by rippling of this seam. It is quite clear that the curved surface was produced by subtle flow of the metal rather than by the application of large forces as the integrity of the inner curve seam was maintained by rivet head nip on its outer surface of the order of $0.2mm$. Such a small nip would have failed with only a minute force and it seems likely that these rivet heads now seen on the instrument were produced after bending of the instrument. In this case, a conventional snap-headed rivet could have been formed when originally manufacturing the tube, only to remove this head, presumably for aesthetic reasons after bending the tube to the required form.

One instrument, Loughnashade, has an external riveting strip in addition to the internal riveting strips seen on all the other instruments. As far as can be seen the IRS was fixed on the seam in the normal way and the rivet heads abraded flush. The external riveting strip was riveted over this seam with the rivets alternating between those already in the tube. Because of the inaccessibility of the tube‘s bore and necessity of inserting the rivets from the outside of the tube, the internal rivet heads could be only poorly formed. This additional strip, unlike the IRS has a central spine running along its length. (See fig, 6.11).

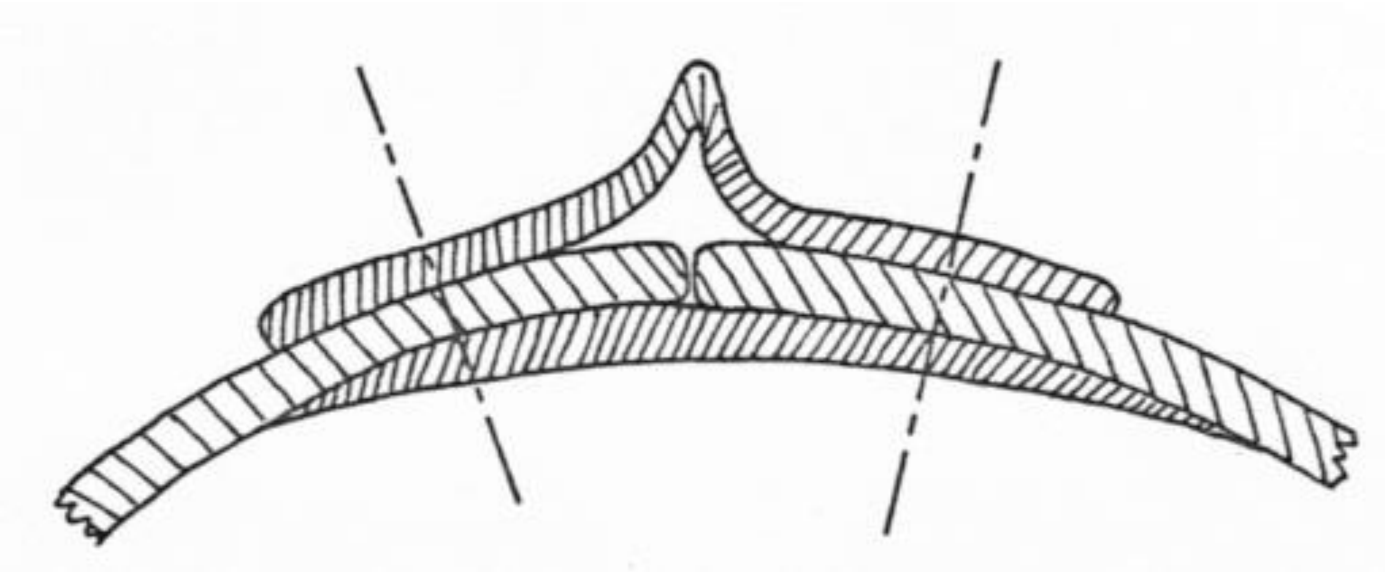


Figure 6.11: The Riveting Strips on the Loughnashade Horn

Were this strip to have been put onto the bell-yard prior to forming it into a curve it would then have been damaged during this operation

With the central spine projecting as it does from the tube surface, it would have been required to thicken considerably along the top of the spine. However, no signs of rippling are visible along this surface and it would seem likely, therefore, that the strip was formed into a curve and applied to the bell after this too had been similarly formed. It could, thus, be that the strip served to cover deficiencies in the earlier riveting operation such as sprung rivets. Many of the rivets on the bell of Ardbrin are pulled below the surface by some 0.37 to 0.50*mm*, this probably having occurred during bending of this yard. However, only one rivet is actually missing and it is not possible to say when this loss occurred.

Clearly the whole process of producing a seam was seen as a functional operation and post-riveting operations carried out for aesthetic reasons, both on this and other material from this area. On the Petrie Crown, for instance, following the riveting, the backing material was tooled away leaving a raised decoration which, as its line cut across a rivet, included part of this raised portion.[227]

A similar riveting technique to that on the horns was also utilised on several spear butts currently seen in the National Museum at Dublin but, unfortunately unlocalised. (See Plate 6.6 (a/b), below)

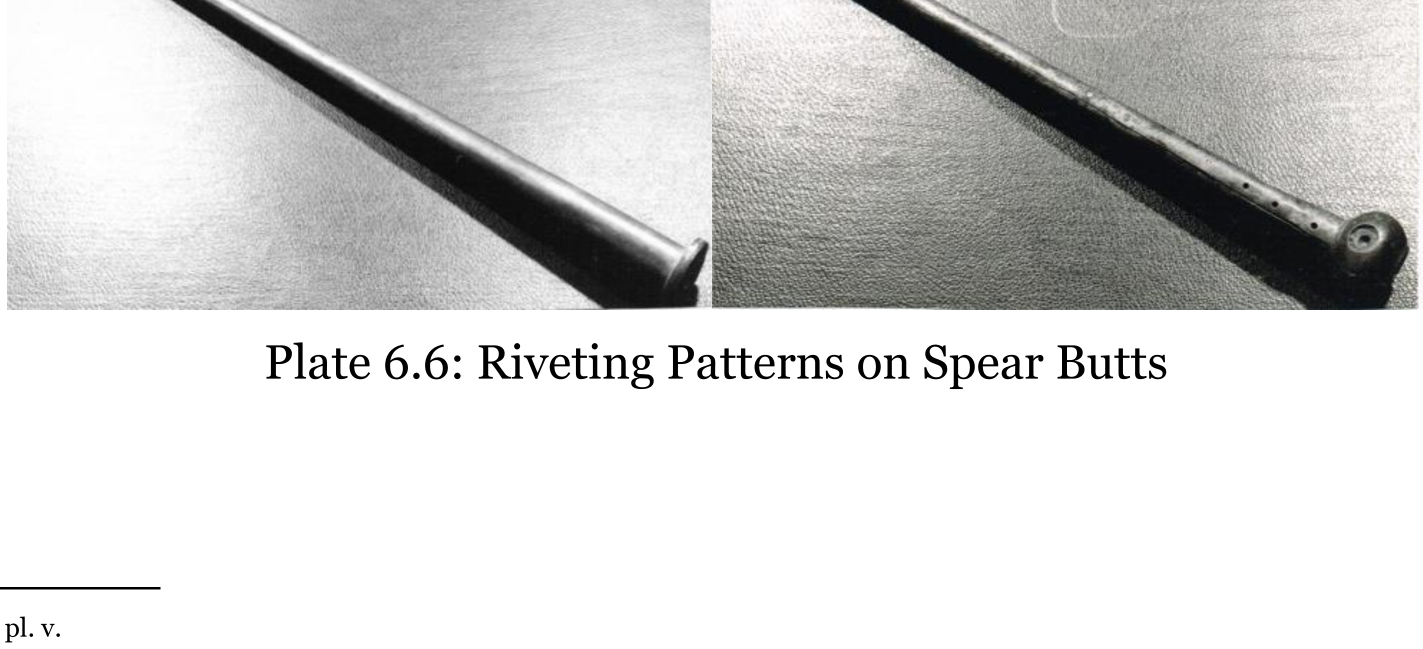


Plate 6.6: Riveting Patterns on Spear Butts

[227] O'Kelly, 1961, 9, pl. v.

However, the elaborately-riveted seam on these seems to be technically in excess of what is required to produce functional items. Also in this collection of spear butts are shorter cast types which, presumably, pre-dated the riveted ones. For some reason, possibly the difficulty in coring out the bore of these to give a reasonably thin section, and possibly because of the availability of bronze sheet, approximately 0.75*mm* thick, these butts were simply wrapped around to form a seam from the butted ends of the sheet. Then, to maintain the seam closed, cast bosses have been fixed over the tube ends. In some cases these seem to be cast-on, in others pressed on and, perhaps brazed. Clearly the key factor in this mode of construction is the integrity of the end fittings and, as most of these seem to have survived, this particular technical problem appears to have been solved.

However, one spear butt has a riveted seam and as the maximum diameter of its tube is 15.8*mm*, the creation of this called for enormous technical skill.(Plate 6.6b, above) One possible explanation of this is that the smith attempted to apply the simple butted seam to other artefacts such as the Cork Horns, etc. and found that, because of their greater cone angle the seam would not remain closed. They thus developed riveting to overcome this problem. Having developed this technique it could then be applied to both horns and spear butts, If this is true then a possible sequence of development of the technique would be:

Cast Spear Butts ⇨ **Wrought Spear Butts with Structural Bosses** ⇨ **Wrought Riveted Conical Ware, e.g., Cork Horns Bosses** ⇨ **Wrought Riveted Horns** ⇨ **Wrought Riveted Spear Butts**

One of the most complex processes in manufacturing a sheet-metal piece such as the long bells of these instruments is the development of the sheet outline needed to produce a particular curved form. The sequence proposed above would allow for the problem of developing surfaces shapes to be solved on the simpler shapes of spear butts and, then to progress to the more complex forms of horn bells. Even with the instruments studied, which were presumably towards the end of the evolutionary sequence, problems of defining the horn form were experienced.

THE JOINING OF ADJACENT YARDS

In the case of Loughnashade, the tube yard end slides into the bell yard tip to a depth of 48*mm* but as this tube has been subjected to such a degree of repair and reworking it is not possible to say if this inter-relationship was part of the original design. However, the end 20*mm* or so of the external riveting strip is omitted from the bell yard tip and its spine abraded back by 7-8*mm*. This would allow the boss found with this instrument to fit onto the bell yard tip and, when pushed hard up to the external riveting strip, would be half on the bell yard and half on the tube yard. It would, thus, cover the actual joint of the two yards, hiding whatever attempts had been made here to effect a seal.

No other features exist which would serve to join together the yards of these instruments in a satisfactory way. Such features would need to be mechanically stable enough for one yard to be held rigidly when the instrument is supported by the other, and, in view of the fact that two people are required to handle Ardbrin, if this is to be done without damaging it, the requirement of this mechanical fixing can be seen to be an exacting one. In addition, a moderately air-tight seal would be required to enable them to be blown satisfactorily as musical instruments. As discussed above, the ends of the yards of Ardbrin are slightly belled out and the tube and bell yards do not fit together. A separate junction-piece must have been used on these instruments and, presumably, this fitted inside the two yards.

It is at the junction of individual yards where the requirement for accurate diameters is at its greatest. The surface development of a tip diameter is not simply defined by π times tip diameter on a cone unlike on a length of parallel sided tube. Hence, the Smith must have either developed a technique for laying-out surface developments or stored the dimensional information in some way between making one instrument and the next.

Clearly, difficulties were experienced with bell yards, as is seen on Loughnashade. On this, the bell yard is extended at its tip by 99*mm* and by continuing the slope of the bell by this amount its tip diameter is reduced. Presumably the bell and tube yards were made with internal riveting strips only and, on offering up together found not to fit. The small 99*mm* portion of sheet was then formed into a tube and carefully riveted onto the short band previously riveted to the bell tip. (Figure 6.12, below, Plate 6.7a, below).

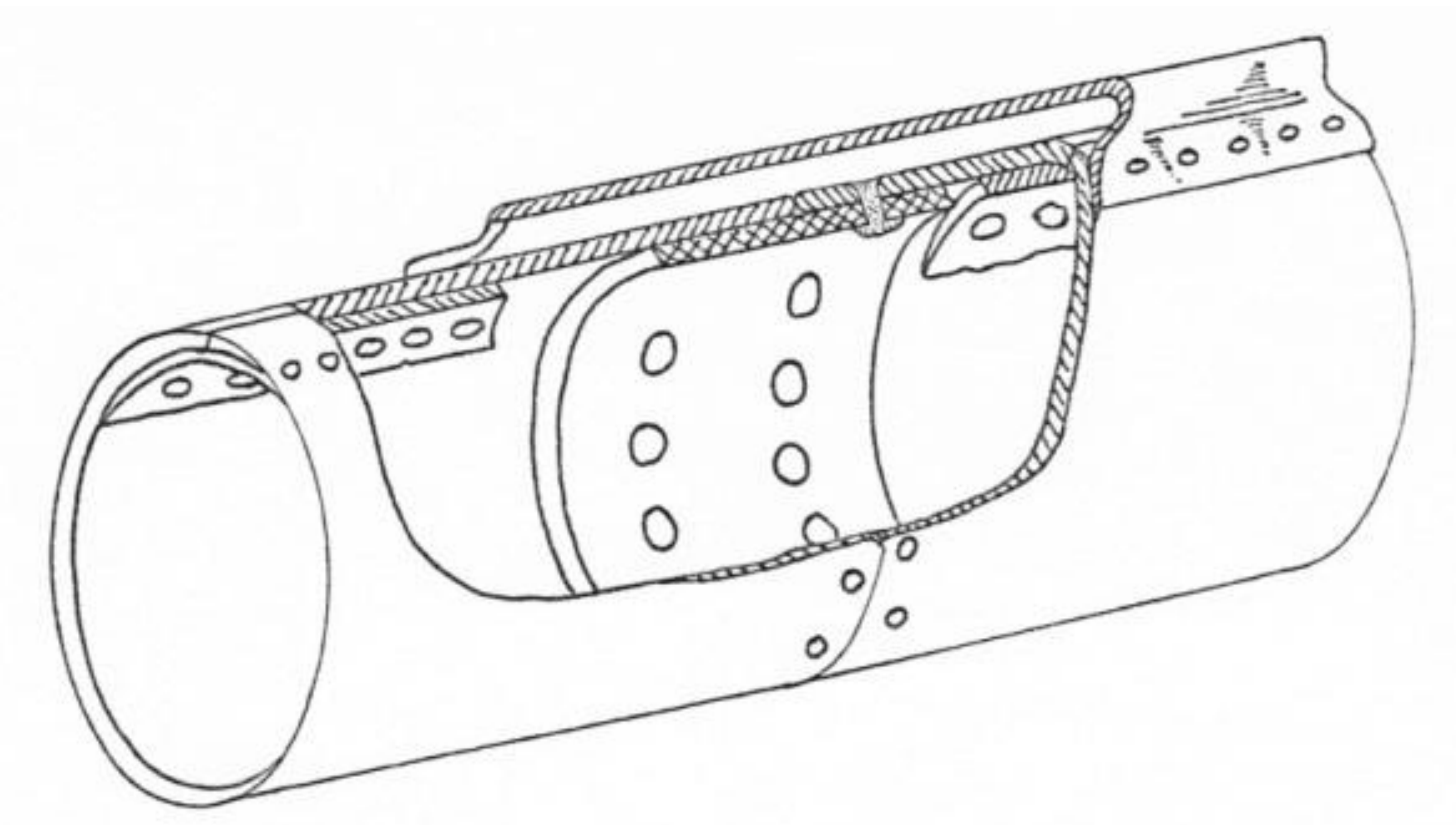


Figure 6.12: The Tip End of the Loughnashade Tube Yard

The tip of this additional tube was provided with an internal riveting strip only where no external riveting strip was to be provided. This external riveting strip was then riveted in position along the whole length of the bell, overlapping the junction of the tube extension, and stopping about 20*mm* short of the bell tip, presumably to allow the boss to slide over the tube at this point.

Three instruments, Loughnashade, Rosscrea and Llyn Cerrig, have bosses which were probably originally used at the junction of yards but are not in a form which could effect a seal at this point. None of these bosses that have survived would be much use in this respect and seem only to serve an aesthetic function, perhaps as skeuomorphs of some earlier device. On Rosscraea and Llyn Cerrig these bosses are cast and retained by the edge of the tube which has been peened over to form a retaining rim. (Plate.6.5b) above) Thus, on these instruments the boss would not cover the actual joint between adjacent yards but would be to one side of this.

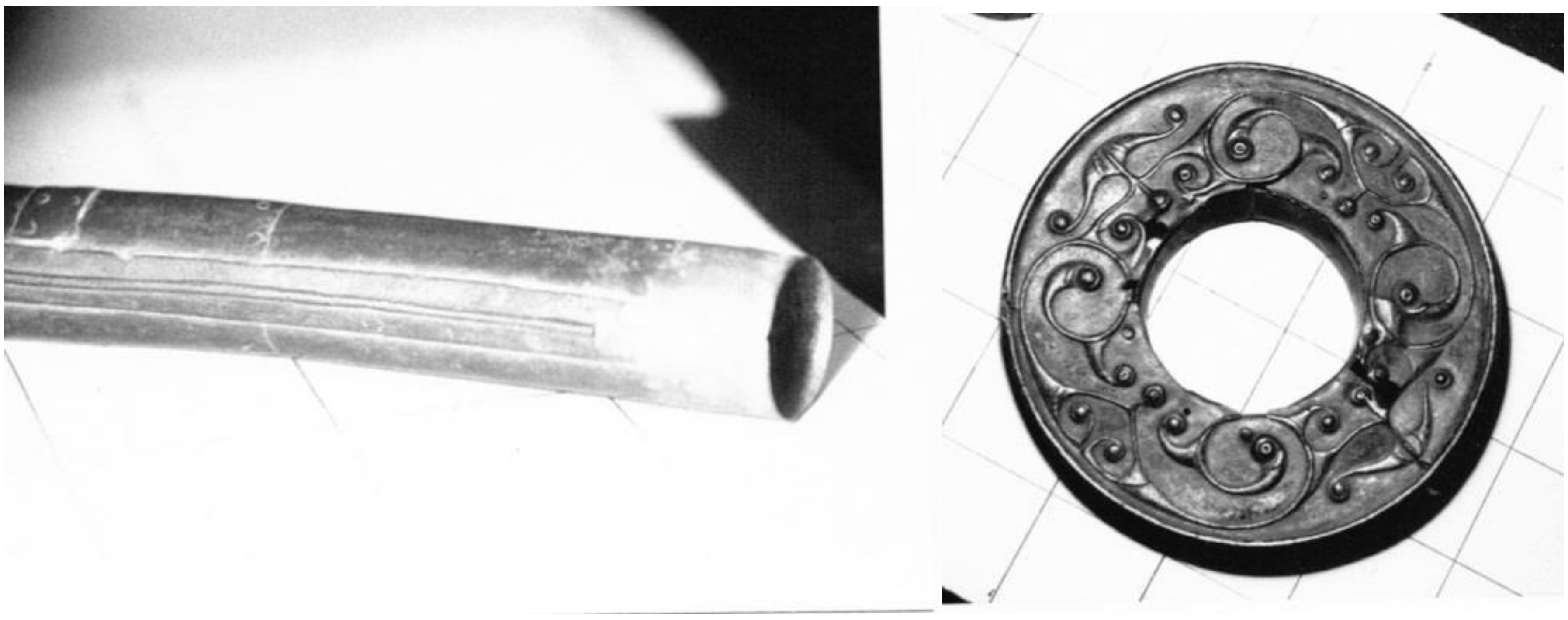


Plate 6.7: Details of the Loughnashade Instrument

The importance attached to the provision of this feature is perhaps illustrated by the wrought boss provided on Loughnashade. To a practicing silversmith, this is probably the most satisfying piece of craftsmanship seen in the present study. Its form is shown on Fig, 6.13 where it can be seen to consist of two pieces. Each of these would need to be cut out from sheet, and worked as shown on this figure. The modern smith would use a variety of tools to produce such pieces and would need to work systematically to develop the various features that this boss has. It is hard to imagine how such a piece as this could have been made without both a wide variety of tools and a considerable tradition of metalworking.

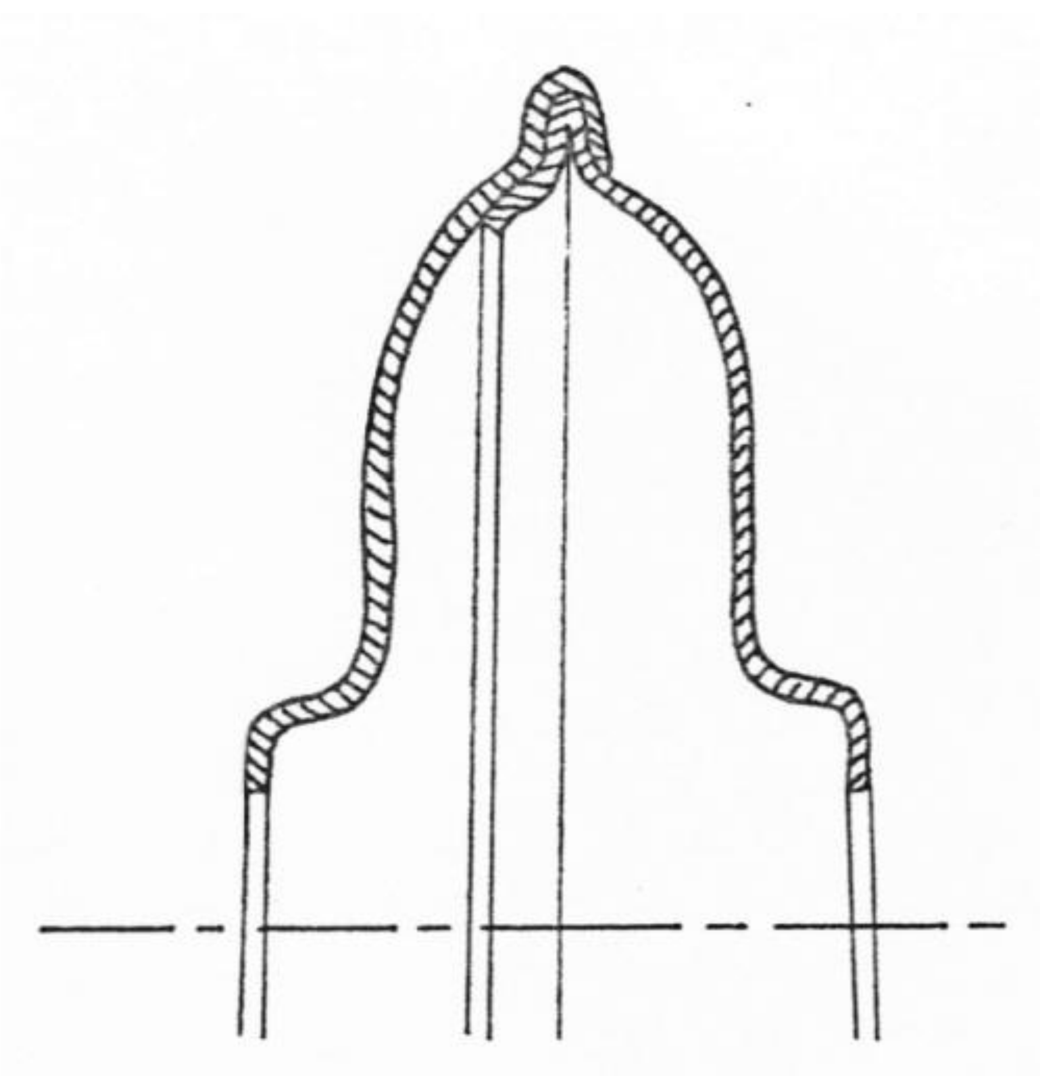


Figure 6.13: The Loughnashade Boss

TERMINATION OF THE BELL-YARD

Only one instrument still possesses an annular bell disc which seems designed to fit around the bell exit diameter. This too is a carefully made piece worked from sheet and decorated by repousse work. The elements in this decoration are dated by Dr. Joseph Raftery to the La Tène period, probably about 100BC[228] See Plate 6.7b, above).

THE KILLYFADDY FIND

This find,[229] was of pieces of wood curved in form and hollowed out into semi-circular cross-sections. The eight pieces can be matched together in pairs to form four curved tubes each roughly 0.74*m* long along their outer curve, with outside diameters of approximately 37*mm* and bores of 24*mm*. Three of the yards have both male and female ends and the fourth two male ends. They thus appear to be a single set of material and not two pairs. On the external surfaces of the tubes are numerous square bronze pegs with traces of corrosion products around these. From the shape of these traces and indentations on the tube surface, the tubes appear to have been held together by means of a bronze strip approximately 13*mm* wide wrapped spirally around the tube and nailed into position.

When re-assembled in what appears to be a reasonable reconstruction, the four pieces appear to be the four yards of PVA with a cylindrical bore and curved in a semicircle. In

[228] Fox, 1946.
[229] Wilde, 1857, 244.

this form, the overall length is about 2.6*m* and, combined with their bore of 24*mm*, these pieces form an instrument very similar in morphology to the other Celtic curved horns.

THE ORGANOLOGY OF THE INSTRUMENTS

These instruments consisted of two or three yards of large bore (c. 25*mm*) tubing some 2*metres* long. From the evidence of SR16 they appear to have had little or no mouthpiece or mouthsupport and, thus must have been very similar, acoustically, to Ardbrin as it now exists. (The two yards of this are now held together with a modern junction piece that allows the instrument to be blown). When blown, this instrument sounds its first two or three formants readily but becomes progressively more difficult to play as higher pitches are attempted. However, during blowing tests for this study it was found to be playable up to its eighth harmonic. Undoubtedly, with only a small measure of support for the lips these higher harmonics would come within the range of feasibility for use as they could be played with moderate success using the tube end alone. In view of the tradition in this area of PVAs with large diameter tubes and simple mouthsupports, i.e. no developed throat, there seems to be no justification for proposing that these instruments had any form of mouthpiece. Thus, the increase in lengths of instruments in this area was probably brought about by the desire for deep bass notes rather than the increase in playable harmonics that came with this longer tube. In any case, regardless of the number of attainable notes, the performer could never sound these with any agility. The lack of mouthpiece throat makes a rapid alternation between notes almost impossible to achieve.

When complete, the Celtic curved horns are anything but portable. Their physical size alone is such that two persons are required to handle them if they are not to be damaged in the process. The presence of an elaborate bell disc on Loughnashade gives rise to further difficulties in the handling of this and leads one to propose that these instruments would almost certainly be used in a stationary position.

The tradition of large bore PVAs in Ireland has been mentioned previously in this study and the question of their usage discussed in Chapter 3. In this chapter it was proposed that the Bronze-Age horns of Ireland were blown as variable tone-colour instruments with a complex usage pattern. With the iron-age horns under discussion here, however, the ratio of tube length to tube diameter is much greater than on the bronze-age instruments and does not appear to allow their use in this way. One must enter a caveat here, of course in that the author while being able to play the didjeridu and, hence the Irish bronze-age horns moderately well, may lack the technique to make these iron-age instruments speak in the appropriate way.

The uniformity of morphology between the Irish instruments, that from Nice (Munich) and the eastern Meditteranean (SR16) would suggest that a stable technique of blowing these instruments had been developed and was widely utilised. In addition, this wide spread points to their being effective as musical instruments and not simply the product of technology and aesthetic taste.

THE USAGE OF THE CELTIC CURVED HORNS

Earlier discussion has mentioned the size of these instruments and their use in a stationary way. Such use may have been in a social group and, it seems quite likely, as a part of some ritual activity. Close technological affinities can be seen between the Irish horns the so-called Cork Horns and the Petrie Crown[230] and they were probably produced by the same school of craftsmen. These other items are clearly designed for use in a ritual, quite probably the same one where the horns too were utilised.

In the case of Loughnashade this instrument was used over a long period of time and was much repaired. Some of these repairs are of a quality comparable with the original work on the horns but many are very poorly carried out and of a quality grossly inferior to the general standard of workmanship on the instrument. It is hard to express in this brief chapter just how high the quality of workmanship is on these instruments and what this means in terms of control of the manufacturing processes used in their construction. Indeed, a second stage of investigation to carry out a precise metrological examination, possibly utilising photogrammetric methods might well reveal much more of value about the school of smiths making these items. It may well be in the case of the Irish material, that only a very small number of manufacturing centres ever existed, having developed this technology·over several generations. Such a situation would be vulnerable to social disruption and relatively easily destroyed. Perhaps the successively poorer stages of repair on Loughnashade chronicle the decline of the smith over the period of its use. Perhaps too, Killyfaddy, the wooden instrument, is a further example of this decline in metalsmithing. While maintaining the morphology of the Celtic Curved Horns, this instrument is restricted in its use of metal to bronze strip for wrapping around the tube and pins or nails for holding this in place.

CLAY HORNS

These instruments are known only from Spain, having been excavated in Numancia, which was destroyed by the Romans in 135AD. They are now fragmentary but portions of tubes, mouthpieces and instrument bells have been recovered. In their original form they were probably made up of several yards which were made to fit into each other, yielding a spiral instrument of about 40*mm* cross-section 140-200*mm* diameter and possibly about 0.8*m* long. (Figure 6.14; Plate 6.8 (a))

[230] see O'Kelly, 1961.

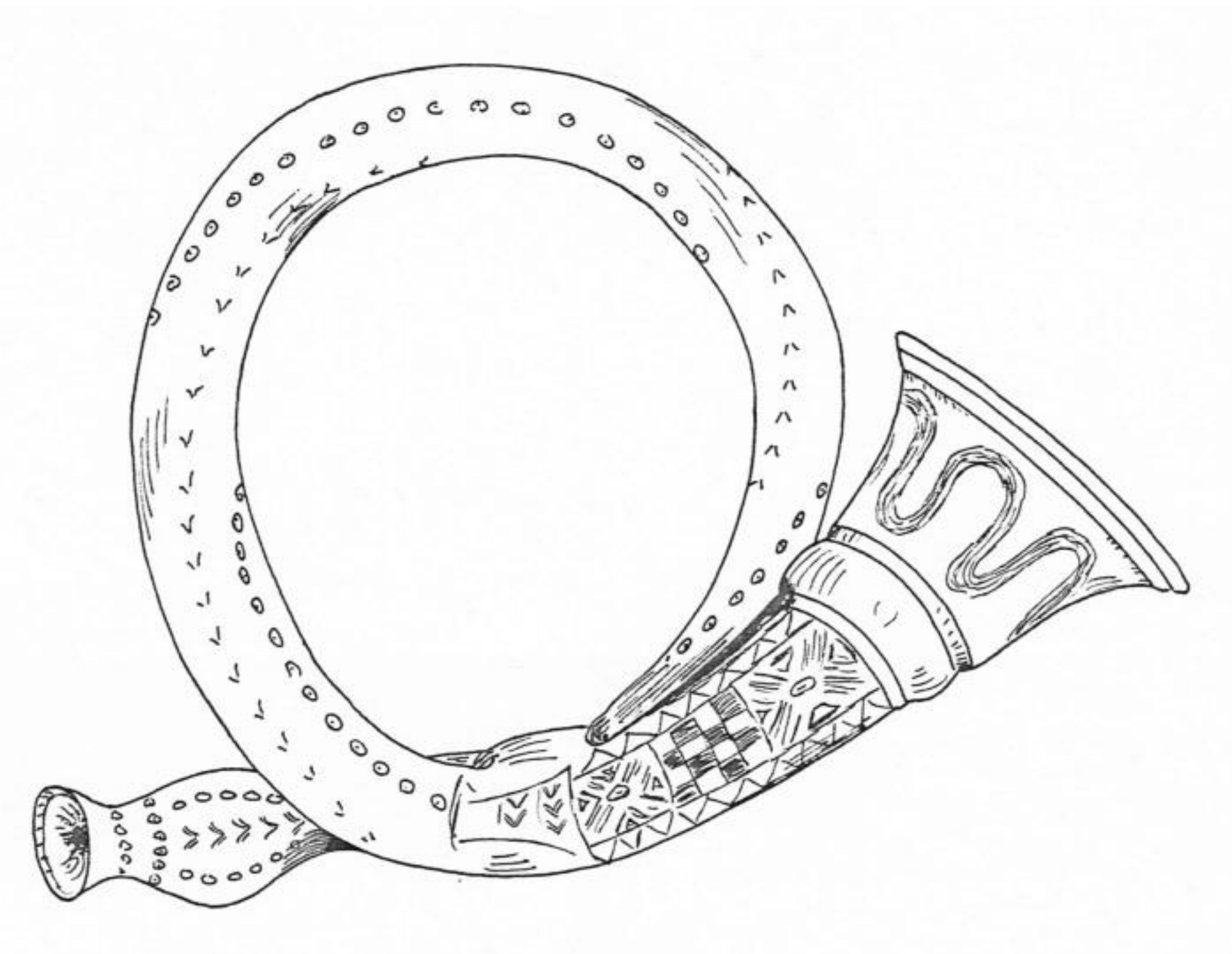


Figure 6.14: An Impression of a Complete Clay Horn from Numancia, Spain

The bell form is conical with a slight flare and on SD266 is richly decorated with geometric shapes and patterns. From the information available nothing can be said about the bore of these instruments but from the illustration of the mouthpiece[231] it seems reasonable to assume that these are conical. The mouthpieces illustrated have a well formed cup and rim with throats of 5*mm* and less.

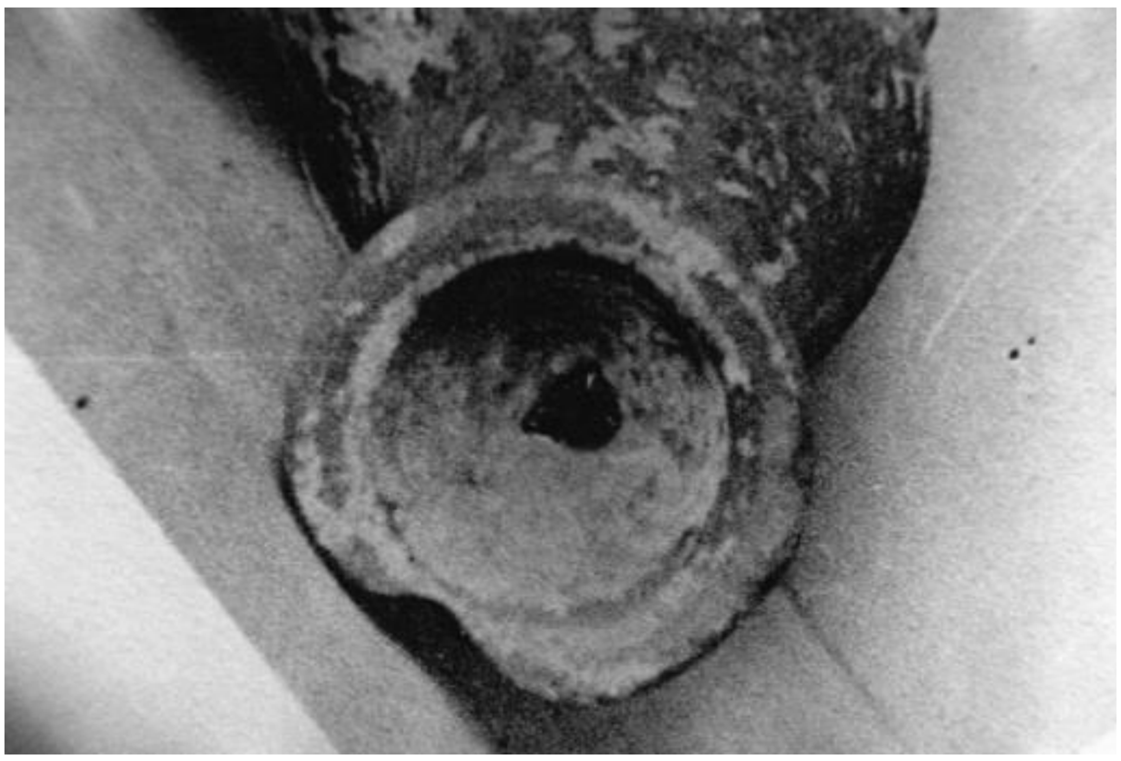


Plate 6.8: The Mouthpiece of one of the Numancia Clay Horns

It is obvious that the makers of these instruments had mastery over their medium, fired clay, and were, thus able to concentrate on the production of their designs in this.

[231] Comision Ejecutiva, 1912, Lam. (plate) LV.

Numancia itself dates from Neolithic times and the local clay industry may well have developed over a period of several thousand years. While the manufacturing material, clay, no doubt gave rise to problems in the formation of a bore, it did provide opportunities lacking in other media. For instance, in the forming of the mouthpieces seen here, the clay has been carefully worked to provide what appear to be very modern looking mouthpieces with a considerable constriction at the throat. It may well have been the plastic quality of the medium that gave rise to what appears to be the indigenous development of the mouthpiece in this area. Certainly, the horns themselves are unique in the Celtic world, the only other roughly contemporaneous material being reported from Cyprus (SD269), the Fayum (SD209) and the Po Valley (SD259). Whether or not the development of the mouthpiece spread from here to the rest of the Celtic world is hard to say but it may be that the development in this area, being related to clay working did not spread to the artisans working in metal.

Clay instruments do appear in Ethnographic material and, interestingly this is concentrated in South America where instruments very similar in form to the Numancia ones can be seen.[232]

These particular instruments are well made and meticulously decorated in a local style and would, thus, be used for either social or some form of ritual or cult use. Whatever they were designed for, they were effective and, no doubt, eminently playable instruments capable of producing up to about five notes, which if the bore is conical, should be harmonically related.

CELTIC INSTRUMENTAL USAGE

The Celts utilised a wide variety of player-voiced aerophones and each would have had its place in the day-to-day running of their society. This range of instruments, at the same time, expresses both the uniformity and the diversity of the Celtic peoples, in that instruments such as the Carnyx are ubiquitous through most of the Celtic world while other instruments are of very local distribution.

Represented as it is on coins in the hands of horsemen, the Carnyx is, par excellence, the instrument of the cavalry. Its spread throughout and beyond the Celtic world, therefore, symbolises the mobility of the warrior class at this time. Unlike earlier instruments of the north, however, the Carnyx is of wrought construction.

Its source from the Celtic point of view could well be northern Anatolia, one instrument having been found in Paplagonia (SD208) See Map 6.1. However, as well as spreading to the Celtic world, two instruments of this type (admittedly earless!) are clearly depicted on a relief of an "orchestra" playing at Sanchi, central India. (IC27).[233] This would suggest that its origin could be to the east of Anatolia, perhaps having developed there from the lituus and spread both to the east and west. Celts (Galatae) are known from this general

[232] Collaer, 1973.
[233] Dubois 1937, 38; Sachs 1940, 156/7.

area from Greek authors around the 4th century BC and were frequently involved in military actions against the populations of Greece, Rome and Asia Minor.[234] In addition to this:

> *"Celtic mercenaries were frequently found in Hellenistic armies in the third century (BC). It was originally by the invitation of the king of Bythinia that some 20,000 Galatae (Celts) were invited into Asia Minor, about half of them as warriors, and in 270 (BC) were permanently settled in something of a native 'state' in the area still known as Galatia."*

(Quote: Chadwick, 1970, 52).

Thus, a Celtic "nation" occupied this area with its record of instrumental use and connections with the eastern Mediterranean world. They had every opportunity to absorb the instruments of that area and to spread them to the rest of the Celtic world.

If the lituus already existed in an early form in this area, the new "nation" was in a position to take it over and embellish it to suit their own customs. However, this does not explain its passage to the east (IC27, Sanchi) as the Celtic connections were to the north and west and it may be that the lituus developed in Anatolia and thence spread north and east, perhaps during the campaigns of Alexander c. 323BC. During this spread, its conversion to a vertical instrument could well have taken place and, along with this the elaboration of its bell mouth. The subsequent collapse of this Empire and the return of Alexander's men would bring the modified instruments back to Anatolia and leave its form behind in what became the Maurya Empire in India.

A further possibility is that the Carnyx developed in India and was subsequently brought back to the Anatolia area where it was adopted by the Celts. Certainly, the name Karna survives in India for a straight trumpet (Karana in Persian) and is also found in Sanskrit records. If such a name was brought back to the Greek world and suitably hellenised, Karnon would result, i.e. the name that the Greeks did apply to the Celtic instrument. It also seems likely that the Greeks met this instrument ready-developed and with a name as their proclivity for the use of the term "salpinx" for all PVAs that they met, would have given rise to the use of this term all the time had the instrument not already been equipped with a name.

Undoubtedly, about 500BC in Northern ltaly great experimentation in instrument design was taking place. The Etruscans had developed numerous forms of PVAs and further south, a type of side-blown salpinx had been produced. (SR2) (See Chapter 3) It was with this society that the Celts had frequent contacts, albeit not always friendly ones. They could, from these contacts, have adopted a form of sheet-metal lituus which subsequently developed into the carnyx. This instrument could then have spread around the Celtic world and account for the location of SD207 in Dacia. However, Galatia was finally

[234] Chadwick, 1970.

absorbed into the Roman Empire in 25BC, having been isolated from the rest of the Celtic world since about 75BC by the Romans and, prior to that essentially isolated by the Greek and other Empires except for the brief period around 270BC (see above).

Thus the instrument must have been developed prior to 270BC whichever argument one follows, i.e. accepting a southern origin. Its distribution around the Celtic world is little more than one would expect from an instrument carried by a mobile force and universally used as both a standard and a musical instrument.

THE CELTIC TUBA

The development and spread of this instrument is discussed in Chapter 2 along with other forms of the tuba. As discussed there this instrument seems to have come from contacts with the Etruscans.

THE CELTIC LITUUS

With its northern distribution (see Map 6.1) this instrument is clearly a development of a north-west European industry. Its mouthpiece has a typical cup form that seems designed to achieve a particular tone-colour. This contrasts with the Roman and most southern mouthpieces whose cups are relatively simple hemispheres. It seems unnecessary to look further than the North German/Scandinavian experience with mouthpiece design to seek a source for the inspiration in these mouthpieces and the technology of the area was clearly adequate for their production. In the Scandinavian area at this time the technological base of casting practice clearly declined since the heyday of lur production and the only manufactured instrument of this period is SD249. (Stenstugan) This is of wrought construction, on an animal horn base and lacks a developed mouthpiece, having only a mouthsupport. The Celtic lituus, therefore, was probably the heir to the tradition of lur making in this area and, being utilised by a Celtic people spread throughout the Northern Celtic world.

THE CELTIC CURVED HORN

As discussed above, the origins of this instrument seem to be firmly in Ireland, its organological ancestors being the Irish Horns. What may be indicative of coastal trading with the Mediterranean World is the presence of SD223 (Nice) and IC148 (Narbonne) which would also account for SR16 at Pergamon, the sculptor having seen the instrument brought in by this trade.

Within the range of instruments used by the local Celtic "nations" a variety of technological processes are seen. Indeed, particular instrument types are made in different ways, in different areas, presumably each area applying that technology appropriate to its own technological infrastructure. For example, in the case of the Celtic lituus, three examples are cast by use of lost-wax, while two are cast in two-piece moulds. (The remaining two not found). In the case of one of Caprington (SD241), for instance, the technology is applied in a very similar way to that of the Irish horns, which were made only 150*km* away across the Irish sea, admittedly sometime earlier. Thus, the Celts were using a design to which they applied the appropriate manufacturing technology, i.e. an example of design diffusion.

A similar pattern is seen on the Celtic curved horn where the seams on the Irish instruments are riveted in a variety of ways while that from Nice (SD225) appears to have a soldered or brazed seam. Similarly in the case of the Carnyx the tube seems to have been soldered or riveted as suited the particular manufacturer. In addition, in the case of the Carnyx, the bell termination was also modified to suit local demand. This does not mean, however, that any particular area utilised only one form of bell, as can be seen on the coins minted at Verulam. A wide variety of terminations is seen on these coins, all of which circulated in the same area at roughly the same time.

This complex picture points to a complex pattern of usage of instruments in the Celtic world. Only the carnyx has a documented military usage with the other instruments, most probably being used in religious or cult practice.

CHAPTER 7

A GENERAL OVERALL VIEW OF THIS STUDY

Player Voiced Aerophones as a Type

PVAs have been used in the past in a wide variety of forms, for a wide variety of uses. In this study they have been seen as an extension of the human voice, i.e. developing via the megaphone to the PVA proper. Thus, one expects to find a spectrum of forms spanning this range as, indeed, is found in antiquity. The name proposed in this study, player voiced aerophones, recognises this intimate connection with the human voice and, frequently, with other parts of the vocal apparatus. As discussed in Chapter I, the term "Brass instruments" serves well as a commonly used name for the group and its restricted range of usage is generally understood.

Along this continuum of instruments, one clearly identifiable form exists, that of the variable tone-colour instruments which includes the modern didjeridu. Unfortunately, our separation from instruments of this type is effected by our organocentric view of "high development". An instrument developed to this level today being categorised as having a pure tone and producing distinct clear notes, However, the developments towards the achievement of this purity of tone breed out the attributes of PVAs that are valuable in performance in the variable tone-colour mode. This group, while highly developed in performance is frequently simple in structure. The opposite is true of the PVAs that are considered acceptable today. Uncertainty of pitch of the higher formants of these instruments is bred out by control of tube morphology. Where a parallel tube is used this is attained by the provision of a flared bell and, on a conical instrument, by the development of uniform conicity, both these features pulling the formants into a harmonic relationship. The further refinement of a mouthpiece with a cup, throat and backbore increases the effective impedance of the tube, helping the player to excite the instrument's higher formants and to do this in a repeatable way. Instruments of this developed form were developed as early as the late bronze age in Scandinavia.

In its form of a voice modifier or megaphone, the PVA is most generally used for performance in the ritual. When used in this way it becomes effectively tied to its ritual and its use outside this frequently forbidden. However, when the instrument breaks from this simplicity and becomes able to perform as a modern natural PVA, the resulting demystification - its appearance as an instrument with the voice of an instrument - frees it from the ritual restriction and it begins to fill a wide range of roles. However, even after millennia of use, instruments of all types still evoke particular responses in individuals. Their voices are still considered mysterious, martial, etc. and arouse generally similar reactions in all members of a particular society.

The Ancient Mediterranean World

The earliest datable records of PVAs are in the Middle East where naturally occurring materials such as animal horns and shells were used to form instruments. From about 2600BC, however, these naturally occurring types are joined in the instrumentarium by the tuba and this remains a common pattern of instrument usage right until the 6th century BC.

Of the animal horn instruments, the main source of knowledge, is based on the shofar and its highly elaborated and ritualistic usage. In spite of its range of two or, at most, three notes, an enormous variety of calls were built up using pitch, duration, volume and tone quality, to perform in both peace and war - in both uses, being seen as a religious observance. In the Scroll of the War.. .... (Yadin, 1962) quoted in Chapter 2 , an idea of the range of performance is given along with a picture of the great detail to which this performance had been ritualised.

The tuba emerges in two basic forms, the single cone variety which tapers smoothly from mouthpiece to bell and the two-cone type whose mouthpipe has one taper which leads into a rapidly opening-out bell. Their distributions remain essentially distinct, with the single cone to the northern part of the Middle East and the two-cone to the south for a considerable period. However, the conicity of the bell yard on the two cone type, eventually achieved a smoother, more "exponential" form which ran more smoothly into the tube yard. This development led to the convergence of the two types, obscuring their differences. The evidence suggests that the tuba was always made in sheet and never cast as were some of the northern instruments.

As early as the instruments of Tutankhamen (1350BC) the manufacture of the tuba had become a very elaborate technological procedure. The extant specimens from Tutankhamen's tomb demonstrate that these instruments were carefully made, presumably to the well-established accepted design of the period. In solving the major technical problem of manufacturing a tube, that of producing a strong air-tight seam, the craftsman had already developed a technique which is still in use today in instrument manufacture.

The Greeks adopted their own version of the two-cone tuba, the salpinx. Whether or not this was indigenous development or was a result of influence from North Africa/Egypt is hard to say. However, all depictions show salpinges with very narrow but clearly parallel tube yard and this contrasts with the conical tube of the two-cone tuba. What seems likely, therefore, is that the salpinx was developed on the northern side of the Mediterranean either by the Greeks or, as the Greeks claim by the Etruscans, possibly as a result of a very low level of design diffusion.

At some time, the tuba acquired the mouthpiece that, combined with a suitable tube morphology gave the instrument a range of harmonically related formants. Several documentary references tell of the use of bone mouthpieces and the iconography shows large wedge-shaped features fitted onto the tips of instruments. Perhaps the Etruscans took this step along with the many others that seem to be attributable to them. Whether or not this was so, the Romans inherited the tuba from the Etruscans and utilised it in virtually all the roles that a modern PVA now fills.

Their main development was probably the refinement of its acoustic characteristics to bring its formants into harmonic relationships as it is seen in several scenes being played both with other PVAs and with the hydraulis. As well as this, the Romans developed forms with bell terminations reminiscent of the salpinx and utilised various cords both for carrying and for supporting the long instrument while being played. In use, both the tuba and cornu were frequently grouped in threes as opposed to the more common pairing of instruments in earlier times. Their technique for making the tube-yard seam remained similar to that used on the Tutankhamen instrument, it being soldered or brazed together.

The Etruscans and the inhabitants of the western seaboard of Italy were the first recorded peoples to use a wide range of PVAs. From about 500BC onwards, about ten different types of instrument were in use in this area. Several of these, such as the metal analogue of an animal horn, the lituus and the cornu appear for the first time in this area and of these, the latter two were adopted by the Romans and the cornu, along with the tuba, formed the staple assemblage of Roman PVAs. The lituus had survived for a time in its ritual role but then was supplanted by the easier-to-make tuba.

As used by the Etruscans, the lituus was a metal analogue of an animal horn extended by means of a long reed. Its early contemporary, the Cornu, however, while it had, no doubt, emerged from a natural form or its analogue, i.e. a highly curved animal-horn form, it had developed into a form which in no way resembled its pre-cursor, Thus, removed from the morphological restraints imposed by this earlier form, it was free to develop rapidly and to evolve forms that suited its use.

Roman Instrumental Usage

From its Etruscan form as a large diameter, very conical instrument, the Romans evolved a longer, smaller-bored tuba with a parallel tube over most of its length. At its bell end, these instruments sometimes terminated in a flat annular bell disc and sometimes in a cup-like feature similar to that seen on some salpinges. The curvature of the cornu evolved, by the turn of the millenium, from the oval form of the Etruscan instrument into a "G" shape. This tighter curvature of the mouthpipe brought the mouthpiece of the instrument comfortably to the lips of the player. As made by the Etruscans, the cornu had a cross-brace both to stiffen its form and to allow it to be supported on the shoulder of the player. The Romans extended this feature beyond the tube of the instrument itself, decorating its termination and, on occasion, using this as a supplementary standard in battle. On the three metre long instruments of the 1st century AD, this cross-brace had a highly important role both in stiffening the instrument and in increasing its ease of handling.

Together, the tuba and cornu filled many roles in the day-to-day life in the Roman world, as in the military. They played in the circus, in the ceremonies of the state religion, the pomp of triumph and the ceremonial of the funeral. In the military, as the instruments of the infantry, they played to signal the watches of the day and to command and control in battle. Both the tuba and cornu, however, are long and large and, although their acoustic performance is enhanced by this, their portability is not. However, the Romans seem to have done nothing to overcome this, the only attempt to increase the portability being a local development in the Rhineland. Here the tuba was curved on itself twice to produce an instrument looking something like a modern trombone. These are identified, by their occurrence on the tombstones of cavalrymen, as instruments of the cavalry.

The Development of Instruments in Northern Europe

In Northern Europe two great schools of manufacture and performance existed during the late bronze-age (approximately 1600-500BC). Their conjunction in time, however, is occasioned in all probability by no more than the prevalent cults of the time being of a type which could incorporate ritual performance into their proceedings. In no other ways were the instruments or their usage similar. In Ireland, pairs of horns were used with one being end-blown and one side-blown, while in Scandinavia, the instrument pairs were of similar right and left-hand lurs. Being of large bore, with large mouthsupports or blowing apertures, the Irish instruments perform poorly as conventional PVAs. The lurs on the contrary had long tubes of very uniform conicity and well-developed mouthpieces. In the hands of only a moderately skilled performer, they produce a range of formants, very precisely related harmonically.

Being made in an area which used two-part moulds for casting, the Irish horns were made that way and the lurs too were made in the local fashion, i.e. by lost-wax casting. However, both extended the repertoire of the local founders considerably and very specific techniques of manufacture were used.

The Scandinavian Late Bronze Age

During the late bronze age in Scandinavia, the lurs evolved stage-by-stage from a simple short extended animal horn form with a mouthsupport, to a long, conical instrument with a mouthpiece of very modern appearance. The increasingly-close approximation of their form to an overall cone, along with the increasing roundness of their tubes has been charted in this study. Other features of the manufacturing technology such as methods of joining individual segments outline the progress of the manufacturer in refining and

improving his techniques. This technology, however, was for a purpose, the overall aim being to produce more functional musical instruments. The purpose was achieved by the casting of long tubes with thin walls and uniform morphology and then by assembling these carefully to produce pairs which matched to a high degree. Decorative bell-discs adorned their bell ends and clear attention was paid to the aesthetic appeal of the instruments. Their tubes were carefully finished and, in one case, decorated by a carefully applied rifled pattern along its mouthpipe and tube yard.

Having been made in pairs, these instruments were most certainly played in pairs. They are accurately tuned one with another and in the case of a multiple find, two pairs are in tune, pair-for-pair. It seems unlikely that such well-made and functional instruments were played in unison as is commonly suggested. Their mellow tone combined with deep resonant bass notes provide the potential for performances of considerable complexity, both in terms of melody, rhythm and harmony.

The Irish Late Bronze Age

Ina similar way to the lurs, but utilising different manufacturing procedures, the Irish horns also evolved steadily throughout the late bronze age. From instruments utilising relatively simple three piece moulds, they were developed into large complex forms that used complex and novel moulding procedures. From integral construction their makers moved to prime manufacture, following which parts were added, initially by simple procedures but later by indigenously developed techniques akin to brazing. To achieve larger instrument sizes without consequential weight increases, thinner wall thicknesses were used which called for extremely careful core location and matching of core form to that of the mould. Chapletting systems were developed which allowed the core to be both located accurately and held securely in position while the mould was poured.

The sequences of manufacturing processes that can be isolated are intimately intermixed and show that many workshops were involved in the process of development and that contacts between these ensured that the developments of one area were shared with another.

The tradition of performance in this area is more difficult to recreate as the instruments themselves were used in pairs made up of one end and one side-blown instrument. The large size of the blowing apertures on these instruments indicate that they were used in the variable tone-colour mode and not in the same way as the lurs or modern instruments. This performance technique is unique both at this time and in this area, re-enforcing the view that these horns, as did the lurs, developed both manufacture and performance indigenously.

The Celtic World In a heterogeneous "nation" such as that of the Celts, in reality more a "nation of nations", the instrumental usage itself was very varied. The vast spread of the Celtic nations encompassed, at various times, most of Europe, bringing them into contact with both northern and southern traditions of musical instrument manufacture and usage

alike. In the past, however, in keeping with the diffusionist view of cultural spread, the southern connection has been emphasised and the credit for the Celtic instruments that have been recognised, attributed to diffusion from the south and east.

Next to the carnyx, the most clearly identifiable Celtic instrument is the Celtic curved horn. Of its origin in Ireland there is little doubt, the stages of its development and its relationship to the Irish bronze-age horns having been described in Chapter 6. The three examples of this form known from the Mediterranean attest to its use or knowledge of its use in that area, pointing to it having filled a role in more than one of the Celtic "Nations."

Similarly Northern in origin are the Celtic Litui. Their construction utilises the local manufacturing techniques and, in at least one area, that of Northern Germany, used a tradition of manufacture which is known to have existed during the Bronze-Age. Most impressive on these instruments, is their mouthpiece. These are well developed in form with a constricted throat and, in all, well designed to suit the instruments to which they were attached. Again this aspect of instrument manufacture, the design of mouthpieces, was known from the bronze age in Northern Germany/Scandinavia. The Celtic Lituus, however, was not always manufactured conservatively by the same techniques. In Scotland two-part moulds were used, in Europe, lost-wax, albeit with differences in the detailed manufacturing procedure. Thus, the design itself had been spread among the nations, each applying its own manufacturing expertise to their manufacture.

In Spain too, the Celts developed a functional mouthpiece. In that area it was made in clay, a material that facilitated detail changes in morphology to attain an organological aim.

The carnyx is, of course, the instrument, par excellence, of the Celts, and much has been said of its origins in this study. Unlike the other Celtic instruments, a southern origin does seem likely for this particular instrument. In particular, the experimentation with side-blown instruments in the area of Southern Italy from where both a side-blown lituus (Plate 7.1a, below) and a side-blown salpinx are known. In addition, the clear representation of a carnyx-like instrument in Maurya India points to its presence that far east in the 1st century AD.

Plate 7.1: An Etruscan Side-Blown Instrument and an Embouchure

It may be, of course, that the carnyx was the hybrid of northern and southern traditions. The Irish horns had been in use in Ireland for many years and some relict tradition may have survived to hybridise with instruments from the south. At least one coin shows a Celtic warrior carrying an instrument of hooked form like an Irish horn but carrying it after the fashion of a carnyx. Whatever its source, the Celts made it their own, developing a form that is unmistakably Celtic.

A further way in which the Celts may have made a contribution to the contemporary instrumentarium is in the development of the double-curved instruments. These seem clearly to have developed in the Rhineland, most probably by Celtic craftsmen bringing to bear their experience in instrument manufacture.

Having a diverse assemblage of instruments, the Celts undoubtedly used these together as several documentary references report. In addition, the iconography shows two mixed assemblages of instruments, one of a carnyx and tuba and one of a Celtic curved horn, a tuba and a highly curved horn.

The Embouchure

Generally speaking, the accepted view of the development of embouchure mirrors that of music itself as emerging from the Dark Ages. Baines[235] says of embouchure that

> *"Up to, and partly including the 16th century, we find almost invariably an inflation of the cheeks, still in the manner of Roman trumpeters more than a thousand years before. Too constant a feature to be interpreted as caricature, it must perpetuate a primitive obedience to the animal instinct to feel at one's most formidable when making the loudest possible noise. With cheeks distended and lips under no further restraint than the pressure of the mouthpiece, a great blast produces a vibration of vast amplitude and the ear-splitting sound required of a military trumpeter by the ancient practices of warfare."*

Tarr[236] paints an equally uniform picture of embouchure practice with the present practice of playing without inflating the cheeks emerging in the late Middle Ages. Further to this he states[237] that no good professional player can play using the pressure method. ("Kein guter Berufsblaser konnte hingegen mit druckstarkem Ansatz blasen, ... ")_ Both these views of embouchure are clearly too clear cut and restrictive. In the case of the latter view, for instance, many jazz musicians play with what a more rigorously trained player would call a poor embouchure. However, they produce very credible performances and have extended the potentiality of PVAs more so than conventional players in recent years.

In the ancient world too, the picture is equally mixed, the assertion in Baines[238] that Roman trumpeters "almost invariably" inflate the cheeks being contradicted by the evidence. Tuba players sometimes blow this way but, more generally, hold the cheeks in while blowing; cornu players do generally puff out the cheeks. Salpinx players hold the

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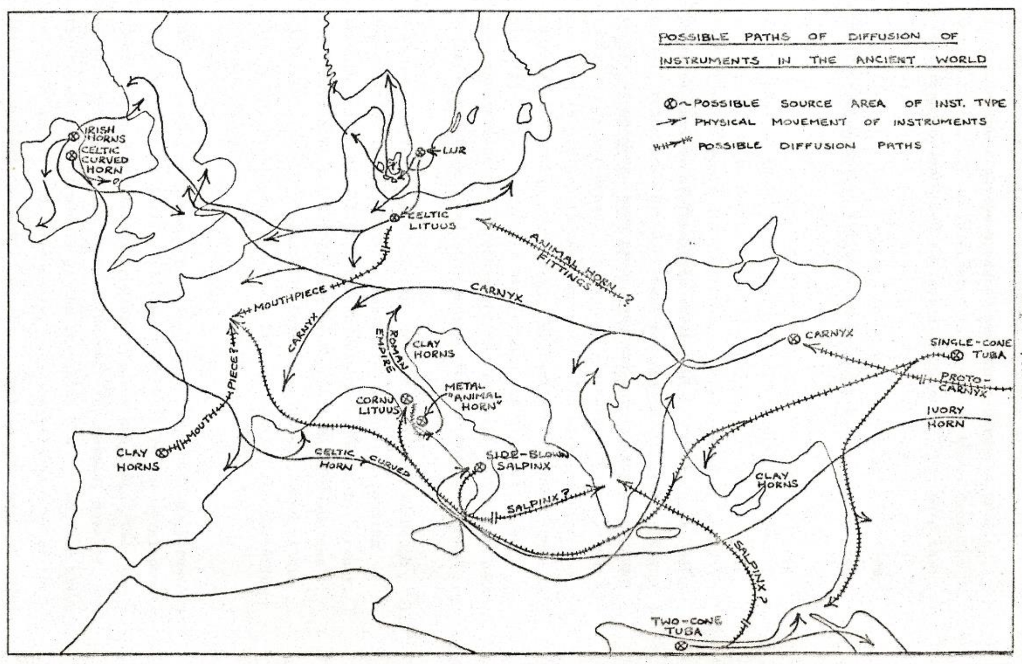
[235] Baines, 1976, 31.
[236] Tarr 1977, 60.
[237] Op cit, 60.
[238] Baines 1976, 31.

cheeks in while playing, often being helped by a phorbeia or strap around the cheeks. Several Egyptian and Etruscan representations show players quite clearly using a modern looking embouchure (Plate 7.1b, above).

Diffusion



Map 7.1: Trails of Instrument Influence

A somewhat cringeworthy representation which is left in because such views were still around in the 1970s

Map 7.1, above, provides a representation of the location and spread of instruments seen in this study. The production of such a map, however, is fraught with difficulties and is, at most, a rather simplistic representation of the facts. Most contentious of the simplifications required when producing such a representation lies in the drawing of lines from A to B and the defining of the meaning of these lines. This study has confirmed neither the present-day predisposition to see all processes of development as indigenous, nor the earlier fashion of their all having diffused from the Near East.

The term "diffusion" is itself too blunt an instrument to be of great use without conditioning prefixes. It must be controlled and directed to tell much more about the nature of diffusion that took place. In the case of both northern instrument types studied, developmental sequences are apparent from very primitive forms to the later complex and elaborate instruments. To this extent, both these schools of manufacture and performance are clearly indigenous and encompass a complex of inter-relating attributes that are unique to the area in question. However, within that area, likely sources of the instruments themselves can be outlined; Scania in the case of the lurs and north·eastern Ireland in the case of the Irish horns. Of the very early stages of these instruments, no firm conclusion can be drawn. Perhaps the peoples who settled the areas when they were originally colonised or a subsequent wave of immigrants brought with them the idea of simple blowing horns, a very low level of user diffusion.

In the case of Ireland, continuity of usage of their PVA form into the iron age produced the large riveted Celtic Curved Horns. Three references to these are known from the Mediterranean world and the solid line connecting these to the Mediterranean area on Map 7.1 represents transport and not diffusion. There appears to be no evidence for the form having diffused from Ireland, to be manufactured and adopted to suit another society.

In the case of the carnyx and the Celtic lituus, however, the contrary seems to be the case. The carnyx, for instance, is found from Maurya India to iron-age Lincoln, appears in an enormous variety of forms and is the subject of frequent documentary references by the Greeks and Romans. In the Celtic family of nations, each group used the carnyx adapted to suit their own requirements. The animal-headed termination was modified to perform the secondary function of a standard and featured the design current in that particular group. More significantly, the mode of manufacture was also varied to suit the manufacturing technology available locally, sometimes using a brazed seam and sometimes a riveted one.

A similar pattern was seen with the Celtic lituus, although the distribution of these is restricted to an arc passing through Scotland, Holland, the Rhineland and Northern Germany. The Scottish instrument is made by two-part mould technique while the others are generally lost-wax cast and, even within this group, great variety exists in the detailed manufacturing procedure adopted.

Further strong evidence for diffusion exists, with the Etruscans and other western Italics playing a key role in the development of new forms. Of diffusion prior to these peoples, little can be said because of the scant evidence. The Romans, however, took the two basic instruments of the Etruscans and spread them throughout their Empire and, presumably, made these locally where the local technology existed to do this. Only in one case did local adaption occur, in the Rhineland. Here the Roman tuba was curved back on itself twice to produce a shorter form presumably more convenient for the cavalry to handle.

If the evolutionary process, in which the PVA proper developed from the megaphone, really did take place then the argument for polygenesis is strong. Language is a universal phenomenon and the use of external voice modifiers are likely to be almost as widely distributed. Thus, the path from sound induced by vocal apparatus to that induced from the lips alone, perhaps having passed through a variable tone-colour stage, could have occurred at many points.

Two areas seem to provide links between the megaphone and PVAs proper. In Egypt where, during the 4th Dynasty (2723-2565 BC) a megaphone was used to summon troops, this paralleled very closely the use of the trumpet in this area sometime later. In Ireland, the side-blow horns with their large blowing apertures are capable of use both as megaphones and variable tone-colour instruments.

Clearly, the most difficult part of a PVA to fashion is the mouthpiece, although some manufacturing processes allow its manufacture more readily than others. It is reasonable, therefore, that those areas with the most appropriate technology produced the first mouthpieces. Scandinavian manufacturers for instance built up their expendable wax pattern from pieces of sheet. This is clearly visible on several instruments where the shape of the individual sheets can be made out. The flexibility of the wax medium allowed the maker full freedom to form the space between the throat and the mouthpiece rim to suit himself thus leading to the very sophisticated mouthpieces seen on the lurs. In the case of the other, possibly very early, mouthpieces, those from Numancia, these too are produced in a medium that allows simple generation of the form, i.e. clay.

With instruments made of sheet—metal, the generally adopted technique in ancient times was to cast mouthpieces. However, even this involved the complex job of producing the mouthpiece throat accurately. Thus, these cast mouthpieces were preceded by bone ones in which their internal form could be carved more readily. Documentary references tell of the practice and several iconographic sources depict mouthpieces of large external dimensions pushed onto the tip end of instruments. This practice may well have developed as a result of the manufacture of instruments from animal horn, where the solid tip would allow a mouthpiece of some form to be carved out. In addition a passageway would need to be drilled through into the horn cavity, automatically creating a constricted throat.

If diffusion of ideas did take place in the ancient world of PVAs, then it is the mouthpiece that was most likely to have featured strongly in such an exchange of ideas. Map 7.1 shows possible paths (crossed lines) of diffusion, where it could have spread from either Scandinavia or Spain.

Thus, the evidence of PVAs shows a mixture of types, some have been transported from one culture to another and elaborated by the receptor society, others having originated and developed in single societies. Of the very early days of PVAs, when made entirely of natural materials in the pre-metal ages, nothing is known. It would seem reasonable to suppose that their use was widespread, although nothing stronger than supposition can be justified.

The Organological Specificity of Technology

All instruments which evolve, go through the process in which existing dimensions are matched either visually or otherwise and the resulting dimensional drift leads to a gradual change in morphology. When such instruments are manufactured using the general technology of the day, they appear to evolve principally in aesthetic and organological ways. Thus, when similar instruments are manufactured in different regions whose manufacturing technology sub-divides into various different industrial groups, different processes are used to make what is essentially the same instrument in different areas. This is seen, for instance, in the case of the Celtic litui where instruments with very similar morphology were made using two-part moulds, and lost-wax techniques, some of which involved final assembly using a "solder." In this situation no manufacturing technique became very specific to musical instruments, presumably because the local technology was sufficient to produce instruments to an acceptable standard. Because of this manufacture as a general process, probably along with other items which required a similar manufacturing technology, it is possible that the instruments themselves were perceived as general items made to be used in a general way. If this were so, then the instrument would most likely be free to be used in all the ways open to PVAs including the "musical."

In the Mediterranean world, the majority of instruments were made from sheet and thus, the major technical problem associated with manufacture was that of making a seam. As early as the time of Tutankhamen the technique of interleaving the two edges of a seam was developed in order to hold these together while brazing the seam. In the case of the Tutankhamen instruments, one edge of the seam had a series of slots along its length which were bent alternately up and down and the other edge folded over and fed in between these tabs. The whole seam was then brazed and swaged over to smooth in the tabs, although not necessarily in that order. See image above (Plate 7.2)

A later instrument has a similarly made seam although the seam overlap is attained using wedge-shaped teeth cut into one side of this. Modern instrument bells are invariably made of sheet in this way, although the tube or bell may be subjected to working after the seam has been brazed, thus resulting in a uniform thickness of metal over the seam.

Other parts of instruments such as mouthpieces and bosses were cast using even older metalworking techniques that allowed the complex form of these to be produced. The morphological flexibility offered by casting was utilised to enrich instruments with elaborate decoration such as is seen on the Celtic tubae.

In clear contrast to those areas where "off-the-shelf" technology was used to manufacture instruments are the areas where a very specific manufacturing technology emerged that was devoted almost exclusively to the manufacture of instruments. Significantly in both areas where this was so, Ireland and Scandinavia, the manufacture involved casting; the more ancient, and spectacular, form of metal-working. In societies such as these, all facets of life would be closely integrated as would all the facets of life of the artefacts that it produced. Thus, for a lur or an Irish horn, the creation of the original form must have been a significant event. The technique used, casting, justifies the term "creation" entirely. A founder takes a jumble of scrap or ingots and creates from it an artefact that appears as the mould is broken open. Failures of the process add immeasurably to the mystery that surrounds it. Explanations for success or failure would have invoked the supernatural as they still do today.

In contrast to the creation by casting, the sheet-metal worker forms an item from sheet and this emerges as he works, guides and coaxes the metal to the form he wants. That is not to deny the use of ritual in the manufacture of fabricated items, nor the use of fabricated items in ritual. The Celtic curved horns and the horned helmets clearly employ similar manufacturing technology and were, presumably, similarly associated in their ritual use. Even today, ritual words are extensively employed in sheet-metal working, particularly when recalcitrant metal flows "the other way!"

Many examples of ritual in manufacture are reported and these seem to perform two particular functions in that they provide an organised basis for the recording, storage and retrieval of precise information and that they invest the artefact its maker and its user with special powers. Such a ritual practice concentrates the efforts of the manufacturer onto a narrower range of products and techniques and it is this specialisation that leads to rapid development.

In the case of the Irish horns, these are all made by the same basic process, in spite of regional variations in design and detailed manufacturing procedures. However, this manufacturing technology itself shows continuous experimentation, development and improvement. Indeed, in this area, development of the complete technique of chapletting to produce tubes with uniform wall thicknesses can be followed stage by stage. Such development is contingent on the deep understanding of the basic properties of the materials used, i.e. both the metal, bronze, and the mould material,·clay.

In spite of the different manufacturing technique used with the Scandinavian instruments, much of what has been said of the manufacturing of the Irish horns applies equally well to them. Their makers used a technology very specific to the lurs, in fact, of little use in manufacture other than for long tubular instruments. This concentration similarly led to experimentation and, eventually, to the development of the manufacturing process to a very high degree of sophistication. As with the Irish technology its high degree of specialisation was to prove fatal as, when elements of the tightly interconnected ritual

changed, the whole structure collapsed. Thus, the processes that had been developed for such a specific aim collapsed with the ritual.

The Use of Standard Measures in the Design of Instruments

The advantage of the abstraction of dimensional data is that, along with the abstraction of writing, i.e. the storage of words and numbers in graphic form, it allows data to be stored. However, such an abstraction seems to offer little advantage to a pre-literate society where one would expect greater use to be made of concrete forms of storage of dimensional data, i.e. models. In expressing the dimensions in terms of the best-fit regression lines ($y = mx + c$), a mathematical technique is being used which is based on the use of an algebraic expression of geometrical features which developed during the 17th century. While it is a useful descriptive tool for comparing, contrasting and otherwise analysing geometrical shapes it must be used with circumspection. However, there is little doubt that the concept of slope was understood and that, in the case of several instruments, the maker was aiming for an overall uniform slope throughout the whole instrument's length.

The need to create a tube of uniformly increasing diameter calls for the ability to produce regular increments in diameter along its length. Hence, the requirement for a standard unit by which the tube's diameter can be regularly increased. This alone seems sufficient to account for the use of a unit like the brin and its use for both length and diameter suggest that the idea of unit increase in diameter per unit (or multiple units) of length was well understood.

While the lurs are of a form that is complex and not easy to analyse mathematically, their sub-division into segments does provide some basis for analysis. Thus, on these instruments the lengths of individual segments can be measured, along with their end diameters, giving some degree of sub-division of the tube. However, the Irish horns are not sub-divided in this way and their conicity and high degree of curvature makes them difficult to analyse mathematically. Where measurements could be taken, these have shown a considerable degree of consistency both in wall thickness and tube diameter and suggest that further detailed metrological analysis of these might well prove fruitful.

The Interpretation of Mathematical Data

Much emphasis has been placed on the relevance of the mathematical data as a tool for reconstructing manufacturing techniques. In particular, roundness and diameter are parameters of considerable·interest. This study appears to be novel in proposing that the difference between technical processes, generating inherently round forms, and human perception could possibly be quantified as the result of experimentation. It may be, therefore, that the proposition itself is false. Unfortunately the parameters of roundness and diameter are not of great interest to the perceptual psychologist as both these concepts are rather technical and he is more concerned with "size" and "shape" in a much more

general way. In addition, tests allowing multiple modalities are considered to be poor experimentally and all but one modality are generally designed out of the experiment. However, in drawing our conclusions as to the ability to perceive small increments we are particularly interested in the ability of subjects when they have available the full range of visual and tactile processes to enable one to make judgements.

Experiments to test for these abilities are outlined in Appendix III. However, being somewhat novel and requiring a great deal of preparation of both specimens and experimental procedure, no attempt was made to carry these out during this study. One of the prime considerations when making this decision was the realisation that a whole series of preliminary tests would need to be carried out before the tests proper could commence. No data at all is available on the level, say, of roundness at which to attempt discrimination, let alone the effect of the number of faces on the polygon or the radius between these. It is hoped, therefore, that this work can be carried out in the near future.

An Overall Appraisal of this Study

When beginning this study, one of the main aims was to investigate the interrelationship between the various instrument groups which existed prior to 500AD. To this end, the major two groups studied have been shown to be quite independent both of each other and of other groups of instruments of the time. In the case of the southern instruments, interrelationships have been demonstrated that tell of the inter-mixing of ideas and cross-fertilisation between the various cultures.

The sequence of developments in the manufacturing of the Irish horns have been investigated and described in detail for the first time. This has demonstrated the presence in Ireland during the late bronze-age of an active, progressive and successful school of manufacturing not previously recognised. Their products show the use of increasingly-complex technology which is here demonstrated to be indigenous to that area. In addition, the organological features of these instruments have been studied and a mode of usage proposed that had not previously been considered.

A considerable amount of precise metrological work was carried out on the lurs during this study, often under very difficult conditions. The analysis of this data has led to novel conclusions about the principles underlying their design. This interpretation of dimensions on artefacts from as early as the bronze age opens up the whole area of the analysis of the design of early objects and the understanding of the concepts of measurement and of length, diameter etc. by early manufacturers. In addition to this, the use of figures for the roundness of objects along with those obtained for perceptual experimentation as a means of determining manufacturing techniques is proposed in this study for the first time.

In the study of the tuba and the Etruscan and Roman iconography use was made of the work of acoustic theory to trace the patterns of developments seen. This, combined with the large corpus of iconographic material collected during the study has established dates for the changes in instrument morphology, particularly during Roman times.

The corpus of extant and iconographic material has also enabled the place of the Etruscans, in the history of PVAs, to be stated clearly for the first time.

Celtic instruments have never previously been considered in entirety in one study. In this work, their range, their similarities and differences have been studied. An overall picture of the active musical life of this "nation of nations" has emerged and their wide diversity of instruments forms and their sources outlined.

A comprehensive catalogue of contemporary references to PVAs of the period has been produced. This corpus of some 650 entries forms the basis upon which this study is written and remains to be modified, updated and, where necessary, corrected by future scholars. Thus, this increasingly comprehensive document should provide a firm basis for future study.

In a subject so vast as that of the PVAs in antiquity, no single study can cover the whole field either in breadth or depth. However, this study has examined the large range of instrument types and put them into an overall context. In addition it has highlighted particular areas where more detailed analysis is required and produced a catalogue which, it is hoped will enable future scholars to begin their study of these instruments with ready access to at least a good proportion of the available material to hand.

Bibliography

Items marked with an asterix* have been added for this edition. They are all listed in my web site: http://www.hornandtrumpet.com

A

Aldred, C. 1973 Tutankhamen's Egypt BBC

Almgren, O. 1926-7 Hallristningar och Kulturbruk

Allen, D. 1958 Belgic coins in the Late Pre-Roman Iron Age of Britain. P.P.S. XXIV. P44ff Plate 1

Althin, C.A. 1945 Studien zu den bronze-zeitlichen Felszeichnungen von Skåne I. Lund. pp. 144ff

Amelung, W. 1903 Die Skulpturen des Vatikanischen Museums. Vol. I. Taf. 28, nr. 1370

Andersson, O. 1934 Nordisk Musikkultur i äldsta tider. Stockholm.

Anstee, J.W. 1956 Technology of ancient glass and metal. Nature. Dec 1956. Vol. 178 part 1430

Archaeological Institute of America. 1976 Archaeological Discoveries in the Holy Land. Thomas Y. Cromwell Co. New York.

Armstrong, E.C.R. 1922 Some Irish Bronze-Age Finds. Proc. Royal Irish Acad. XXXVI. Sec C. 134

Aurigemma, S. 1954 Le Terme di Dioclaziano e il museo Nazionale romano. Roma

B

Backus, J. 1970 The Acoustical Foundations of Music. John Murray.

Bacon, E. 1960 Digging for History. Adam and Charles Black, London.

Bacon, E. 1971Archaeological discoveries in the 1960's. Adam and Charles Black, London.

Baines, A.C. and Wachsmann, K.P.1961. Classification of Musical Instruments Translated from the original German, G.S.J. No. 14. pp. 3ff

Baines, A.C. 1976 Brass Instruments, their History and Development. Faber and Faber, London.

Balzer, L. 1934 Bohuslänska Hällsristninger. Stockholm.

Banks, Sir J. 1934 Four volumes of original topographical and archaeological drawings made for Sir Joseph Banks and now in the possession of Colonel W. King-Fane of Fulbeck Hall, Lincoln.

Bartholinus, C. 1677 De tibiis veterum, Romae.

F Basedow, H. 1925 The Australian Aboriginal. F.W. Preece and Sons, Adelaide.

Bate, P. 1966 The Trumpet and Trombone. Ernest Benn Ltd.

Becker, E. 1936 Von der Gusstechnik der nordischen Bronzezeit. Technische Blätter, Wochenschrift zur Deutschen Bergwerks-Zeitung. Nr. 3/1936

Becker, E. 1936 Über die Herstellung alter Luren. Zeitschrift für Instrumentenbau Jargang 56/1936 nr. 16.

Behn, F. 1912Die Musik im Romischen Heeres. Mainzer Zeitschrift 7. p. 36ff

Behn, F. 1913Bucinator. Mainzer Zeitschrift 8, p.17

Behn, F. 1954 Musikleben im Altertum and Fruhen Mittelalter. Stuttgart.

Bell, 1815The Newry Magazine (Register) Vol. l, no. 4.Sept and Oct 1815

Bellori 1706 Le pittura antique.

Belz, R. 1910 Die vorgeschichtlichen Altertumer des Gross- herzogtums Mecklenburg-Schwerin

Benade, A.H. 1976 Fundamentals of Musical Acoustics. Oxford University Press

Berndt, R.M. and C.H. 1965 Aboriginal Man in Australia in Essays in Honour of Em. Prof. A.P. Elkin. Angus A and Robertson

Bessaraboff, N. 1941Ancient European Musical Instruments. Harvard University Press

Blanchet, A. 1954 Traité des monnaies gaulois

Bleau 1654 Bleau's Atlas. Amsterdam.

Boardman, J. 1975 Athenian Red Figure Vases of the Archaic Period. Thames and Hudson.

Boardman, J. 1975 Athenian Black Figure Vases of the Archaic Period. Thames and Hudson.

Bode, 1905 Treasures of Astrabad. Archaeologica. XXX.

Bragard, R. & de Hen F.J. 1 968.Musical Instruments in Art and History. Barrie and Rockliff.

Brandenburg, H. 1967 Meereswesensarkophage und Clipeusmotiv. Jahrb. d. Inst. 82.

Brencour, R. 1921Histoire des Instruments de musique, Paris.

Bricqueville, E. de 1895 Un coin de curiosité. Les anciens instruments de Musique, Paris.

Bridge, J.C. 1905 Horns. Journal Architectural, Archaeological and Historical Soc for North Wales and Chester. pp. 85-166.

Brightwell, A, Demitriou, G., Massey, N. and Neacy N. 1972 The Horniman Museum Kiln experiment at Highgate Wood. The London Archaeologist 1972, 2, Part I, 12-17.

British Museum 1972 Treasures of Tutankhamen. BM & Times.

Britton, D. 1960 The Isleham Hoard Cambridgeshire. Antiquity, Vol. 34, pp. 279-282, pts XXVI & XXXVII.

Broholm, H.C., Larsen, W.P. and Skjerne, G. 1949 The Lures of the Bronze Age. Glydendalske Boghandel. Nordisk Forlag.

Broholm, H. 1965 Lurfundene fra bronzealdern. Kopenhagen.

Bronsted. 1938-40 Danmarks Oldtid. Kopenhagan.

Brown, M.A. & Blin Stoyle A.E. 1959 A Sample Analysis of British Middle and Late Bronze-Age Material using optical spectrometry. PPS. 25. 188-208

Brown, H.M. & Lascell, J. 1972 Musical Iconography - A Manual for cataloguing musical subjects in Western Art before 1800. Harvard University Press.

Bruzelius, N.G 1860 Beskrivning över tvenne stridslurar av bronz, funna i Skåne. Svenska Fornlamningar II. Lund.

Bryant, G.F. 1970 Two experimental Romano-British kiln firings at Barton-on-Humber, Lincs. J. Scunthorpe Museum Society. 3. (1). 1-16

Bryant, G.F. 1971 Experimental Romano-British kiln firings at Barton-on-Humber, Lincs. Workers Education Association. Barton-on-Humber Occasional 2 ‘ Paper.1. 1971.

Buchner, A. 1971 Folk Music Instruments of the World. Octopus Books. Prague.

Buchner, A. 1973 Musical Instruments: An illustrated History. Octopus Books.

Buhle, E. 1903 Die Musicalischen Instrumente in den Miniaturen des Frühen Mittelalters. I. Die Blasinstrumente. Leipzig.

Burenhalt, G. 1973. The Rock Carvings of Gotaland. Acta. Arch. Lundensia.

Bushrell. A 1968 The First Americans.

Butler, J.J. & Sarfatij, H. 1970-71 Another Bronze Ceremonial Sword by the Plougrescant - Ommerschans Smith. Berichten van de Rijksdienst voor het ondheid-kundig Bodemonderzoek. Vol. 20-121 pp. 301-309

Buttner, M. 1953 Studien zur Geschichte der Trompete. Phil. Diss. Munster.

C

Cardwell, W.T. Jr. 1976 Working Theory of Trumpet Air-column design. J. Acoust. Soc. Am. 40; 1252.

Caskey, L.D. 1937 Archaeological Notes. American Journal of Archaeology. XLI. pp. 525-527

Chadwick, N. 1970 The Celts. Pelican.

Cochran-Patrick, R.W. 1878 The Caprington Horn. Proc. of Soo. Of Ant. of Scot. 1878(Feb) pp 565-6

Coffey, G. 1913 The Bronze-Age in Ireland. Dublin.

Coghlan, H.H. 1939 Some Experiments on the Origin of Early Copper. Man. xxxix (1939) pp 106-8

Coghlan, H.H. 1940 Prehistoric Copper and some experiments in Smelting. Trans. Newcommen Soc. 20: 49-65

Coghlan, H.H. 1951 (1975) Notes on the Prehistoric Metallurgy of Copper and Bronze in the Old World. Occasional Papers on Technology 4, Pitt-Rivers Museum, University of Oxford.

Coissin, P. 1923 L'Arc de Triomphe d'Orange Revue Archéologie 24. 26

Coleman-Norton. 1948 Cicero Musicus. Journal of the American Musicological Society (i) pp 3-22

Coles, J.M. 1963 Irish Bronze-Age Horns and their relations with Northern Europe. P.P.S. Vol XXIX pp. 326-356

Coles, J.M. 1967 Some Irish Horns of the Late Bronze-Age. Royal Soc. of Antiquities of Ireland: 97, 2 pp 115-117

Collaer P and van der Linden A. 1968 Historical Atlas of Music. George G. Harrap

Collaer P. 1973 Music of the Americas. Curzon Press.

Comision

Ejectutiva Madrid, 1912.Exoavaciones De Numancia.Memoria presentada al Ministerio de Instruccion Publica y Bellas Artes por la Comision Ejecutiva. Madrid. Jose Blass y cia.

Cowell, F.R. 1972 Everyday Life in Ancient Rome. Batsford.

Crane, F. 1972 Extant Medieval Musical Instruments: A Provisional Catalogue by Types. University of Iowa Press.

Cumont, F. 1942 Recherches sur le symbolisme funeraire des Romains. Paris.

Curle, A.O. 1932-3Further Excavation at Jarlshof, Shetland.Proc. Soc. Ant. of Scotland IXVII pp 118-24 Figure 41

D

Dalton, O.M. 1964 Treasures of the Oxus, with other examples of Early Oriental Metalwork. London.

Day, R. 1875 Irish Bronze War Trumpets. J. Roy. Hist. and Arch. Assoc. of Ireland. 4th Ser. III, (1874-75). 442.

Dechelette, J. 1927 Manuel D'Archéo1ogie Préhistorique Celtique et Gallo-Romaine. Paris.

Dechelette, J. 1927 Manuel D'Archéo1ogie. Age due Fer II

De Lagoy 1849 Recherche sür l'armement des Gaulois. Aix.

Diagram Group 1976 Musical lnstruments of the World. Paddington Press.

Dorow, W. 1827 Romische Alterthumer in und um Neuwied am Rhein.

Dubois, C.M. 1937 Notes sûr les instruments de musique figures dans l‘art plastique de l'Inde ancienne. Revue des Arts Asiatiques. XI.

Ducati, P. 1927 Storia dell'arte etrusca, Florence.

E

Edwards, I.E.S. 1972 Treasures of Tutankhamen

Eichborn, H. 1881 Die Trompete in Alter und neuer Zeit. Leipzig

Eisner, E. 1967 Complete solutions of the "Webster" Horn Equation. J. Acoust. Soc. America: 41: 1126-46

Elkin, A.P. and Jones, T.A. 1953-7 Arnhem Land Music (North Australia) The Oceania monographs No. 9. Sydney: The University of Sydney.

Elkin, A.P and Berndt, C.H. 1965 Aboriginal Man in Australia. Angus and Robertson Ltd., Sydney.

Esperandieu 1907 Bas-reliefs de la Gaule romaine. Rev. Et. Anc. I.

Evans, Sir J. 1864 The coins of Ancient Britain.

Evans, Sir J. 1881 The Ancient Bronze Implements, Weapons and Ornaments of Great Britain and Ireland. London.

F

Fischer, F. 1959 Der Spatlatenezeitlische Depot-fund von Kappel (Kreis Saulgau). Stuttgart

Fleischhauer, G. 1960 Bucina und Cornu. Wiss. Zeitschf. Martin-Luther Univ. Halle. Ges-sprachweiss 9. P.501-505.

Fox, L.M. 1967 Instruments of Processional Music. Lutterworth Press.

Frankfort, H. 1939 Sculpture of the Third Millenium BC from Tell Asmar and Khafajah. Chicago.

Frey, O-H. 1969 Die Entstehung der Situlenkunst. Rom. Germ. Kommission des Deutschen Archeolog. Inst. Zu Frankfurt am Main. Bank 31. Berlin. Verlag. Walter de Gruyter & Co.

G

Galpin, F.W. 1910 old English Instruments of Music

Galpin, F. 1937 A Text-book of European Musical Instruments.

Galpin, F. 1937 The Music of the Sumerians and their immediate successors the Babylonians and Assyrians. Cambridge University Press.

George, W.H. 1965 The Sounds of Music: The Trumpet. Hi—fi News. August 1965. pp.214-216

Giglioli, G.Q. 1935 L'arte etrusca. Milano.

Gimbutas, M. 1971 The Slavs. Thames and Hudson

Glob, P.V. 1969 Helleristninger i Danmark

Gonen, R. 1975 Weapons of the Ancient World. Cassell. London.

Gowland, 1912 Copper and its alloys in Early Times. J. Inst. Met. Vol. 7.

Gradenwitz, P. 1949 The Music of Israel. Norton, New York.

Green, P. 1967 A Concise History of Ancient Greece.

Gressman, H. 1903 Musik und Musikinstrumente im Alten Testament. Giessen.

Grose, F. 1786 Ancient Armour and Weapons. London.

H

Hachmann, Rolf 1971 The Germanic Peoples. Barrie and Jenkins, London.

Hadland, J. 1959 The Mechanics of Trumpet Blowing. New Scientist Jan. 1. 1959. pp. 12-13

Hahne 1915 Die Lure von Garlstedt, Kreis Osterholz, Vorzeitfunde aus Niedersachsen. Teil A.

Hammerich 1893 Aabøger for Nordisk Oldkyndighed og Historie p. 144 ff.

A Harcourt, R & M. d' 1925 La Musique des Incas et Ses survivance. Paris.

Harrison, F. and Rimmer J. 1964 European Musical Instruments. London.

Hartmann, H. 1960 Die Musik der Sumerischen Kultur. Frankfurt am Main. Hartwig, Meisterschalen.

Haspels, C.H.E. 1936 Attic Black-Figured Lekythoi. Ecole Francaise D'Athenes. De Boccard. Paris.

Heidenreich, R. 1951 Tod und Triumph in der romischen Kunst. Gymnasium 58.

Hencken, H. 1951 Palaeobotany and the Bronze-Age. Journ. Roy. Soc. Ant. Ireland IXXXI. pp 6ff

Henderson, H.W. 1942 An experimental study of trumpet embouchure. Journ. of the acoustical Soc. of Amer. Vol. 13 pp. 58-64

Henry, F. 1967 Irish Art during the Viking Invasions.

Herbig, R. 1952 Die jungeretruskischen Steinsarkophage. Berlin.

Herzfeld, E. 1920 Am tor von Asien. Berlin.

Heurgon, J. 1972 Daily Life of the Etruscans.

Hickmann, H. 1946 La Trompette dans L'Égypte Ancienne. Supplément aux Annales du Service des Antiquites de l'Égypte. Le Caire.

Hickmann, H. 1949 Catologue General des Antiquités Égyptiennes du Musée du Caire: Instruments de Musique. Cairo.

Hickmann, H. 1956 45 Siécles de Musique dans l'Égypte Ancienne. Paris. 1

Hickmann, H. 1961 Musikgeschichte in Bildern II. Aegypten. Leipzig.

Hodges, H.W.M. 1954 Studies in the late Bronze-Age in Ireland. 1. Stone and clay moulds and wooden models for bronze implements. Ulster Journ. Arch. XVII pp. 62-80.

Hodges, H.W.M. 1970 Technology in the Ancient World. Pelican.

***Holmes, P** 2010 La Musica in Etruria, Article in Conference Proceedings, Convegno Internazionale, Tarquinia, Settembre 2009, Published by: Comune di Tarquinia

Hommel Äthiop. Physiologus.

Hornbostel, E.M. von and Sachs, C. 1914Systematik der Musikinstrumente. Zeitschrift fur Ethnologie. Vol. 46. pp 553-590.

Hornbostel E.M. von1933 The Ethnology of African Sound instruments. Africa VI.

I

Idelsohn, A. 1949 Jewish Music. Tudor. New York.

J

Jones, 1912Catalogue of the Ancient Sculptures preserved in the Municipal Collections of Rome: Museo Capitolino. Oxford.

Jones 1926 Catalogue of the Ancient Sculptures preserved in the Municipal Collections of Rome: Pallazo dei Conservatori. Oxford.

Jones, T.A. 1965 Australian Aboriginal Music: The Elkin collection's contribution towards an overall picture. In Aboriginal Man in Australia. See Elkin 1965.

Jones, T.A. 1967 The Didjeridu, some comparisons of its typology and musical functions with similar instruments throughout the world. Studies in Music. University of Western Australia Press. Pp. 23-55.

Jope 1966 An Archaeological Survey of Co. Down. H.M.S.O.

K

Kaff, L. 1952 Die Cornu-Fragmente von Ovilaba. Jahreshefte des Oesterr. Archaolog. Inst. Vol. 59.

Keim, J. and Klumbach, H. 1951Der Romische Schatzfund von Straubing.

Kemble, J.M. 1865 Horae Ferales.

Kennedy, J.M. 1973 A Psychology of Picture Perception. Jossey-Bass Ltd.

Kent, J.P.C. and Painter, K.S. 1977 Wealth of the Roman World. BM Publications Ltd.

Kinsky, G. 1921 Musikinstrumenten - Sammlung in Vergangenheit und Gegenwart. Jahrbuch due Musikbibliothek Peters Vol. 27. pp. 47-60.

Kinsky, G. 1929 History of Music in Pictures. ‘

Kirby, P.R. 1947 The Trumpets of Tutankhamen and their successors. J Roy. Anth. Inst. Vol. 77 pp.33-45.

Kirby, P.R. 1952 Ancient Egyptian Trumpets. Musical Yearbook. Vol. VII pp. 250-55. Hinrichsen Edition. London.

Kirby, P.R. 1953 The Musical Instruments of the Native Races of South-Africa. London-Johannesburg.

Kjellen 1976 Upplands Hallristningar. Kungl. Vitterhets, Historie och Antikistets Akadamien.

Klar, M. 1966 Musikinstrumente in Romerzeit in Trier. Kurtrierisches Jahrbuch. Vol. 6.

Klar, M. 1971Musikinstrumente derRomerzeitin Bonn. Bonner Jahrbuch, 171.

Klein, U. Gymnasium IXXIV 139ff

Korte, G. 1916I. Rilievi delle urne etrusche III. Berlin.

Kroman 1902, 1904 Aabøger for Nordisk Oldkyndigned og Historie 1902 p 79ff 1904 p 65ff.

L

La Borde J.B. 1780 Essai sûr la Musique ancienne et modern.

Langwill, L. and Morley Pegge R. Wind Bands Waits and HOrns Hinrichsen.

Larsson, L. 1973-4 The Fogdarp Find. A Hoard from the Late Bronze Age. p.169-243 Memoirs du Musée Historique de L‘Universite de Lund. Meddelanden Fran Universitets Historika Museum Lund.

Laur-Belart, R. 1967 Der Spätrömische Silberschatz von Kaiseraugst, Aargau. Basel.

Laurent and Dugas 1907 Rev. et Anc. Plate VI pp. 58 and 64

Layard, A.H. 1853 Monuments of Nineveh. London.

Leymann-Hartleben, K. 1926 Die Trajansaule. Berlin.

Lewis and Short 1945 A Latin Dictionary. Oxford, Clarendon Press.

Lief, O.R.L. Kastell Waldmossingen.

Liversage, J. 1971Britain in the Roman Empire.

Lukonin, V.G. 1967 Epigraphika Vostoka. 18. pp. 28-9. Fig 6. Moscow-Leningrad.

Lucas, A. 1948 Ancient Egyptian Materials and Industries. Edward Arnold (Pam.) Ltd.

Lucas, A.T. 1973 Irish Pagean and Early Christian Art. Gill and Macmillan.

Lund, C. 1973 Oldtidens Orkester. Kronik in Skalk nr. 2. pp. 18-28.

Lund, C. 1974 Klang i Flinta och Brons. Musikmuseet Stockholm. Also abbreviated in English as The Sound of Archaeology.

Lund, C. and Reimers, C. 1976 Preliminary inventory of instruments in Sweden. Riksinventeringens rapport m. 4. Stockholm.

Lund, C. 1977 Nordisk musikarkeologi - en introduktion in Artes: Tidskrift for Litteratur Konst och Musik. Musikaliska Akademien.

Lund, C. 1977 Bevarade Bildframställningcr med musikinstrument fran det forhistorika Sverige. Rapport vid Riksinventeringens seminarium den 29.3.77.

M

Macwhite, E. 1945 Irish Bronze-Age Trumpets. J.R.S.A. Ireland LXXV:85

Mahr, A. 1952 Christian Art in Ancient Ireland I. Dublin.

Mantellier, P, 1868 Memoir sûr les Bronzes Antiques de Neuvy-en-Sullias. Mémoires de la Societé Archéol. De L'Orleanais. Vol. IX. pp 177-255, Plate 1-XVI.

Marcuse, S. 1964 Musical Instruments: A Comprehensive Dictionary. New York.

Marcuse, S. 1975 A Survey of Musical Instruments. David and Charles. Newton Abbot, London.

Marshal, Sir, J. 1931Mohenjo-Daro. London.

Marstrander, S. 1963 Østfolds Jordbruksristningar Skjeberg. Institutet for Sammeligende Kultur forskning, Universitets forlaget. Serie B. Skrifter LIII.

Maryon, H. 1936 Soldering and Welding in the Bronze and Iron Ages. Technical Studies in the Field of Fine Arts. Vol. 2. pp 75-108.

Maryon, H. 1938 Technical Methods of Irish Smiths in the Bronze and Iron Age. Proceedings of the Royal Irish Academy. (0):44. Pp. 1810228.

Maryon, H. 1941Archaeology and Metallurgy. 1. Welding and Soldering. 11. The Metallurgy of gold and platinum in pre-columbian Ecuador. Man XLI. Nos. 84-103.

Masson, G. 1973 A Concise History of Republican Rome. Thames and Hudson.

McEvedy, C. 1976 The Penguin Atlas of Ancient History. Penguin.

Megaw, J.V.S. 1968 Problems and non-prob1ems in palaeo-organology; a musical miscellany. Studies in Ancient Europe, Leicester 1968 pp. 341-6.

Merhaut, J. 1976 Method of Measuring the Acoustic Impedance. J. Acoust. Soc. America. 45, 331.

Minto, A. 1943 Populonia Florence.

Mommeen, T. 1955 Weltreich der Casaren. Buchergilde Gutenberg. Phaiden Verlag.

Montagu, J. 1976 One of Tutankhamon's Trumpets. GSJ XXIX pp. 115-7-

Mordant, C and B and Prampart J-Y.1976 Le dépôt de bronze de Villethierny. IXQ supplément à Gallia Prehistorique. Edition du Centre National de la recherche Scientifique.

Moreau, J. 1958 Die Welt der Kelten. Stuttgart.

Morley-Pegge, R. 1960 The French Horn. Ernest Benn Ltd.

Moyle, R.M. 1975 Conch ensembles - Tonga's unique contribution to Polynesian organology. GSJ XXVIII.

Moyle, R.M. 1976 Tongan Musical Instruments. CSJ XXIX.

Müller, A. 1914-16 Zur Verwendung der Musik im römischen ‘Heere. Philogus 73.

N

Naville, 1908 The Temple of Deir El-Bahari. London.

Nef, K. 1926 Geschichte unserer Musikinstrumente. Leipzig.

Neugebauer, O.1957 The Exact Sciences in Antiquity. Brown University Press. Providence R.I.

Nierhaus, R. 1953 Zu den ethnografischen Angaben in Lukans Gallien-Exkurs. Bonner Jarhbuch 153. pp 46-62.

Noack 1872 Notes on a horn find near Hannover. Zeitschrift für Ethnology pp. 217-21.

Nogara, B. 1955 Gli etruschi e la Ioro civitta. Milano 1933

Nordbladh, J. 1975 Hällsristringar Bottna sn. Bilder. Göterborg.

O

O'Donovan, J. 1860 Three Fragments of Irish Annals. Dublin.

O'Kelly, M.J. 1961The Cork Horns, the Petrie Crown and the Bann Disc. Journal of the Cork Historical and Archaeological Soc. Part I. Vol. LXVI, Nos 203, pp. 1-12.

Oldeberg, A. 1950 Vallhorn, herdepipor och lunar. (Värmland förr och nu) XLVIII. Karlstad.

Oldeberg, A. 1947 A Contribution to the History of the Scandinavian Bronze Lur in the Bronze and Iron-Ages. Acta Archaeologica XVIII, I.

Olshausen, 1891 Vorgeschiohte Trompeten. Zeitschrift fur Ethnologie. XXIII, pp. 847-861.

Otto, W. 1953/4 Ephemeris Archaeol. 92/3. p. 8lff.

P

Pallottino, M. 1938 Il grande fregio di Trainano. Bull. com. 66.

Parrott, A. 1958 Mission archeologique de Mari, Vol. II le palais, peintures, murales. Paris.

Parrott, A. 1961Nineveh and Babylon. London. ·

Pearson, G. 1796 Philosophical Transactions of the Royal Society, ‘ LXXXVI.

Peters, J.P. and Theirsch, H. 1905 Painted tombs in the Necropolis of Marisa. London.

Phillips, C.W. 1934 The Present state of Archaeology in Lincolnshire. Arch. Journal XCI Part II, pp. 103-5.

Pič-Déchelette Stradonitz.

Picken, L. 1975 Folk Musical Instruments of Turkey. Oxford University Press.

Piggott, S. and Daniel, G. 1951Picture-book of Ancient British Art.

Piggott, S. 1952 Celtic Chariots on Roman Coins Antiquity XXVI (Notes and News)

Piggott, S. 1952/3 Three metal-work hoards of the Roman Period from Southern Scotland. Proc. Soc. Ant. Scotland IXXXVII pp. 1-50.

Piggott, S. 1959 The Carnyx in Iron-Age Britain. Antiquaries Journal, 39.

Piggott, S.(ed) 1967 The Dawn of Civilisation. Thames and Hudson

Pope, A.U. 1938 A Survey of Persian Art. Oxford.

Porter, M.M. 1967 The Embouchure-Boosey and Hawkes.

Powell, T.G.E. 1948 The Celts.

Pritchard, J.B. 1954 The Ancient Near East in Pictures, elating to the Old Testament. Princetown.

Q

Quasten 1930 Musik und Gesang in den Kulten der heidnischen Antike und Christlischen Fruhzeit. Munster.

R

Raftery, J.(Ed) 1941Christian Art in Ancient Ireland II. Dublin.

Reinach, S. Bronze Figurés.

Reinach, S. 1900 Revue d'Archéologie. Paris.

Rimmer, J. 1969 Ancient Musical Instruments of Western Asia in the British Museum. B.M.

Robert, C. 1939 Die antiken Sarkophagreliefs. v. Die Meerwesen. Berlin.

Ryberg, I.Scott- 1955 Rites of the State Religion in Roman Art. American Academy in Rome. Memoirs XXII.

S

Sachs, C. 1929 Geist und werden der Musikinstrumente. Berlin.

Sachs, C. 1930 Handbuch du Musikinstementen Kunde. Leipzig.

Sachs, C. 1934 La signification, la tache et la technique museographique des collections d'instruments de musique. Mouseion XIII, No. III - IV.

Sachs, C. 1940 The History of Musical Instruments. J.M. Dent and Sons Ltd. New York.

Sachs, C. 1943 The Rise of Music in the Ancient World. New York.

Sachs, C. 1964 Real-Lexicon der Musikinstrumente, zugleich ein Polyglossar fur das gesamte Instrumentengebiet. Berlin.

Sarre F and Herzfield E. 1910 Iranische Felsreliefs. Berlin. Schaeffer, A. 1936 Origine des instruments de musique. Paris.

Schenk, E. 1946 Die Cornu-Fragmente von Virunum. Anz. d. Oester. Akad. Wiss. Wien. Phil. Hist. Kl. 83, m. 2.

Schmidt, H. 1915Die Luren von Daberkow. Praehistorische Zeitschrift VII.

Seewald, O. 1934 Beitrage zur Kenntris der Steinzeitlichen Musikinstrumente Europas. Wien.

Sendrey, A. 1969 Music in Israel. Vision. London.

Sheteligh, H. and Johannessen, F. 1929 Kvalsundfundet. Bergen 1929

Shoppa, H. Die Kunst der Romerzeit in Gallien, Germanien und Britannien. Deutscher Kunstverlag.

Smirnov, Y.I. 1909 Oriental Silver. St. Petersburg.

Smith New Aspects of the Menon Painter.

Smith, J.A. 1866-7 The Finding of the Deskford Boar's Head. Proc. Soc. Ant. Scotland. VII : 334

Smith, R.A. and Mercer 1974 Possible Causes of Woodwind Tone Colour, D.M.A. Journal of Sound and Vibration. 32(3) pp 5347-358.

Solari, A. 1931Vita pubblica e privata degli etruschi. Firenze.

Spielberg, H. 1922 Das Horn vom Gollen. Unserer Heimat. Beilage fur Késliner Zeitung. nr. 8.

Sprockhoff, E. 1956 Jungbronzezeitliche Hortfunde der Sudzone des nordischen Kreises. (Periode V) Vo. l. p.248.

Starr 1941The Roman Imperial Navy. Cornell.

Strong 1926 La Scultura Romana. Florence (also available in English).

Stuart, J.A.B. 1819 Historical Memoirs of the City of Armagh.

T

Tarr, E. 1977 Die Trompete. Hallway Verlag. Bern and Stuttgart.

Tillyard, H.J.W. 1907 Instrumental Music in the Roman Age. Journal of Roman Studies XXVII.

Trimpe-Burger, J.A.1960-61, Beknopt overzicht von het oudheidkundig bodemonderzoek in het Deltagebied in Berichten van de Rijksdienst voor het Ondheidkundij Bodemonderzoek. 10-11.

Tylecote 1962 Metallurgy in Archaeology. Arnold.

V

Verrall, A.W. 1884 The Bell and the Trumpet. Journal of Hellenic Studies.

Voigt, A. Die Signalinstrumente des romischen Heeres und der Lituus. Deutsche Instrumentbauzeitung. 34

W

Waterman, D.M. 1969 An Early Medieval Horn from the River Erne. Ulster Journal of Archaeology. Vol. 32. pp. 101-4.

Weaver, M.P. 1972 The Aztecs, Maya and their Predecessors. Seminar Press.

Webster, G. 1960 The Roman Military Advance under Ostorius Scapula. The Archaeological Journal CXV.

Weege, F. 1921 Etruskische Malerei. Halle.

Wegner, M. 1950 Die Musikinstrumente des Alten Orients. Münster.

Wegner, M. 1964 Musikgeschichte in Bildern.

Wellese, E. 1969 Ancient and Oriental Music No. 1. in The New Oxford History of Music.

Westermarck, M.E.1926 Ritual and Belief in Morocco. Vol. II. London.

Wihlborg, A. 1974 Sagaholm en bronsaldershog in hällristningar. 3-uppsats Lund.

Wilde, 1857 Catalogue of the Antiquities of Stone, Earthern and vegetable materials in the Museum of the Royal Irish Academy.

Wilde 1861 Catalogue of Museum of Royal Irish Academy.

Wilder, R.L. 1968 Evolution of Mathematical Concepts. Transworld Publishers Ltd.

Wilkinson, J.G. 1878 The Manners and Customs of the Ancient Egyptians. London.

Wille 1967 Musica Romana. Amsterdam.

Winternitz, E. 1966 Musical Instruments of the Western World. Thames and Hudson.

Wulstan, D. 1973 The Sounding of the Shofar. GSJ. XXVI.

Y

Yadin, Y. 1962 The Scroll of the War of the Sons of Light against the Sons of Darkness. Oxford 1962.

Z

Zhivkova, L. 1975 The Khazanluk Tomb. Verlag Aurel Bongers Racklingshausen.

APPENDIX 1

DOCUMENTARY REFERENCES

The numerical listing below has been added to provide access to the entries by their DR Number. It is sorted as text. These are all also listed on my web site http://www.hornandtrumpet.com

DR Number References

DR1 TUSHRATTA 1380BC

DR2 EUSTATHIUS (i)

DR3 Hesychius

DR4 EUSTATHIUS (ii)

DR5 Gilgamesh c. 1950BC

DR6 Ur-Lama 2275 BC

DR7 Bur-Sin 2200BC

DR8 M. Tullius Cicero (1) ob. BC 43

DR9 Diodorus Siculus BC 40

DR10 ENNIUS (i) Poet Ob. BC 169

DR11 HORATIUS FLACCUS (i) Poet Ob BC 8

DR12 JUNIUS JUVENALIS poet Ob. AD 130

DR13 LIVIUS (i) Historian ob. AD 17

DR13 PLINIUS Ob. AD 79 (Oops!)

DR14 LUCANUS (i) Poet ob. AD 65

DR15 OVIDIUS (i) Poet ob. AD17

DR16 Biblical II CHR. V

DR17 POLYBIUS (i)

DR18 SENECA (i) Philosopher and tragedian Ob AD65.

DR19 Vegetius (i) Writer. fl. AD 386
DR20 C. VALERIUS FLACCUS
DR21 Vegetius (ii)
DR22 Vegetius (iii)
DR23 Vegetius (iv)
DR24 Varro (i) ob.·BC 27
DR25 Varro (ii)
DR26 Varro (iii)
DR27 Vergilius (ii)
DR28 Ovidius (ii)
DR29 Appuleius (i) Lucius Appuleius, philosopher Fl. AD 160
DR30 Silius Italicus (i) Poet Ob. AD 101
DR31 Claudius Claudianus (i) poet AD 400
DR33 Ammianus Marcellinus (i) historian ob. AD400
DR34 Ammianus Marcellinus (ii)
DR35 Ammianus Marcellinus (iii)
DR36 Ammianus V (iv)
DR37 Sshol. Hor Poet Ob. BC 8
DR38 VERGILIUS (i) Poet Ob. BC 19
DR39 OVIDIUS (iii)
DR40 M.TULLIUS CICERO (ii)
DR41 VOPISCUS Historian AD 305
DR42 Statius Poet Ob. AD 96
DR43 Florus Historian fl. AD 140
DR44 Ammianus Marcellinus (v)
DR45 Tacitus (i) Historian Ob. AD 119
DR46 Livius (ii)
DR47 Quintilianus, Rhetorician Ob. AD 95
DR48 Plutarch (i) c. 50 AD
DR49 Appian
DR50 Vergilius (iii)
DR51 Horatius Flaccus (ii)
DR52 Festus Grammarian fl. AD 150?
DR53 Hieronymus, Christian writer Ob. AD 420
DR54 Vegetius (v)
DR55 Decimianus

DR56 Rufinus
DR57 Athen
DR58 Seneca (ii)
DR59 Horatius Flaccus (iii)
DR60 Ovidius (iv)
DR61 Antonius Ianuarius
DR62 Sophokles (i)
DR63 Arist
DR64 Aeschylus (i)
DR65 Sophokles (ii)
DR66 Euripedes (i)
DR67 Euripedes (ii)
DR68 Euripedes (iii)
DR69 Euripedes (iv)
DR70 Euripedes (v)
DR71 Homer
DR72 Bacchylides
DR73 Plutarch (ii)
DR74 Plutarch (iii)
DR75 Biblical I Chr. XV
DR76 Biblical II Chr. XV
DR78 Biblical Hos. V
DR79 Biblical Hos. VIII
DR80 Biblical Jos VI
DR81 Biblical Ex XIX
DR82 Biblical Nu X
DR83 Biblical EZ. VII
DR84 Biblical DAN III
DR85 Ennius (ii)
DR85 Paulus Flor. AD 200
DR87 Herennium
DR88 Vergilius (iv)
DR89 M.Tullius Cicero (iii)
DR90 M. Tullius Cicero (iv)
DR91Vergilius (v)
DR92 Plautus Writer of comedy ob. BC 184

DR93 Pollux (i)

DR94 Aristides Quintilianus

DR95 Acro

DR96 Polybius (ii)

DR97 Lucanus (ii)

DR98 Biblical Jer. VI

DR99 Horatius Flaccus (iv)

DR100 JOSEPHUS (i) Jewish historian 37-100 AD

DR101 PLUTARCH (iv)

DR102 MISHNAH (i)

DR103 MISHNAH (ii)

DR104 BIBLICAL 1 CHR V

DR106 LIVIUS (iv)

DR108 CAIUS JULIUS CAESAR (i) Historian ob.BC 44

DR109 CAIUS JULIUS CAESAR (ii)

DR110 APPULEIUS (ii)

DR111 CAIUS JULIUS CAESAR (iii)

DR112 AMMIANUS MARCELLINUS (vi)

DR113 L.CAELIUS LACTANTIUS FIRMIANUS Christian writer ob.AD 325

DR114 PLUT (i)

DR115 DIO CASS

DR116 CAIUS JULIUS CAESAR (iv)

DR117 LIVIUS (v)

DR118 LIVIUS (v1)

DR119 PROPERTIUS (i) Poet ob. BC 16

DR120 OVIDIUS (v)

DR121 DEAD SEA WAR SCROLL

DR122 TALMUD SHABBAT

DR123 TALMUD SUKKOTH

DR124 TALMUD ROSH HA-SHANAH (i)

DR125 MISHNAH (iii)

DR126 TALMUD ARAKIN

DR127 TALMUD ROSH HA-SHANAH (ii)

DR128 MISHNAH (iv)

DR129 BIBLICAL LEV XXV

DR130 SOPHOKLES (iii)

DR131 DIOD
DR131 Vergilius (vi)
DR132 Mishnah (v)
DR132 Tacitus (ii)
DR133 Appuleius (iii)
DR135 Plut (ii)
DR136 App
DR137 Tacitus (iii)
DR138 Tacitus (iv)
DR139 DION
DR140 Tacitus (v)
DR141 POLYB
DR142 LIVIUS (vii)
DR143 M.TULLIUS CICERO (v)
DR143 PROPERTIUS (ii)
DR144 AMMIANUS MARCELLINUS (vii)
DR145 AMMIANUS MARCELLINUS (viii)
DR146 JOSEPHUS (ii)
DR146 ‘SILIUS ITALICUS (ii)
DR147 SILIUS ITALICUS (iii)
DR148 HYGINUS poet and fabulist
DR150 AESCHYLUS (ii)
DR151 Biblical II SAM VI
DR152 Biblical II SAM XVIII
DR153 Biblical II SAM II
DR154 Biblical II SAM XX
DR155 Biblical II KINGS IX
DR156 Biblical AMOS III, 6
DR157 Biblical I SAM XIII
DR158 Biblical I KINGS 1
DR159 Biblical JER IV
DR160 Biblical JER. LI
DR161 Biblical JOEL II
DR162 Biblical PS. CL
DR163 Biblical PS. XL VII
DR164 Biblical NEH XII

DR165 Biblical PS LXXXI

DR166 Biblical II SAM XV

DR167 Biblical JER. XLII

DR168 Biblical AMOS 11, 2

DR169 Biblical II KINGS 11

DR170 Biblical II CHR. XXIII

DR172 Biblical I CHR XIII

DR173 Biblical I CHR. XVI

DR173 Biblical II CHR. XX

DR174 Biblical II CHR. XXIX

DR175 Propertius (iii)

DR176 Biblical GEN IV

DR177 JEROME 340-420 AD

DR178 Hosy 1298-1232 BC

DR179 PERPETSCHAU 1200-1085 BC

DR180 RABBINIC SCRIBES

DR181 CAIUS JULIUS CAESAR (v)

DR182 POLLUX (ii)

DR183 VARRO (iv)

DR184 TACITUS (vi)

DR185 IULIUS VICTOR

DR186 Biblical I CHR. XV

DR198 (105) PETRONIUS ARBITER Satirist Fl. AD 60

ACRO

DR95

Instrument Cited: Lituus Tuba

Citation: "Litui acutus sonus est, tubae gravis. In antiquis scriptis lituus equitum est et incurvus, tuba vera peditum est et directa".

Commentary on Haratius Flaccuo.

Cited O. Keller. Pseudacronis, Scholia in 1 Horatium Vetustiora I, Leipzig 1902, p 18.

AESCHYLUS (i)

DR64

Instrument Cited: Salpinx

Citation: Pers.395

Aeschylus, in his immortal picture of the nation's victory at Salamis is careful to note that the "trumpet" inflamed the ardour of "the other side".

Cited Verrall(1884) p 80.

AESCHYLUS (ii)

DR150

Instrument Cited: Etruscan Tuba

Citation: Eumeniden.

Aeschylus writes of the sound of the Tuba.

Cited in Tarr (1977) pp. 15/16.

AMMIANUS MARCELLINUS (i) historian ob. AD400

DR33

Instrument Cited: Lituus

Citation: 31, 7, 10

"Candente itaque protinus die, signo ad arma capienda ex utraque parte per lituos dato".

Cited in Wille (1967) p 90 208

AMMIANUS MARCELLINUS (ii)

DR34

Instrument Cited: Lituus

Citation: "Extracta quiete nocturna itinerarium sonare lituos iubet". _

Cited in Wille (1967) p 91 209

AMMIANUS MARCELLINUS (iii)

DR35

Instrument Cited: Lituus, Tuba

Citation: 19, 6, 9. Refers to use of tubicines to sound the retreat.

(19, 6, 10 "et resultantibus e civitate Lituis multis portae panduntur recepturae nostros".

Cited in WiIle (1967) p 91 211

AMMIANUS MARCELLINUS (iv)

DR36

Instrument Cited: Lituus

Citation: 19, 11, 15. "postque deletos omnes in receptum canentibus lituis nostri quoque licet rari vedebantur examines".

Cited in Wille (1967) p 91 211

AMMIANUS MARCELLINUS (v)

DR44

Instrument Cited: Lituus

Citation: 14, 2, 16. "viso itaque exercitu procul auditoque liticinum cantu, represso gradu parumper stetere praedones".

Cited in Wille (1967) p 92 ‘

AMMIANUS MARCELLINUS (vi)

DR112

Instrument Cited: Tuba

Citation: Amm 20, 11, 8. Refers to use of tubicines to sound the attack.

Cited in Fleischhauer (1960) p 502

AMMIANUS MARCELLINUS (vii)

DR144

Instrument Cited: Bucina, Cornu, Tuba

Citation: 27, 2, 6. In the battle the bucina, cornua and tubae play together.

Cited in Fleischhauer (1960) p 504

AMMIANUS MARCELLINUS (viii)

DR145

Instrument Cited: Bucina, Cornu, Tuba.

Citation: 31, 15, 13.

Refers to bucina, tubae and cornua playing together.

Cited in Fleischhauer (1960) p 504

ANTONIUS IANUARIUS

DR61

Instrument Cited: Cornu

Citation: Gravestone

"Cornicen M. Antonius Ianuarius D (is) M (anibus)."

Cited in Fleischhauer (1960) p 502

APP

DR136

Instrument Cited: Tuba

Citation: App. bell. civ. I, 105

Refers to use of tubicines in the funeral.

Cited in Fleischhauer (1960) p 502

APPIAN

DR49

Instrument Cited: Trumpet

Citation: Pun. 66.

Trumpeters were a regular feature of the triumphal procession.

Cited in Ryberg (1955) p 21

APPULEIUS (i) Lucius Appuleius, philosopher Fl. AD 160

DR29

Instrument Cited: CONCHA, Bucina

Citation: Metamorphoses 4, 31.

"adsunt Nerei filiae chorum canentes...iam passim maria persultantes Tritonum catervae hic concha sonaci leniter bucina..."

Cited Fleischhauer (1960) p 504.

APPULEIUS (ii)

DR110

Instrument Cited: Tuba

Citation: De Mundo 30, 357.

Refers to tubicines giving alarm to Legionaries.

Cited in Fleischhauer (1960) p 502.

APPULEIUS (iii)

DR133

Instrument Cited: Tuba

Citation: Pun. 66

Refers to tubicines in the triumphal procession. (Probable overlap with Appian DR 49)

Cited in Fleischhauer (1960) p 502

ARISTIDES QUINTILIANUS

DR94

Instrument Cited: Trumpet

Citation: De Musica II 6.

States that the trumpet had a different melos for each contingency.

Cited in Baines (1976) p 63.

ARIST

DR63

Instrument Cited: Salpinx

Citation: Ach.1001 "and it is significant that though the Euripides of the Frogs does not, of course, make the blunder of separating from "the familiar things we use" the instrument whose note invited the families of Athens to the dearest feast of the year and whose solemn and "Chlhonian" sound preceded the reverend meeting of the Areopagos.

Cited Verrall(1884) p 80

ATHEN

DR57

Instrument Cited: Keras, Salpinx

Citation: Alhen IV, 184A

Assigns the invention of the salpinges and the keratae to the Tyrrhenians or Etruscans.

Cited in Fleischhauer (1960) p 501.

BACCHYLIDES

DR72

Instrument Cited: War Trumpet (Salpinx)

Citation: Paean 9

Among the earliest references to the war trumpet must be Bacchylides, Paean 9.

Cited in Verrall (1884) p 81. Behn dates this as beginning of 5th century BC. Behn (1954) p 81.

BIBLICAL AMOS III, 6

DR156

Instrument Cited: Trumpet

Citation: Amos III, 6

”Shall a trumpet be blown in the city, and the people not be afraid? Shall there be evil in a city, and the LORD hath not done it?"

BIBLICAL AMOS 11, 2

DR168

Instrument Cited: Trumpet

Citation: Amos 11, 2.

_ "... and Moab shall die with tumult, with shouting and with the sound of the trumpet."

BIBLICAL 1 CHR V

DR104

Instrument Cited: Chatzotzerah

Citation: I Chronicles V, 13. A

Tells the trumpeters (Chatzozerah) and singer as one to make one sound". Probably ties with instruction in DR103 Mishnar Tamid.

BIBLICAL I CHR XIII

DR172

Instrument Cited: Chatzotzerah

Citation: I Chronicles XIV, 8.

"And David and all Israel played before God with all their might, and with singing, and with harps, and with psalteries, and with timbrels, and with cymbals and with trumpets."

BIBLICAL I CHR. XV

DR75

Instrument Cited: Shofar

Citation: I Chonicles XV, 28

"Thus all Israel brought up the ark of the covenant of the Lord with shouting, and with sound of the cornet and with trumpets and with cymbals, making a noise with psalteries and harps".

BIBLICAL I CHR. XV

DR186

Instrument Cited: Chatzotzerah

Citation: I. Chronicles XV, 24.

".....the priests, did blow with the trumpets before the ark of God."

BIBLICAL I CHR. XVI

DR173

Instrument Cited: Chatzotzerah

Citation: I. Chronicles XVI, 6,

"... Benaiah also and Jahaziel the priests with trumpets continually before the ark of the covenant of God·".

BIBLICAL II CHR. V

DR16

Instrument Cited: Chatzotzerah

Citation: II Chronicles V, 12, 13,

12 "Also the Levites which were the singers.and with them an hundred and twenty priests sounding with trumpets.

13. “It came even to pass, as the trumpeters and singers were as one ...."

BIBLICAL II CHR. XV

DR76

Instrument Cited: Shofar, Chatzotzerah

Citation: II Chronicles XV, 1M.

"And they swore unto the Lord with a loud voice and with shouting, and with trumpets and with cornets. "

BIBLICAL II CHR. XX

DR173

Instrument Cited: Chatzotzerah

Citation: II Chronicles XX, 28.

"And they came to Jerusalem with psalteries and harps and trumpets unto the house of the Lord."

BIBLICAL II CHR. XXIII

DR170

Instrument Cited: Chatzotzerah ‘

Citation: II Chronicles XXIII, 13.

"And she looked, and, behold, the king stood at his pillar at the entering in, and the princes and the trumpets by the king .... "

BIBLICAL II CHR. XXIX

DR174

Instrument Cited: Chatzotzerah

Citation: II Chronicles XXIX, 26

"And the Levites stood with the instruments of David, and the priests with the trumpets."

BIBLICAL DAN III

DR84

Instrument Cited: Karna

Citation: Daniel III, 5

"Ye hear the sound of the cornet, flute, harp, sackbut, psaltery, dulcimer, and all kinds of musick, ye fall down and worship the golden image that Nebuchadnezzar the king hath set up".

Similar phrase in.verses 7, 10 and 15.

See Wulstan (1973) p 45 for detailed commentary on original text.

BIBLICAL EX XIX

DR81

Instrument Cited: Yovel

Citation: Exodus XIX, 13.

"There shall not be an hand touch it, but he shall surely be stoned, or shot through; whether it be beast or man, it shall not live: when the trumpet soundeth long, they shall come up to the mount."

(Also refs in 16, 19).

Commentary in Wulstan (1973) p 31.

BIBLICAL EZ. VII

DR83

Instrument Cited: TAQOA

Citation: Ezekiel VII, 14

"They have blown the trumpet, even to make all ready; but none goeth to the battle: for my wrath is upon the multitude thereof."

BIBLICAL GEN IV

DR176

Instrument Cited: None General Reference to Musician

Citation: Genesis IV, 20-22 0 I

20. "And Adah bore Jabel: he was the father of such as dwell in tents and of such as have cattle.

21. And his brother's name was Jubal: he was the father of all such as handle the harp and the organ.

22. And Zillah, she also bore Tubal-cain, an instructor of every artificer in brass and iron: and the sister of Tubal—cain was Naamah."

Cited in Sendrey, 1969, 60

BIBLICAL HOS. V

DR78

Instrument Cited: Shofar, Chatzotzerah

Citation: Hosea V, 8

"Blow ye the cornet in Bibeah and the trumpet in Ramah; cry aloud at Beth-aven, after thee, O Benjamin."

Commentary on text in Wulstan (1973) p.31

BIBLICAL HOS. VIII

DR79

Instrument Cited: Shofar

Citation: Hosea IX, 1

"Set the trumpet to thy mouth. ‘

He shall come as an eagle against the house of the Lord because they have transgressed my covenant, and trespassed against my law."

BIBLICAL JER IV

DR159

Instrument Cited: Shofar

Citation: Jeremiah IV, 5, 19, 21

"Declare ye in Judah, and publish in Jerusalem; and say, Blow ye the trumpet · in the land:.."

19. "...I cannot hold my peace, because thou hast heard, O my soul, the sound of the .trumpet, the alarm of war."

21. "How long shall I see the standard, and hear the sound of the trumpet".

BIBLICAL JER. VI

DR98

Instrument Cited: Shofar

Citation: Jeremiah VI, 1

"Oh ye children of Benjamin, gather yourselves to flee out of the midst of Jerusalem, and blow the trumpet in Tekoa, and set up a sign of fire in Beth-haccerem:..."

BIBLICAL JER. XLII

DR167

Instrument Cited: Shofar

Citation: Jeremiah XLII, 14

"Saying, No: but we will go into the land of Egypt, where we shall see no war, nor hear the sound of the trumpet ...... "

BIBLICAL JER. LI

DR160

Instrument Cited: Shofar

Citation: Jeremiah L1, 27

"Set ye up a standard in the land, blow the trumpet among the nations."

BIBLICAL JOEL II

DR161

Instrument Cited: Shofar

Citation: .JOEL II, 1, 15

1. "Blow ye the trumpet in Zion, and sound an alarm in my holy mountain.

15.Blow the trumpet in Zion, sanctify a fast, call a solemn assembly."

BIBLICAL JOS VI

DR80

Instrument Cited: Qeren Hayyovel

Citation: Joshua VI, 4, 5

"And seven priests shall bear before the ark, seven trumpets of rams horns: and the seventh day ye shall compass the city seven times and the priests shall blow with the-trumpets."

5. And it shall come to pass, that when they make a long blast with the rams horn, and when ye hear the sound of the trumpet, all the people shall shout ...... "

Similar references in verses, 6, 8, 9, 13, 16 and 20.

See Wulstan (1973) p 30 for commentary on this.

BIBLICAL I KINGS 1

DR158

Instrument Cited: Trumpet

Citation: I Kings 1, 34, 39, 41

34 "And let Zadok the priest and Nathan the the prophet anoint him there king over

Israel: and blow ye with the trumpet, and say, God save King Solomon.

39. ..... And they all blew the trumpet; and all the people ....

41. And when Joab heard the sound of the trumpet, he said, wherefore is this noise

of the city being in an uproar."

BIBLICAL II KINGS IX

DR155

Instrument Cited: Trumpet

Citation: II Kings IX, 13.

"Then they hasted, and took every man his garment, and put it under him on the top of the stairs and blew with trumpets, saying Jehu is king."

BIBLICAL II KINGS 11

DR169

Instrument Cited: Chatzotzerah

Citation: II Kings XI, 14

"And when she looked, behold, the king stood by a pillar, as the manner was, and the princes and the trumpeters by the king, and all the people of the land rejoiced, and blew with trumpets: .... "

BIBLICAL LEV XXV

DR129

Instrument Cited: Shofar

Citation: Leviticus XXV, 9

"Then shalt thou cause the trumpet of the jubilee to sound on the tenth day of the seventh month, in the day of atonement shall ye make the trumpet sound throughout all your land."

BIBLICAL NEH XII

DR164

Instrument Cited: Chatzotzerah (35) Shofar 41

Citation: Nehemiah XII, 35, 41

35. "And certain of the priests' sons with trumpets ....

41. And the priests: Eliakim .... with trumpets."

BIBLICAL NU X

DR82

Instrument Cited: Chatzotzerah

Citation: Numbers X, 1-10

"And the Lord spake unto Moses saying

2. Make thee two trumpets of silver; of a whole piece shalt thou make them; that thou mayest use them for the calling of the assembly, and for the journeying of the camps.

3. And when they shall blow with them, all the assembly shall assemble themselves to thee at the door of the tabernacle of the congregation.

4. And if they blow but with one trumpet, then the princes, which are heads of the thousands of Israel, shall gather themselves unto thee.

5. When ye blow an alarm, then the camps that lie on the east parts shall go forward.

6. When ye blow an alarm the second time, then the camps that lie on the south side shall take their journey: they shall blow an alarm for their journeys.

7. But when the congregation is to be gathered together, ye shall blow but ye shall not sound an alarm.

8. And the sons of Aaron, the priests shall blow with the trumpets; and they shall be to you for an ordinance for ever throughout your generations.

9. And if ye go to war in your land against the enemy that oppresseth you, then ye shall blow an alarm with the trumpets; and ye shall be remembered before the lord your god, and ye shall be saved from your enemies.

10. Also in the day of your gladness and in your solemn days, and in the beginnings of your months, ye shall blow with the trumpets over your burnt offerings, and over the sacrifices of your peace offerings; that they may be to you for a memorial before your God:

I am the Lord your God."

BIBLICAL PS. XL VII

DR163

Instrument Cited: Trumpet

Citation: Psalm XL VII, 5

"God is gone up with a shout, the Lord with the sound of a trumpet."

BIBLICAL PS LXXXI

DR165

Instrument Cited: Trumpet

Citation: Psalm LXXXI, 3

"Blow up the trumpet in the new moon, in the time appointed, on our solemn feast day."

BIBLICAL PS. CL

DR162

Instrument Cited: Trumpet

Citation: Psalm CL, 3.

"Praise him with the sound of the trumpet: praise him with the psaltery and harp."

BIBLICAL I SAM XIII

DR157

Instrument Cited: Trumpet

Citation: I Samuel XII, 3

"And Saul blew the trumpet throughout all the land, saying, Let the Hebrews hear."

BIBLICAL II SAM II

DR153

Instrument Cited: Trumpet

Citation: II Samuel II, 28.

"So Joab blew a trumpet, and all the people stood still, and pursued after Israel no more, neither fought they any more."

BIBLICAL II SAM VI

DR151

Instrument Cited: Trumpet

Citation: II Samuel VI, 15.

"So David and all the house of Israel brought up the ark of the LORD with shouting and with the sound of the trumpet."

BIBLICAL II SAM XV

DR166

Instrument Cited: Trumpet

Citation: II Samuel XV, 10.

"But Absalom sent spies throughout all the tribes of Israel, saying, As soon as ye hear the sound of the trumpet, then ye shall say, ·Absalom reigneth in Hebron. " _

BIBLICAL II SAM XVIII

DR152

Instrument Cited: Trumpet

Citation: II Samuel XVIII, 16.

“And Joab blew the trumpet, and the people returned from pursuing after Israel: for Joab held back the people."

BIBLICAL II SAM XX

DR154

Instrument Cited: Trumpet

Citation: II Samuel XX, 1, 22

1. ".. the son of Bichri, a Benjamite: and he blew a trumpet and said ....

22.Then the woman went unto all the people in her wisdom. And they cut off the head of Sheba the son of Bichri, and cast it out to Joab. And he blew a trumpet, and they retired from the city, every man to his tent."

BUR-SIN 2200BC

DR7

Instrument Cited: SIM-DU SIM-DA

Citation: Mention of the SIM with the copper determinative before the name also included in an inventory of copper articles in temple receipts for Ningirsu patron deity of Lagash.

Cited in Galpin (Sumerians), 1937, 23

L.CAELIUS LACTANTIUS FIRMIANUS Christian writer ob.AD 325

DR113

Instrument Cited: Tuba

Citation: De Mortibus Persecutorum 47,1.

Refers to use of tubicines to sound the attack.

Cited in Fleischhauer (1960), p 502

CAIUS JULIUS CAESAR (i) Historian ob.BC 44

DR108

Instrument Cited: Tuba

Citation: Bellum Gallicum 7, 81, 3

Refers to tubicines giving alarm to Legionaires.

Cited in Fleischhauer (1960) p 502.

CAIUS JULIUS CAESAR (ii)

DR109

Instrument Cited: Tuba

Citation: Bellum Gallicum 2, 20, 1

"Caesari omnia uno tempore erant agenda: vexillum proponendum, quod erat insigne cum ad arma concurri oporteret, signum tuba dandum, ab opere revocandi milites, qui paulo longius aggeris petendi causa processerant arcessendi, acies instruenda milites cohortandi, signum dandum."

Cited in Fleischhauer (1960), p 502

CAIUS JULIUS CAESAR (iii)

DR111

Instrument Cited: Tuba

Citation: Bellum Civile 3, 46,4

Refers to use of Tuba in the attack.

Cited in Fleischhauer (1960) p 502

CAIUS JULIUS CAESAR (iv)

DR116

Instrument Cited: Tuba

Citation: Bellum Gallicum 7, 47, 1-2

Refers to use of tubicines to sound the retreat.

Cited in Fleischhauer (1960), p 502

CAIUS JULIUS CAESAR (v)

DR181

Instrument Cited: Trumpets

Citation: Bellum Civile? 111, 92

Refers to use of trumpets for tactical purposes and to frighten the enemy.

Cited in Yadin (1962), p 113.

M. TULLIUS CICERO (1) ob. BC 43

DR8

Instrument Cited: Lituus

Citation: Div. I, 17, 30

"An example of Ciccro's antiquarian interests is his etymology of Lituus, the staff marking the augural office. This wand, which was crooked and at the top slightly curved, took its name from its likeness to the trumpet lituus with which was sounded the charge to battle.

M.TULLIUS CICERO (ii)

DR40

Instrument Cited: Cornu, Lituus

Citation: De Re Publica 2, 22, 40

"quin etiam accensis velatis liticinibus, cornicinibus, proletariis. "

Cited in Wille (1967) p.91 219 also Behn (1912) p 46

M.TULLIUS CICERO (iii)

DR89

Instrument Cited: Cornu, Tuba

Citation: Oratio pro Sulla. 5, 17

"ille arma misit, cornua, tubas, falces."

Cited in Lewis and Short 1945, "tuba"

M. TULLIUS CICERO (iv)

DR90

Instrument Cited: Tuba

Citation: Orationes in Catilinam 2, 16, 13

"tubae et signa militaria"

Cited in Lewis & Short, "tuba"

M.TULLIUS CICERO (v)

DR143

Instrument Cited: Bucina

Citation: Oratio pro L. Murena. 22

Refers to use of bucina signals to sound reveille.
Cited in Fleischhauer (1960) p 504.

CLAUDIUS CLAUDIANUS (i) poet AD 400
DR31
Instrument Cited: Lituus
Citation: Claud. carm. 5, 218
"traceant litui. Prohibete sagittas."
Cited Wille 1967 p 90, 207

CLAUDIUS CLAUDIANUS (ii)
Instrument Cited: Lituus
Citation: Claud. carm. 8, 152ff
"redditque ferocem/vagitum lituus."
Cited Wille (1967) p 90, 207

DECIMIANUS
DR55
Instrument Cited: Bucina
Citation: Inscription on gravestone.CIL VI. 3179
"P. Ael. Docimianus eq. sing. Aug. bucinator heres."
Cited in Klar (1971) p 315

DEAD SEA WAR SCROLL
DR121
Instrument Cited: Chatzotzerah
Citation: Reference to the "trumpets of remembrance“.
Cited in Wulstan (1973) p 31.

DIO CASS
DR115 `
Instrument Cited: Tuba
Citation: Dio. Cass. 41, 58, 2

Ref. to use of tubicines in sounding the attack.

Cited in Fleischhauer (1960) p 502

DIOD

DR131

Instrument Cited: Tuba

Citation: Diod. 31, 8, 10.

Ref. to use of tubicines in the triumphal procession.

Cited in Fleischhauer (1960) p 502.

DIODORUS SICULUS BC 40

DR9

Instrument Cited: Salpinx

Citation: Lib. v. c. 30.

"The Celtic Gauls have amongst them trumpets peculiar as well to themselves as to other nations; these, by inflation, emit an hoarse sound, well suited to the din of battle."

Cited in Kemble 1863 p 171. Nierhaus 1953 p 60.Wille (1967) p 623

DION

DR139

Instrument Cited: Bucina

Citation: Cited in Fleischhauer (1960) p 503

ENNIUS (i) Poet Ob. BC 169

DR10

Instrument Cited: Lituus

Citation: Enn. ap Paul ex Fest.

"Lituus sonitus effudit acutos"

Cited Lewis & Short (1945) Lituus.

ENNIUS (ii)

DR85

Instrument Cited: Tuba

Citation: Enn. ap. Prisc. Fragment 143

"at tuba terribili sonitu taratantara dixit"
Cited Lewis & Short (1945) "sonitus". Baines (1976) p 63

EURIPEDES (i)
DR66
Instrument Cited: Trumpet
Citation: Phoenissae (1377)
Ref. to trumpet among the proud emblems of an unholy war: ..
Cited in Verrall (1884) p 80.

EURIPEDES (ii)
DR67
Instrument Cited: Trumpet
Citation: Troades 1267
trumpet tells Trojan captives that moment of expatriation has arrived.
Cited in Verrall (1884) p 80

EURIPEDES (iii)
DR68
Instrument Cited: Trumpet
Citation: Rhesos (989)
The Trojan Hektor names the trumpet as the signal of his attempt, so nearly successful, to burn the Greek ships.
Cited in Verrall (1884) p 80.

EURIPEDES (iv)
DR69
Instrument Cited: Trumpet
Citation: Rhesos (144)
The Trojan Hektor names the trumpet as the signal of his attempt, so nearly successful, to burn the Greek ships.
Cited in Verrall (1884) p 80.

EURIPIDES (v)
DR70
Instrument Cited: Tyrrhene Trumpet;

Citation: The "Tyrrhene trumpet" is the prelude to a scene so horrible that the narrator declines the tasks of describing it.

Cited in Verrall (1884) p 80.

EUSTATHIUS (i)

DR2

Instrument Cited: Carnyx

Citation: Ad Iliade XVIII, 209. 1

Ref. to carnyx having mouthpiece of lead.

Cited in Piggott (1959) p 19.

EUSTATHIUS (ii)

DR4

Instrument Cited: Carnyx

Citation: 1189 = 1139. 56-57

Gives name of carnyx to the instrument of the Celts. Said to be almost identical passage to DR2.

FESTUS Grammarian fl. AD 150?

DR52

Instrument Cited: Bucina Lituus

Citation: Sext. Pompeius Festus

"Lituus appelatus, quod litis sit testis. Est enim genus bucinae incurvae, quo qui cecinerit dicitur liticen."

FLORUS Historian fl. AD 140

DR43

Instrument Cited: Lituus

Citation: L. Annaeus Florus. epit. 2, 13, 67 (IV,2)

"et primum strages a luba coepit, cuius elephanti bellorum rudes et nuper a silva consternati subito clangore lituorum in suos sese circumegere."

Cited Wille (1967) p 92, 224

GILGAMESH c. 1950BC

DR5

Instrument Cited: Trumpet

Citation: Description of Gilgamesh inventing the trumpet from the root and branch of a tree.

Cited in Galpin (Sumerians) 1937 p 22.

HERENNIUM

DR87

Instrument Cited: Tuba

Citation: Auctor and Herennium, v. cornificius, 4, 15, 21.

Ref. to tuba.

Cited in Lewis & Short (1945) "sonitus".

HESYCHIUS

DR3

Instrument Cited: Carnyx

Citation: Hesychius assigns the name carnyx, (karnon) to the Galations.

Cited in Piggott (1959) p 19.

HIERONYMUS Christian writer Ob. AD 420

DR53

Instrument Cited: Buccina, Cornu

Citation: OS. 2, 8, 9.

“buccina pastoralis est et cornu recurvo efficitur "

Cited in Klar (1971) p 312; Wille (1967) p 80 51 p 119; Fleischhauer p 503

HOMER

DR71

Instrument Cited: Salpinx

Citation: According to Verrall, the salpinx is mentioned twice in Homer's work.

Cited in Verrall, (1884) p 81.

HORATIUS FLACCUS (i) Poet Ob BC 8

DR11

Instrument Cited: Lituus, Tuba

Citation: Horatuis Flaccus. Carmina Liber Primus, 1, 1, 23. prob written BC 24

"Multos castra juvant et lituo tubae Permixtus sonitus bellaque matribus Detestata".

"Many camps are aided by litui and tubae which make a confused, warlike warning sound."

HORATIUS FLACCUS (ii)

DR51

Instrument Cited: Cornu Lituus

Citation: Horatius Flaccus. Prob. Carminum II, 1, 17. Written BC 24.

"Jam nunc minaci murmure cornuum

Perstringis aures,jam litui strepunt, Jam fulgor armorum fugaces ..."

HORATIUS FLACCUS (iii)

DR59

Instrument Cited: Cornu Tuba

Citation: VIDERIS Satirae I, 6, 44.

"Et Messalla Vide ? At hic, si plostra ducenta Concurrantque foro tria funera, magna sonabit Cornua quod Vincatque tubas; "

"The corpse was carried in procession from his house with the noise of trumpets, horns and fifes."

Cited in Fleischhauer (1960) p 502

HORATIUS FLACCUS (iv)

DR99

Instrument Cited: Cornu

Citation: Ref. to cornu having a "threatening roar".

Cited in Baines (1976) p 60.

HOSY 1298-1232 BC

DR178

Instrument Cited: Trumpet

Citation: Ref. to Hosy, first named Egyptian trumpeter, time of Ramses II.

Cited in Hickmann (1961) p.122, 166, Abb. 89.

HYGINUS poet and fabulist

DR148

Instrument Cited: TRITON

Citation: C. Julius Hyginus. Astronomia 2, 23 p 66, 13.

Ref. to Triton being first person to hollow out a shell and blow it so successfully that the Giants were afraid of the unknown and fled.

Cited in Fleischhauer (1960) p 504.

IULIUS VICTOR

DR185

Instrument Cited: Lituus Cornu

Citation: Inscription 0n gravestone.

"M(arcus) Julius Victor ex collegio liticinum cornicinum" See IC71.

JEROME 340-420 AD

DR177

Instrument Cited: Keras, Buccina, Tuba, Shofar

Citation: "Buccina pastoralis est et cornu recurvo efficitur, unde et proprie hebraice shofar, graece keratine appelatur. Tuba autem de aere conficitur vel argento quae in bellis et solemnitatibus concrepabant."

"The buccina is the instrument of the shepherds made from curved horn, therefore it is called, in Hebrew shofar, in Greek keratine. The tuba however is made of brass or silver and its resounding tone is used in wars and festivities."

Cited in Sendrey 1969 p 367. (513)

JOSEPHUS (i) Jewish historian 37-100 AD

DR100

Instrument Cited: Chatzotzerah

Citation: Flavius Josephus Antiquities III xii, 6.

Ref. to use of two chatzozerot

Cited in Wulstan (1973) p 30.

JOSEPHUS (ii)

DR146

Instrument Cited: Chatzotzerah

Citation: According to Josephus the length of the Jewish trumpet was one Ell. (c 45.7 cm).

Cited in Tarr (1977) p 15.

JUNIUS JUVENALIS poet Ob. AD 130

DR12

Instrument Cited: Cornu, Lituus

Citation: D. Junius Juvenatis Juv. 14, 200

"Aut longos castrorum ferrelabores/si piget et trepidum solvunt tibi cornua ventrem/cum lituis audita".

Cited in Wille (1967) p 83, 104

LIVIUS (i) Historian ob. AD 17

DR13

Instrument Cited: Lituus

Citation: Titus Livius Liv. 1, 18.

Probably a reference to the auger's staff.

"Baculum aduncum tenens, quem lituum appelaverunt".

LIVIUS (ii)

DR46

Instrument Cited: Trumpet, Horn.

Citation: Liv. 9, M1, 17.

Ref. to use of trumpets and horns together during a battle.

Cited in Fleischhauer (1960) p 501; Kemble (1863) p 171.

Livius (iii)

DR107 Entry as for Livius (ii) DR 46

LIVIUS (iv)

DR106

Instrument Cited: Tuba

Citation: 37, 29, 3.

Ref. to tubicines giving Legionaires the alarm signal.

Cited Fleischhauer (1960) p 502.

LIVIUS (v)

DR117

Instrument Cited: Tuba

Citation: 27, 47, 2.

Ref. to use of tubicines to sound the retreat.

Cited Fleischhauer (1960) p 502.

LIVIUS (v1)

DR118

Instrument Cited: Tuba

Citation: 30, 14, 11

Entry as Livius (v) DR117

LIVIUS (vii)

DR142

Instrument Cited: Bucina

Citation: 26, 15, 6

Ref. to use of the bucina to sound the watches of the night.

Cited in Fleischhauer (1960) p 504.

LUCANUS (i) Poet ob. AD 65

DR14

Instrument Cited: Lituus Tuba

Citation: M. Annaeus Lucanus Luc. 1, 237.

"Stridor lituum olangorque tubarum".

LUCANUS (ii)

DR97

Instrument Cited: Tuba. AERE RECURVO

Citation: "Batavique truces, quos aere recurvo stridentes acuere tubae".

Cited in Nierhaus (1953) p 59.

MISHNAH (i)

DR102

Instrument Cited: Shofar, Chatzotzerah

Citation: Mishnah, Rosh ha-Shanah 111, 2.

Ref. to duty days taken in turns between the Shofar and Chatzozerah.

MISHNAH (ii)

DR103

Instrument Cited: Chatzotzerah

Citation: Mishnah, Tamid VII, 3

Ref. to the priests blowing trumpets during a pause in the Levitical singing in the Second Temple: this was also a signal to the worshippers to prostrate themselves.

Cited in Wulstan (1973) p 30.

MISHNAH (iii)

DR125

Instrument Cited: Shofar, Chatzotzerah

Citation: Mishnah, Kinnim. 111, 6.

Ref. to trumpet "can be made of animal horn".

Cited in Wulstan (1973) p 31.

MISHNAH (iv)

DR128

Instrument Cited: Shofar

Citation: Mishnar, Rosh ha-Shana 111, 6.

States that holes made in the shofar make it invalid.

Cited in Wulstan (1973) p 41.

MISHNAH (v)

DR132

Instrument Cited: Keren

Citation: Mishnah, Rosh ha-Shana 111.

States that Keren is a bovine horn.

Cited in Wulstan (1973) p 42.

OVIDIUS (i) Poet ob. AD17

DR15

Instrument Cited: Lituus

Citation: P. Ovidius Naso Fasti 3, 216.

"Jam lituus pugnae sigma daturus erat".

Cited Lewis & Short (1945) "Lituus"; Behn (1912) p 39

OVIDIUS (ii)

DR28

Instrument Cited: Concha, Bucina, Triton

Citation: Metamorphoses 1, 333

"Caeruleum Tritona vocat conchaeque sonanti/inspirare iubet fluctusque et flumina signo/iam revocare dato; cava bucina sumitur illi/tortilis, in latum quae turbine crescit ab imo/bucina, quae medio concepit ubi aera ponto,/litora voce replet sub utroque iacentia Phoebo/Tunc quoque, ut ora dei madida rorantia barba/contigit et cecinit iusos inflata receptus/omnibus audita est telluris et aequoris undis".

Cited Fleischhauer (1960) p 504

OVIDIUS (iii)

DR39

Instrument Cited: Aes. Tuba

Citation: Metamorphoses 3, 704.

"fremit acer equus cum bellicus aere canoro signa dedit tubicen, pugnaeque adsumit a(m)oren".

Cited Wille (1967) p 91 216.

OVIDIUS (iv)

DR60

Instrument Cited: Aes Flexum, Cornu, Tuba

Citation: Metamorphoses I, 98.

"Non tuba directi, non aeris cornua flexi".

"The lituus was not as straight as the tuba, not as twisted as the other (the cornu)".

Cited in Fleischhauer (1960) p 502.

OVIDIUS (v)

DR120

Instrument Cited: Tuba

Citation: Epistulae ex Ponto 3, 4, 31.

Refers to the use of the tubicines in daily service.

Cited in Fleischhauer (1960) p 502.

PAULUS Flor. AD 200

DR85

Instrument Cited: Lituus

Citation: Julius Paulus

"lituus sonitus effundit acutos"

Cited in Lewis & Short (1945) sonitus.

PERPETSCHAU 1200-1085 BC

DR179

Instrument Cited: Trumpet

Citation: Ref. to Perpetschau and Amonchau, two trumpeters of 20th Dynasty Egypt

Cited in Hickmann(1960) p 122, 166, Abb.89.

PETRONIUS ARBITER Satirist Fl. AD 60
DR105
Instrument Cited: INSTRUMENTS
Citation: Petr. 78.
Ref. to different instruments playing together.
Cited in Fleischhauer (1960) p 502.

PLAUTUS Writer of comedy ob. BC 184
DR92
Instrument Cited: Tuba
Citation: T. Maccino Plautus. Amphitruo 1, 1, 73.
"tubae utrimque canunt".
Cited in Lewis & Short (1945) "tuba".

PLINIUS Ob. AD 79
DR13
Instrument Cited: Cornu
Citation: C. Plinius Caeciluis Secunduo.
Plin. 11, 37, 45, 125.
"Aliis cornua adunca, aliis redunca".

PLUT (i)
DR114
Instrument Cited: Tuba
Citation: Plut. Sulla 29, 8.
Ref. to the tubicines in sounding the attack.
Cited in Fleischhauer (1960) p 502.

PLUT (ii)
DR135
Instrument Cited: Tuba
Citation: Plut. Aem. Paul. 33, 1.

Ref. to use of tubicines in triumphal procession.
Cited in Fleischhauer (1960) p 502.

PLUTARCH (i) c. 50 AD
DR48
Instrument Cited: TrumpetS
Citation: Aem. Paul. 33.
Refers to trumpeters being a regular part of the triumphal procession.
Cited in Ryberg (1955) p 21.

PLUTARCH (ii)
DR73
Instrument Cited: Trumpet
Citation: Morals 150
Ref. to Egyptian delta towns where the Egyptian trumpet detested as it made a noise like the braying of an ass.

PLUTARCH (iii)
DR74
Instrument Cited: Trumpet
Citation: Morals 362
Entry as Plutarch (ii) DR 73

PLUTARCH (iv)
DR101
Instrument Cited: Trumpet
Citation: Peri Isidos kai Osiridos 30.
Entry as Plutarch (ii) DR 73.

POLLUX (i)
DR93
Instrument Cited: Reference to signals
Citation: IV, 85.

Reference to use of tactical signals.

Cited in Baines (1976) p 63.

POLLUX (ii)

DR182

Instrument Cited:·Tuba

Citation: Chapter on musical instruments.

Ref. to mouthpiece of tuba being made of bone.

Cited in Behn (1954) p 136.

POLYB

DR141

Instrument Cited: Bucina

Citation: 6, 35, 12.

Ref. to use of bucina to sound the watches of the night.

Cited in Fleischhauer (1960) p 504.

POLYBIUS (i)

DR17

Instrument Cited: Carnyx

Citation: Prob. II, 29, 6.

"The parade and tumult of the army of the Celts terrified the Romans; for there was amongst them an infinite number of horns and trumpets, which, with the shouts of the whole army in concert, made a clamour so terrible and loud, that every surrounding echo was awakened, and all the adjacent country seemed to join in the horrible din."

Cited in Wilde (1861) p 632;Nierhaus (1953) p 60.

POLYBIUS (ii)

DR96

Instrument Cited: HORN

Citation: Hist. 12, iv, 6.

"From Roman times Polybius tells of the astonishing skill of Italian swineherds with the horn; how from a vast herd the pigs of a particular breed or age group would answer without fail to their particular call and sort themselves out for their nightly quarters".

PROPERTIUS (i) Poet ob. BC 16

DR119

Instrument Cited: Tuba

Citation: Sextus Aurelius Propertius 4, 4, 79

Ref. to tubicines in daily duty.

Cited in Fleischhauer (1960) p 502.

PROPERTIUS (ii)

DR143

Instrument Cited: Bucina

Citation: 4, 4, 63

Ref. to use of bucina signal to sound the reveille.

Cited in Fleischhauer (1960) p 504

PROPERTIUS (iii)

DR175

Instrument Cited: Buccina

Citation: "Buccina cogebat priscos ad verba Quirites"

Cited in Bridge (1905) p 138

QUINTILIANUS Rhetorician Ob. AD 95

DR47

Instrument Cited: Trumpet, Horn .

Citation: M.T. Quintilianus 1, 10, 14

Ref. to both trumpets and horns playing together during battle.

Cited in Fleischhauer (1960) p 503

RABBINIC SCRIBES

DR180

Instrument Cited: Chatzotzerah

Citation: Reference to the use of the chatzozerah in the second Temple.

Cited in Sendrey (1969) p 336

RUFINUS

DR56

Instrument Cited: Bucina

Citation: Inscription on gravestone, CIL III 3352 "titulum p(osuit) F(lavius) Refinus eq(ues) buc(inator) coh(ortis) eiusde(m) h(eres) ex t(estamento).“

SCHOL. HOR Poet Ob. BC 8

DR37

Instrument Cited: Lituus, Tuba

Citation: "Litui acutus sonus est, tubae gravis. Inter lituum et tubam in antiquis scriptis hoc distare inveni: lituus equitum est et incurvus, tuba Vero peditum est et directa".

Cited in Wille (1967) p 91 213; Behn (1912) p 36,39; Klar (1971) p 304.

SENECA (i) Philosopher and tragedian Ob AD65.

DR18

Instrument Cited: Lituus, Cornu, AERE

Citation: L. Annaeus Seneca. Oedip. 73 ff.

"sonuit reflexo classicum cornu lituusque adunco stridulos cantus elisit aere".

Cited in Behn (1912) p 36; Klar (1971) p 307.

SENECA (ii)

DR58

Instrument Cited: Aes, Cornu, Tuba

Citation: Apocolocyntosis 12, 1.

"tubicinum, cornicinum omnis generis aeneatorum tanta turba, tantus concentus, ut etiam Claudius sentire posset."

Cited in Fleischhauer (1960) p 502.

SILIUS ITALICUS (i) Poet Ob. AD 101

DR30

Instrument Cited: Lituus

Citation: "Ergo age, qua litui, qua ducunt bella sequamur".

Cited in Wille (1967) p 90 207

SILIUS ITALICUS (ii)

DR146 ‘

Instrument Cited: Bucina, Cornu, Tuba

Citation: 5, 222

Ref. to bucinae, tubae and cornua playing together.

Cited in Fleischhauer (1960) p 504.

SILIUS ITALICUS (iii)

DR147

Instrument Cited: Bucina, Tuba, Cornu

Citation: 15, 605

Entry as Silius Italicus (iii) DR147.

SOPHOKLES (i)

DR62

Instrument Cited: Salpinx

Citation: Asias 14

Ref. to the voice of the brazen-mouthed Italian salpinx

Verrall discusses this as "the broad end of a trumpet".

Verrall (1884) p 76.

SOPHOKLES (ii)

DR65

Instrument Cited: Trumpet

Citation: Ai 291

Ref. to Tekmessa reminding Aias, as he goes out upon his fatal errand, that this time it is not the trumpet which calls him from her side.

Cited in Verrall (1884) p 80.

SOPHOKLES (iii)

DR130

Instrument Cited: Horn

Citation: Ajax 18

Attribution of metal form of horn to the Etruscans.

Cited in Wulstan (1973) p 41.

STATIUS Poet Ob. AD 96

DR42

Instrument Cited: Lituus Tuba

Citation: P. Papinius Statius. Thebais 11, 50 ff & 56

egregius litus dextri Mavortis hortator; sed nunc miseris dabat utile signum suadebatque fugam et tutos in castra receptus .... iam gelida ora tacent, carmen tuba sola peregit".

Cited in Wille (1967) p 92 223

TACITUS (i) Historian Ob. AD 119

DR45

Instrument Cited: Trumpet, Horn

Citation: C. Cornelius Tacitus. Annales 1, 28, 2.

Ref. to trumpeters and horn-players playing together during the battle.

Cited in Fleischhauer (1960) p 503.

TACITUS (ii)

DR132

Instrument Cited: Tuba

Citation: Historia 2, 29, 2

Ref. to use of tubicines in daily duty.

Cited in Fleischhauer (1960) p 502.

TACITUS (iii)

DR137

Instrument Cited: Trumpets, Horns.

Citation: Annales 68, 3. _

Entry as Tacitus (i) DR 45.

TACITUS (iv)

DR138

Instrument Cited: Trumpets, Horns.

Citation: Annales 2, 81, 2.

Entry as Tacitus (i) DR 45.

TACITUS (v)
DR140
Instrument Cited: Bucina
Citation: Annales 15, 30, 1.
Ref. to use of the bucina signal for the last post.
Cited in Fleischhauer (1960) p.504

TACITUS (vi)
DR184
Instrument Cited: ALPHORN
Citation: Ref. to the Alphorn as cornus alpinus.
Cited in Marcuse (1975) p 815.

TALMUD ARAKIN
DR126
Instrument Cited: Shofar, Chatzotzerah
Citation: Babylonian Talmud Arakin 11, 3.
Details of shofar and Chatzotzerah calls.
Cited in Wulstan (1973) p 32.

TALMUD ROSH HA-SHANAH (i)
DR124
Instrument Cited: Shofar , Chatzotzerah
Citation: Babylonian Talmud. Rosh ha-Shanah 36a.
Ref. to interchange of roles of shofart and chatzozerah.
Cited in Wulstan (1973) p 31.

TALMUD ROSH HA-SHANAH (ii)
DR127
Instrument Cited: Shofar, Chatzotzerah.
Citation: Babylonian Talmud Rosh ha-Shanah 33b.

Details of shofar and chatzozerah calls.

TALMUD SHABBAT

DR122

Instrument Cited: Shofar, Chatzotzerah

Citation: Talmud Shabbat 36a.

"What was called a trumpet has become a shofar and what was called a shofar has become a trumpet".

Cited in Wulstan (1973) p 31.

TALMUD SUKKOTH

DR123

Instrument Cited: Shofar, Chatzotzerah

Citation: Babylonian Talmud Shukkoth 34a

Entry as Talmud Shabbat 36a DR122

TUSHRATTA 1380BC

DR1

Instrument Cited: Trumpet Horn

Citation: An inventory of presents offered by King Tushratta of Mitanni to the Pharoah Amenophis IV on the occasion of the betrothal of his daughter Tatuhepa to the Egyptian Monarch. Amongst these were two karan, the pattu, reed or tube, corresponding to the older MEKKU being bound, probably with willow bark or bast, and the kizallu (gourd or-bell), the older PUKKU, made of wood overlaid with gold: one of the instruments was also mounted with two gold bands.

List specified 40 horns all covered with gold and some studded with precious stones. 17 of them specifically called ox-horns.

Cited in Galpin (Sumerians 1937) p 24; Sachs (1940) p 73.

UR-LAMA 2275 BC

DR6

Instrument Cited: SIM

Citation: Ref. to SIM prefixed with copper determinative in inventory of copper articles.

C. VALERIUS FLACCUS

DR20

Instrument Cited: Lituus

Citation: 6, 163-166

"nec tot ab extremo fluctus agit aequore nec sic fratribus adversa Boreas respondet ab unda aut is apud fluvios volucrum canor eathera quantus tunc lituum concentrus adit".

Cited in Wille (1967) p 91 210

VARRO (i) ob.·BC 27

DR24

Instrument Cited: Bucina

Citation: De Re Rustica 2, 4,20

"Subulcus debet consuefacere, omnia ut faciant ad bucinam primo cum incluserunt cum bucinatum est aperiunt, ut silvestri loco dispersi ne dispersant".

Cited in Fleischhauer (1960) p 503

VARRO (ii)

DR25

Instrument Cited: Bucina

Citation: De Re Rustica 3, 13, 3

"ibi erat locus excelsus, ubi triclinio posito cenabamus, quo Orphea vocari iussit qui cum eo venissit cum stole et cithara cantare esset iussus, bucina inflavit, ut tanta circumfluxerit nos cervorum aprorum et ceterarum quadripedum multitudo, ut non minus formosum mihi visum sit spectaculum, quam in circo maximo aedilium sine Africanis bestiis cum fiunt venationes".

Cited Fleischhauer 1960 p 503

VARRO (iii)

DR26

Instrument Cited: Bucina

Citation: De Re Rustica 3, 13, 1

"vidisti ad bucinam inflatam certo tempore apros et capreas convenire ad pabulam".

Cited in Fleischhauer (1960) p 503.

VARRO (iv)

DR183

Instrument Cited: Cornu. ANIMAL HORN

Citation: "Cornua quod ea nunc sunt ex aere, tunc fiebant bubalo e corno".

The cornua, now made of bronze were formerly made from horns of the wild ox.

VEGETIUS (i) Writer. fl. AD 386

DR19

Instrument Cited: Tuba, Cornu, Bucina

Citation: F. Vegetius Renatus

De Re Mil II 22.

Habet praeterea legio tubicines cornicines bucinatores. Tubicen ad bellum vocat milites et rursum receptui canit. Cornicines quoties canunt, non milites sed signa ad eorum obtemperant nutum. Ergo quotiens ad aliquod opus exituri sunt soli milites, tubicines canunt, quotiens movenda sunt signa, cornicines canunt; quotiens autem pugnatur, et tubicines et cornicines pariter canunt.

Cited Fleischhauer (1960) p 502.

VEGETIUS (ii)

DR21

Instrument Cited: Tuba, Bucina, Cornu, AERE CURVO

Citation: De Re Mil II 7.

"Tubicines cornicines et bucinatores qui tuba vel aere curvo vel bucina committera proelium solent".

"Tuba, cornu and bucina players who with the Tuba or either the aere curvo (cornu?) or the bucina usually begin the battle".

VEGETIUS (iii)

DR22

Instrument Cited: Bucina, Cornu.

Citation: De Re Mil II 22

"Classicum item appellatur quod bucinatores per cornu dicunt. Hoc insigne videtur imperii, quia classicum canitur, imperatore praesente vel cum in militem capitaliter animadvertitur, quia hoc ex imperatoris legibus fieri necesse est".

Cited Fleischhauer (1960) p 503.

VEGETIUS (iv)

DR23

Instrument Cited: Tuba Cornu·

Citation: De Re Mil II 22.

"Sive ergo ad vigilias vel agrarias faciendas sive ad opus aliquod vel ad decursionem campi exeunt milites, tubicine vocante operantur et rursus tubicine admonente cessant. Cum autem moventur sigma aut iam mota figenda sunt, cornicines canunt."

Cited in Fleischhauer (1960) p 503.

VEGETIUS (v)

DR54

Instrument Cited: Tuba, Cornu, Bucina, AES

Citation: De Re Mil III, 5

"Semivocalia sunt quae per tubam aut cornu aut bucinam dantur; tuba quae directa est appellatur; bucina quae in semet aereo circulo flectitur; cornu quod ex uris agrestibus, argento nexum, temperatum arte spirituque canentis flatus emittit uditum. Nam indubitatis per haec sonis agnoscit exercitus, utrum stare vel progredi an certe regredi oporteant."

Cited Wille (1967) p 80 46

VERGILIUS (i) Poet Ob. BC 19

DR38

Instrument Cited: Lituus

Citation: P. Vergilius Maro Georgica 3, 182 ff.

"primus equi labor est, animos atque arma videre bellantum lituosque pati tractuque gementem ferre rotam et stabulo frenos audire sonantis"

VERGILIUS (ii)

DR27

Instrument Cited: Bucina, Cornu

Citation: Aeneis 7, 512

"de culmine sumno/pastorale canit signum cornuque recurvo/Tartaream intendit vocem, qua protinus omne/contremuit nemus et silvae insonuere profundae ..... tum vero ad vocem celeres, qua bucina signum/dira dedit, raptis concurrunt undique telis/indomiti agricolae.

Cited Fleischhauer (1960) p 503

VERGILIUS (iii)

DR50

Instrument Cited: Lituus

Citation: Aeneis 6, 167

Ref. to lituus being a military trumpet.

Cited in Ryberg (1955) p 21.

VERGILIUS (iv)

DR88

Instrument Cited: Tuba

Citation: Georgica, 4, 7

Ref. to tubarum

Cited in Lewis & Short (19h5) "Sonitus".

VERGILIUS (v)

DR91

Instrument Cited: Tuba

Citation: Aeneis 9, 503.

at tuba terribili sonitu taratantara at dixit".

Cited in Lewis & Short (1945) "tuba".

VERGILIUS (vi)

DR131

Instrument Cited: Tuba

Citation: Aeneis VIII, 526.

Ref. to Etruscan source for tuba.

Cited Tarr 1977 p 16; Wulstan (1973) p 41.

VOPISCUS Historian AD 305

DR41

Instrument Cited: Cornu, Lituus

Citation: Flavius Vopiscus Aur 31, 7.

"templum sane solis, quod apud Pulmyram aquiliferi legionis tertiae cum vexilliferis et draconarie et cornicinibus atque liticinibus diripuerunt ..... "

Cited in Wille (1967) p 91 220

ICONOGRAPHIC REFERENCES

These are also listed on my web site http://www.hornandtrumpet.com, along with images where possible

IC1 Instrument on Tomb Stone

Find Spot: Mainz, Germany

Current Location: Stadtische Altertumersammlung, Mainz

Description: Carving of small doubly curved instrument on tomb stone of cavalry man Andes.

Citations: Sachs, 1940, 147; Klar, 1971, 315;Behn, 1954, Abb. 180.

IC2 Lituus and Cornu on Wall Painting

Find Spot: Tomb of seven chimneys Orvieto

Date of lllustration: 4th Century BC

Description: Cornu and tuba players carrying instruments, standing with a group of other people. Cornu is of oval form with widebore and no clear mouthpiece. Lituus is clearly conical with a wide mouthpiece and has a possible mouthpiece at tip end

IC3 Lur - Rock-Carving
Find Spot: Tanum, Bohuslan, Sweden
Description: Group of three lur players blowing curved lurs and wearing horn helmets, one other player below and to right.
Citations: Broholm, 1949, Plate 28; Lund, 1976, Figure 3

IC4 Horn - Rock-Carving
Find Spot: Kivik, Scania, Sweden
Current Location: Lost
Description: Two horn players blowing long animal horn-shaped instruments. One points into air, other held under arm. Found on stone slabs in Bronze-Age cist.
Citations Broholm, 1949, Plate 28; Behn, 1954, Abb, 7;

IC5 Carnyx on Frieze
Find Spot: Arch of orange, France
Description: Soldier blowing carnyx with further animal-headed carnyx behind.
Citations: Moreau, 1958; Dechelette, 1927; Espérandieu, 1907; Piggott, 1959 P1.VIIa,

IC6 Lituus - Carving in Tomb
Find Spot: Tomba dei Relievi at Caere
Date of Illustration: 4th Century BC
Description: Carving of lituus on pillars supporting roof of tomb at Caere.
Citations: Oldeberg, 1947, 4; Hencken, 1951, 58; Ducati, 1927, 394; Giglioli, 1935, 64, Tav. CCCXLII/III.

IC7 Horn on Relief
Find Spot: Carchemish
Date of Illustration: c. 1250BC
Current Location: British Museum
Description: Short, thick horn being blown alongside a large frame drum.
Citations: Galpin, 1937, (Sumarians) Plate III, No. 1; Sachs, 1940

IC8 Tubae on Relief
Find Spot: Arch of Titus, Rome l
Date of Illustration: 81 AD
Description:·Tubae being blown at relief celebrating action in 71 AD by emperor Titus. Destruction of the temple of Jerusalem.
Citations: Kinsky, 1929, 20; Behn, 1954, Abb. 83; Mommsen, 1955, 344; Collaer, 1968, 28, No. 116; Strong, 1926, 362;

IC9 Single Cone Tuba on Limestone Fragment
Find Spot: Khafiji (Khafajah) Mesopotamia
Date of Illustration: ca. 2600BC
Current Location: Oriental Institute, Chicago, No. A9275.
Description: Part of head of player blowing a single- coned tuba apparently part of a victory stela.
Citations: Rimmer, 1969, 30, Figure 7; Frankfort, 1939, Plate 100C

IC10 Single Cone Tuba on Relief
Find Spot: Palace of Sennacherib, Nineveh
Date of Illustration: Between 705 and 681 BC
Current Location: British Museum, West Asiatic Antiquities, No. 124820
Description: Two players, one holding single coned tuba other blowing same. Apparently signalling to men hauling a collossal bull.
Citations: Rimmer, 1969, 38, Figure 10; Layard, 1853, Plate 15; Behn, 1954, Abb. 37

IC11 Lituus and Cornu on Wall Painting
Find Spot: Tomb of the Monkey, Chiusi
Date of Illustration: 490-470BC
Current Location: Archaeological Museum, Florence
Description: A lituus carried by a figure in an Etruscan funeral scene.
Citations: Harrison, 1964, Figure 21; Wille, 1967

IC12 Tuba and Two Cornua on Mosaic
Find Spot: Zliten, Tripoli, Libya
Date of Illustration: lst Century AD
Description: Similar to IC 40. Two cornu and one tuba played to accompany a hydraulis heralding the victory in a gladiatorial combat.
Citations: Harrison, 1964, Figure 23

IC13 Carnyx on Frieze
Find Spot: Brague, France
Description Representation of a carnyx on a monument at Brague.
Citations Déchelette, 1927; Espérandieu, 1907

IC14 Carnyx on Frieze
Find Spot: Narbonne, France
Description: Representation of Carnyx on frieze at Narbonne.
Citations: Dechelette, 1927, 685; Esperandieu, 1907, VI

IC15 Carnyx on Carving
Find Spot: Nimes, France
Description: Representation of Carnyx on Altar at Nimes.
Citations: Déchelette, 1927, 685, Figure 496; Espérandieu, 1907

IC16 Cornua and Lituus on a Relief
Find Spot: Amiternum (Preturi), Italy
Date of Illustration: First Century BC
Current Location: Museo Nazionale, Aquila, Italy
Description: Two cornua and side blown lituus being played in Roman funeral procession.
Citations: Quasten, 1930, 202, Figure 31; Wille, 1967, 70; Strong, 1926, 36; Baines, 1976, Figure 6b; Ryberg, 1955, 36, Figure 19b, Plate IX; Masson, 1973, 166, Figure 125

IC17 Tuba on Relief
Find Spot: Rome
Description: Tuba player in procession in Cybele Cult.
Citations: Quasten, 1930, 56, Taf. 21;

IC18 Tuba Players on Bas Relief
Find Spot: Arch of Constantine
Date of Illustration: ca. 550 AD
Description: Two players blow parallel-bored tubae in Suovetaurilium. Instruments have large,oddly-shaped mouthpieces.
Citations: Quasten, 1930, Taf. 5; Strong, 1926, 251, Figure 156; Ryberg, 1955, 115, Figure 59, Plate XL

IC19 Tuba on Silver Dish
Find Spot: Kaiseraugst near Basel, Switzerland
Date of Illustration: 550/1AD
Current Location: Römermuseum, Augst, Switzerland
Description: Player blows slightly curved single-coned tuba with cord/wire from mouthpiece to bell. Dish made and signed by Pansylyppus of Thessalonika found in association with silver ingots marked with the stamp of Magnentius 350 to 353 AD.
Citations: Bacon, 1971, 28; Kent, 1977, 44, No. 80; Laur-Belart, 1967, 8

IC20 Horn
Description: A Sumerian horn cited by Galpin. No other information.
Citations: Galpin, 1957 (Sumerians), 21.

IC21 Horn on Silver Dish
Date of Illustration: 4th Century AD
Current Location: British Museum, Western Asiatic Antiquities, No. 124093
Description: Player blowing slightly-curved single-coned horn on border of large silver dish.
Citations: Galpin, 1937 (Sumerians), 22; Dalton, 1964, Plate XXXVIII, No. 208; Pope, 1938, Plate 239; Lukonin, 1967, 28, Figure 6

IC22 Cornu Nennig
Find Spot: Nennig near Trier, Germany
Description: Player holding cornu standing adjacent to hydraulis player. Cornu has cross piece with pointed decorative ends. Bell end has open hemispherical type bell.
Citations: Behn, 1954, Abb. 147;

IC23 Three Cornua on Limestone Relief
Find Spot: Round temple klissa in the Dobrudscha
Date of Illustration: 109 AD
Current Location: Museum of Antiquities, Bucharest, Romania
Description: Three Roman military cornu players blowing instruments on limestone relief. lnstruments have short bracing piece from mouthpipe to cross-brace.
Citations: Buchner, 1961, Figure 83; Kinsky, 1929, 20

IC24 "Lituus" Player on Bronze Situla
Date of Illustration: 5th to 4th Century BC
Description: Player blowing short conical up-curving instrument with rapidly opening-out bell.
Citations: Behn, 1954, 121

IC25 "Trumpet" on Relief
Find Spot: Bharahat, Central India
Date of Illustration: 2nd Century BC
Description: Reliefs on Stupa or mound at Bharahat showing musicians.
Citations: Sachs, 1940, 156; Dubois, 1937, 38, Plate XIV, no. 3

IC26 Carnyx on Triumphal Arch
Find Spot: Hadrian triumphal arch
Date of Illustration: 115 AD
Description: Celtic carnyx carved on triumphal arch.
Citations: Sachs, 1940, 146.

IC27 Proto-Carnyx on Relief
Find Spot: Temple of Sanchi, Central India
Date of Illustration: lst Century AD
Description: Two "Non-lndian" men playing verticaly-held instruments of similar form to the carnyx but lacking ears.
Citations: Sachs, 1940, 157; Dubois, 1937, 39, pi. XIV, No. 4

IC28 Tuba Player on Relief
Date of Illustration: 176 AD
Current Location: Palazzo dei Conservatori, Rome
Description: Tuba blown by player in vertical position during the triumph of Marcus Aurelius
Citations: Jones, 1926, 25, Plate 12; Mommsen, 1955, 253; Strong, 1926, 254, Figure 162

IC29 Tuba on Sarcophagus
Current Location: Museo Capitolino, Rome
Description: Greek blowing trumpet in battle with Amazons.
Citations: Jones, 1912;

IC30 Carnyx on Coin
Description: Illustration on a Celtic coin with the legend DUBNOCOV - DVBNOREIX showing Celtic warrior carrying a carnyx held vertically.
Citations: Déchelette, 1927, 649; Behn, 1954, Abb. 190

IC31 Trumpet on Fresco
Find Spot: Mampsis, the Negev, Israel
Date of lllustration: Early 3rd Century AD
Description: Trumpeter found on Fresco in large Nabatean house. Part containing trumpet subsequently damaged.
Citations: Bacon, 1971, 173

IC32 Shell Trumpet on Gravestone
Find Spot: Bonn, Germany
Date of Illustration: End 1st, beginning 2nd Century AD
Current Location: Museum in Bonn, Inv. N0. 30576
Description Triton blowing a shell trumpet (Schneckenhorn) on a gravestone found in Bonn.
Citations: Klar, 1971, 323; Wille, 1967, 555; Fleischhauer, 1960, 128

IC33 Hebrew Trumpets on Coin
Find Spot: Bar Kochba, Israel
Description: Illustration of two Hebrew trumpets (chatzotzerot) on Hebrew coins from Bar Kochba. Instruments have appearance of single coned form plus mouthpiece.
Citations: Behn, 1954, Abb. 81; Hill, 1914, 41; Wulstan, 1975, 41

IC34 Horn on Silver Plate

Description: Illustration of horn player blowing animal form horn;
Citations Behn, 1954, 76, Abb. 103

IC35 Trumpet Player on Stone Carving
Find Spot: Tak-l-Bostan 1
Description: Sassanian carving of trumpet player blowing slightly up-curving instrument with wide bell (broadly similar to Celtic lituus.)
Citations: Behn, 1954, 77, Abb. 107

IC36 Trumpet on Stone Carving
Find Spot: Kivik, Sweden
Description: Carving of conical item with flared end generally interpreted as a trumpet carved on stone in Bronze-Age cist at Kivik.
Citations: Behn, 1954, Abb. 7;

IC37 Tuba ? on Coin
Find Spot: Simleul Silvaniel, Transylvania, Romania
Current Location: Kunsthistorisches Museum, Vienna
Description: lllustration of torch or tuba on coin of valens (364-378AD)

IC38 Hittite Trumpet on Wall Carving
Find Spot: Hittite royal palace at Ujuk
Date of Illustration: Beginning of lst Millenium BC
Current Location: Ottoman Museum, Istanbul
Description: Trumpeter blowing short trumpet into air.
Citations: Kinsky, 1929, Plate 4

IC39 Tuba on Marble Relief
Find Spot: Ephesus
Date of Illustration: 165 AD
Current Location: Kunsthistorisches Museum, Vienna
Description: Sacrificial scene with tuba player blowing instrument to rear of panel on a marble relief from a monument to the emperor Marcus Aurelius.
Citations: Kinsky, 1929, 18, N0. 4

IC40 Two Cornua and Tuba on Mosaic
Find Spot: Zliten, Tripoli, Libya
Date of Illustration: Possibly 3rd Century AD
Description Mosaic pavement of a Roman villa depicting two cornua and a tuba being played at a gladiatorial combat, accompanied by a hydraulis. Similar to IC12.
Citations Kinsky, 1929, 20, No. l

IC41 Tuba Players on Marble Relief
Find Spot: Glypothek, Munich, Germany
Date of Illustration: 50 AD
Description: Tuba players heralding the end of a gladiatorial combat
Citations: Kinsky, 1929, 20; Masson, 1973, 126, Figure 100;

IC42 Carnyx on Coin
Date of lllustration: Between 118 and 92 BC
Current Location: British Museum
Description: Warrior in chariot carrying spear and shield with carnyx in background on Denarius signed by Scaurus. Warrior said to be Bituitus, ruler of the Arverni.
Citations: B.M. Cat. Coins Roman Repub. l, 184,
No. 1185; Num. Chron., 1924, 31; 1941, 120

IC43 Carnyx on Coin
Description: Mounted rider carrying carnyx in right hand and unarmed holds instrument by the middle and brandishes it over his head while galloping, on coin of Tasciovanus. Minted at Verulam.
Citations: Allen, 1958, 44, Plate 1, N0. 1; Evans, 1864, 247, Plate 6, N0. 11

IC44 Carnyx on Coin
Description: Rider carrying carnyx in right hand and unarmed holds it by the middle and brandishes it over his head while galloping. 0n coin of Tasciovanus or Cunobelinus.
Citations: Allen, 1958, 44, Plate 1, N0. 2;

IC45 Carnyx on Coin
Description: As IC 44
Citations: Allen, 1958, 44, Plate 1, N0. 3

IC46 Carnyx on Coin
Description: Rider on horse with carnyx over right shoulder on coin of Cunobelinus.
Citations: Allen, 1958, 45, Plate 1, No. 5

IC47 Carnyx on Coin
Description: Rider on horse, unarmed, with carnyx over right shoulder, on coin of Eppillus.
Citations: Allen, 1958, 44, Plate 1, No. 5; Evans, 1864, 191, Plate 3, No. 11

IC48 Carnyx on Coin
Description: Rider on horse carrying carnyx, on coin of Eppillus,
Citations: Allen, 1958, 44, Plate l, No. 6

IC49 Carnyx on Cauldron
Find Spot: Gundestrup, Denmark
Current Location: National Museum of Denmark, Copenhagen
Description: lllustration of three players blowing carnyces held vertically above head, on one of silver pannels of large cauldron.
Citations: Bohn, 1954, Abb. 192;

IC50 Tuba on Tombstone
Find Spot: Carnuntum
Description: Tuba player on tombstone with both tuba and staff of office.
Citations: Liversidge, 1971, 361;

IC51 Trumpeter on Wall Painting
Find Spot: Thebes
Date of Illustration: 18th dynasty (1505 - 1484 BC)
Current Location: Temple of Deir El-Bahari
Description: Trumpet player with group of soldiers, one of whom plays a hand drum, said by Hickmann to be first datable representation of a trumpet in Egypt.
Citations: Hickmann, 1946, 3, Figure 1; Naville, 1908;

IC52 Trumpet on Wall Painting
Find Spot: Tomb No. 74 at Thebes
Date of Illustration: Time of Thoutmes IV
Description: Player carrying trumpet over right shoulder.
Citations: Hickmann, 1946, No. 2, Figure 2; Hickmann, 1961, 74, Abb. 44

IC53 Trumpet on Wall Painting
Find Spot: Tomb No. 90 at Thebes
Date of Illustration: 1496 — 1350BC
Description: Trumpeter blowing instrument in front of a column of soldiers.
Citations: Hickmann, 1946, No. 3, Figure 3; Hickmann, 1961, 74, Abb. 43

IC54 Trumpet on Wall Painting
Find Spot: Tomb of Ahmos, el-Amarna (Tomb 4)
Date of Illustration: 1580-1555 BC I
Description: Trumpeter blowing instrument ahead of four columns of soldiers,
Citations: Hickmann, 1946, No. 4, Figure 4

IC55 Trumpet on Wall Painting
Find Spot: Tomb of Huya, el-Amarna (Tomb 1)
Date of Illustration: ca. 1330BC l
Description: Two trumpeters, one kneeling, with trumpet in hand, other standing and blowing instrument during triumphal march.
Citations: Hickmann, 1946, No. 5, Figure 5

IC56 Trumpeters on Wall Painting
Find Spot: Tomb of Haremheb
Date of Illustration: Time of Thoutmes IV, between 1309 and 1308 BC
Description: Trumpeter blowing instrument ahead of group of soldiers.
Citations: Hickmann, 1946, NO. 6, Figure 6

IC57 Trumpeter on Wall Painting
Find Spot: Tomb of Haremheb
Date of Illustration: Time of Thoutmes IV
Description: Trumpeter blowing instrument behind a group of Nubians.
Citations: Hickmann, 1946, No. 7, Figure 7

IC58 Trumpeter on Wall Painting
Find Spot: Temple at Luxor, Scene 191 and 192
Description: Trumpeter blowing instrument alongside
group clapping hands,
Citations: Hickmann, 1946, No. 8, Figure 8; Hickmann, 1961, 122, Abb. 90

IC59 Trumpeter on Wall Painting
Find Spot: Temple of Luxor, Scene 199 and 200
Description: Player blowing trumpet along with a group of soldiers returning to Karnak.
Citations: Hickmann, 1946, N0. 8b, Figure 9

IC60 Trumpeter on Wall Painting
Description: Trumpeter following a group of soldiers blowing instruments, carrying instrument or wooden stopper under left arm. Detail from the battle of Qadech.
Citations: Hickmann, 1946, No. 9, Figure 10

IC61 Trumpeter on Wall Painting
Find Spot: Abu Simbel
Date of Illustration: ca. 1286 BC I
Description: Trumpeter,following group of soldiers blowing instrument.
Citations: Hickmann, 1946, N0. 10, Figure 11

IC62 Trumpeter on Wall Painting
Find Spot: Temple of Rameses II
Date of Illustration: ca, 1286 BC
Description: Trumpeter blowing instrument ahead of group of soldiers.
Citations: Hickmann, 1946, No. 11, Figure 12

IC63 Trumpeters on Wall Painting
Date of Illustration: 1182-1151 BC
Description: Two trumpeters, one bending over with trumpet in left hand, other upright blowing trumpet, with trumpet ? or stopper under left arm.
Citations: Mickmann, 1946, No. 12a, Figure 13

IC64 Trumpeter on Wall Painting
Date of Illustration: 1200-1090BC
Description: Two trumpeters, one bending forward with trumpet ? in hand, other standing up-right to rear and blowing trumpet.
Citations: Hickmann, 1946, No. 12b, Figure 14

IC65 Trumpeter on Wall Painting
Date of Illustration: 1200-1090BC
Description: Trumpeter blowing trumpet ahead of group of soldiers. Possible second trumpet or stopper under right arm.
Citations: Hickmann, 1946, N0. 11c, Figure 15

IC66 Trumpeter on Wall Painting
Date of Illustration: 1182-1151 BC
Description Trumpeter blowing trumpet during an assault on the town of Tunip.
Citations: Hickmann, 1946, No. 11d, Figure 16

IC67 Trumpeter on Wall Painting
Date of Illustration: 1182-1151 BC
Description: Two trumpeters, one bending down holding trumpet in left hand, behind him second trumpeter blows instrument, holds stopper ? under left arm. Scene depicts inspection of his horses by Rameses III.
Citations: Hickmann, 1946, No. 11e, Figure 17

IC68 Trumpeter on Wall Painting
Date of Illustration: 1182-1151 BC
Description: Trumpeter blowing instrument with a large number of soldiers. Scene depicts first Libyan war of Rameses lll.
Citations: Hickmann, 1946, No. llf, Figure 18

IC69 Trumpeter and Hand Drummer on Wall Painting
Find Spot: Thebes
Date of Illustration: 1182-1151 BC
Description Trumpeter blowing instrument with a group of other musicians playing hand drums and castagnets.
Citations: Hickmann, 1946, No. 13, Figure 19; Behn, 1954, Abb. 65

IC70 Archer Blowing Salpinx on Plate
Find Spot: Vulci
Date of Illustration: 6th Century BC
Current Location: British Museum, N0. B591
Description: Archer carrying bow and quiver blowing trumpet through a phorbeia. Trumpet is narrow bored with bulbous bell.
Citations: Smith,1929 , Plate 4; Harrison, 1964, Plate 21

IC71 Lituus and Cornu on Gravestone
Find Spot: Capitolino Hill, Rome
Current Location: Lost
Description: Gravestone of M. Iulius Victor ex collegio liticinum cornicinum depicts M.I.V. standing holding lituus andcornu. Original stone lost, present depiction from 17thcentury illustration.
Citations: Baines, 1976, 61, rig. 6a

IC72 Tuba on Wall Painting
Description: Tuba player blowing instrument. Head and mouthpiece part of instrument damaged.
Citations: Behn, 1954, 131, Abb. 164

IC73 Cornua and Litui on Wall Painting
Find Spot: Tomba Tarquiniesi
Date of Illustration: 4th Century BC
Description: Group of figures on Etruscan wall painting.Two of these carry cornua over left shoulder, instruments of archaic form, one clearly showing flattish mouthpiece. Two other figures carry long lituus·shaped objects over left shoulder. These lack visiblemouthpieces but terminate in a pointed end.
Citations: Behn, 1954, Abb. 165; Ducati, 1977, 533, Tav. 259, No. 632

IC74 Salpinx on Black Figure Vase
Date of Illustration: 525-500BC
Current Location: British Museum, No. B590
Description: Greek salpinx player blowing salpinx pointing into air on black figure vase. Said by Beazley to be painted by Psiaz.
Citations: Boardman, 1975, 106, No. 169; Behn, 1954, 117, Abb. 151

IC75 Salpinx on Greek Vase
Find Spot: Vulci
Date of Illustration: ca. 510BC
Current Location: Munich, Antikensammlungen, No. 2423
Description: Greek Salpinx player in group of three figures blowing narrow bored salpinx pointing downwards on a Hydria signed by Hypsis-Amazons.
Citations: Behn, 1954, Abb, 152; Boardman, 1975, 35, No. 43; Beazley, 1956, 30, 1

IC76 Trumpet and Horn on Vase
Description: Two figures, one blowing gently curving single coned tuba instrument, other blowing highly curved animal form horn on a "Unteritalischen Vase."
Citations: Benn, 1954, Abb. 153

IC77 Cornu and Tuba
Date of lllustration: 110 AD
Current Location: Museo Civilta Romana, Rome
Description: Horn players and trumpeters in an illustration of the triumphant army of Trajan.
Citations: Fleischhauer, 1960, Abb. 1

IC78 Celtic Lituus, Tuba and Highly Curved Horn on Roman Standard
Find Spot: Kastell Niederbieber, Germany
Date of Illustration: 211-217 AD
Current Location: Uriginal in collection of Furst zu Wied. Copy in Kreismuseum Neuwied
Description: lllustration of Caracalla subjugating the lands of the Rhine. Shows Celtic and Germanic trophies which include a Celtic
Lituus, a Celtic tuba and a Celtic highly curved horn.
Citations: Dorow, 1827, 67, Tafel 15

IC79 Horn on Sarcophagps Relief
Find Spot: Via Bocca di Leone 17, Rome
Description: Illustration of youthful Triton blowing a shell trumpet.
Citations: Fleischhauer, 1960, 503, Abb. 2

IC80 Carnyx on Frieze
Find Spot: Pergamon
Description: Item generally interpreted as carnyx with very elaborate bull head, depicted behind shields on a frieze in Pergamon.
Citations: Behn, 1954, Abb. 97;

IC81 Lituus and Cornu
Find Spot: Caere
Date of lllustration: 4th/5th Century BC
Current Location: Museo Etrusco Gregoriano, Rome
Description: Four musicians, at the head a cornu player followed by a lituus player and two others with Kithara and Tibia.
Citations: Fleischhauer, 1960, 501; Herbig, 1952, 46, Taf. 1, No. 83, Taf. 108, No. C.83; Giglioli, 1935, 44, Tav. CCXLI

IC82 Instruments ? on Urn
Current: Location Museum in Volterra
Description: Procession of Etruscan magistrates depicted on an urn apparently with accompanying instrumentalists.
Citations: Fleischhauer, 1960, 501; Korte, 1916, 102; Nogara, 1933, 238

IC83 Instruments ? on Urn
Current Location: Museo Archeol. in Florence, Inv. No. 5513
Description: Etruscan instruments depicted on urn.
Citations: Fleischhauer, 1960, 501; Korte, 1916, 102; Nogara, 1933, 238

IC84 Cornua on Urn
Current Location: Museo di Volterra, Urn No. 169
Description: Two cornu players leading procession along with two others with objects over left shoulder (possibly instruments). Scene depicts a funeral cortege in the form of a triumphal procession. On an alabaster urn.
Citations: Fleischhauer, 1960, 501; Korte, 1916, 102; Nogara, 1933, 238, Figure 129

IC85 Carnyx on Coin
Description: Coin with head facing right and vertical carnyx behind this.
Citations: Behn, 1954, Abb. 190, No. 1

IC86 Carnyx on Coin
Description: Head facing right,behind this vertical carnyx.
Citations: Behn, 1954, Abb. 190, No, 2

IC87 Carnyx on Coin
Description: Mounted horseman facing right carrying carnyx with hooked bell over right shoulder.
Citations: Behn, 1954, Abb. 190, No. 4

IC88 Carnyx and Tuba on Carving
Find Spot: Trajan's Column
Description: Well illustrated carnyx with animal head and gaping mouth with other trophies on Trajan's column. Beneath this what appears to be representation of tuba.
Citations: Behn, 1954, Abb. 187

IC89 Cornu on Wall Painting
Find Spot: Amphitheatre at Herculaneum
Date of Illustration: Prior to 79 AD
Description: Illustration of Cornu player holding large cornu over right shoulder standing alongside other figure. Said to be preparations for a gladiatorial contest.
Citations: Collaer, 1968, 28, No. 117

IC90 Salpinx Players on Frieze
Find Spot: Tomb at Kazanlik, Bulgaria
Date of Illustration: ca. 280BC
Description: Two trumpeters blowing Salpinges on frieze showing scene of Thracian funeral.
Citations: Zhivkova, 1975; Venedikov, 1974

IC91 Trumpet on Wall Painting
Find Spot: Tomb at Thebes
Description: Illustration of two Egyptian trumpeters at Thebes.
Citations: Kirby, 1947, 37

IC92 Cornu and Tuba
Date of Illustration: Either 251-253 AD or 268-270 AD
Current Location: Thermen Museum, Rome, Collezione Ludovisi Description Battle scene on sarcophagus at top right hand corner cornu player blowing instrument, top left hand corner tuba player blowing instrument.
Citations: Mommsen, 1955, 128; Strong, 1926, 326, Figure 200; Aurigemma, 1954, 101, Tav. LXXIV No. 239

IC93 Cornu and Tuba
Description: Most probably same illustration as IC 92.
Citations: Fleischhauer, 1960, 503;

IC94 Trumpet on Amphora-Rhyton
Find Spot: Lukovet, Bulgaria
Date of Illustration: 4th to 3rd century BC
Description: Representation of a trumpeter on a Thracian Amphora-Rhyton.
Citations: None known

IC 95 Salpinx on eye-Cup
Date of Illustration: 527-514 BC
Description Archer blowing salpinx on an eye cup by the Andokides Painter.
Citations: Boardman, 1975, 105, 115, No. 160, 1 and 2

IC96 Horn on Black Figure Cup
Find Spot: Nola
Date of Illustration: 575 - 555 BC
Current Location: British Museum, No. B382
Description Animal shaped horns with definable mouthpieces hanging on a wall in a scene on a cup. Painted by the C painter of the Siana cup painter school.
Citations: Boardman, 1975, No. 36; Beazley, 1956, 51, No. 5

IC97 Salpinx on Cup
Date of Illustration: 520-490BC
Current Location: British Museum, No. E5
Description Illustration of a Satyr blowing a Salpinx on an Athenian Red-figure cup signed by Epiktetos H.
Citations: Boardman, 1975, 57, No. 66; Beazley, 1963,70, N0. 3

IC98 Triton on Cup
Find Spot: Vulci
Date of Illustration: Before 510BC
Current Location: Castle Ashby
Description Player armed with spear blowing shell trumpet on cup by the Nikosthenes painter.
Citations: Boardman, 1975, 60, N0. 93, 1; Beazley, 1963. 124, no. 7

IC99 Lituus and Tuba on Stele
Find Spot: Vele Cecina
Date of Illustration: Probably 5th century BC
Description: Several instrument players on rather worn stone, lituus player on top reasonably clear, players on bottom probably tuba players.
Citations: Ducati, 1927, 356, Tav. 155, No. 403

IC100 Animal Horn on Sarcophagus?
Description: Horn player with animal horn instrument in a procession.
Citations: Ducati, 1927, 552, Tav. 275, No. 664

IC101 Triton on Fresco
Find Spot: Glypothec, Monaco
Description: Illustration of a player blowing a Triton shell at the marriage of Posidone e Anfitrite.
Citations: Strong, 1926, 10, Figure 5

IC102 Tuba on Frieze
Current Location: Budapest Museum
Description: Fragment of a carving showing a tuba player with several other figures, one of whom is playing a lyre. Part of a frieze commemorating the battle of Azio.
Citations: Strong, 1926, 14, Figure 7; Ammelung, 1903, 65, No. 22

IC103 Cornua on Carving
Find Spot: Arch of Constantine
Date of Illustration: ca. 80 AD
Description: Three,or possibly four,cornu players playing in a battle scene on the Arch of Constantine.
Citations: Strong, 1926, Figure 90

IC104 Cornua on Carving
Find Spot: Trajan's Column, Scene 5
Description: Two cornu players at rear of scene on Trajan's column. Instruments have extended cross-braces with lunate end-pieces.
Citations: Strong, 1926, 159, Figure 98; Behn, 1954, Abb. 177; Lehmann-Hartleben, 1926, Taf. 26

IC105 Cornu and Tuba
Find Spot: Trajan's Colunm
Date of Illustration: ca. 110 AD
Description: Cornu player blowing instrument behind tuba player blowing a very short instrument, probably rest of instrument having broken off.
Citations: Strong, 1926, 178, Figure 105; Ryberg, 1955, 111, Figure 57, Plate XXXVIII

IC106 Cornua
Find Spot Column of Marcus Aurelius 5
Date of Illustration: 169-172AD
Description: Two cornu players at rear of group of soldiers crossing bridge.
Citations: Strong, 1926, 267, Figure 168

IC107 Tuba ? on Carving
Find Spot: Arch of Constantine
Description: Tuba player on battle scene on Arch of Constantine.
Citations Strong, 1926, 144, Figure 89

IC108 Cornua and Tubae
Find Spot: Trajan's Column
Date of Illustration: Before 110 AD
Description: Three cornu players and three tuba players playing during the preparations for a sacrifice.
Citations: Strong, 1926, 161, Figure 99; Rybcrg, 1955, 109, Figure 55, Plate XXXVI; Lehmann-Hartleben, 1926, Plate VII

IC109 Carnyces on Carving
Find Spot: Triumphal Arch at Orange
Date of Illustration: 197-159BC
Description: Carnyces depicted among other trophies on triumphal arch. Instruments generally grouped in threes.
Citations: Powell, 1948, 267, Figure 50

IC110 Tuba on Carving
Find Spot: Arch of Constantine
Date of Illustration: 306-350AD
Description: Tuba player blowing short instrument in battle scene.
Citations: Strong, 1926, 336, fig, 206

IC111 Carnyces on Sarcophagus
Find Spot: Room & of baths of Diocletion, Rome
Date of Illustration: Last quarter of 2nd Century AD
Description: Carnyces displayed as trophies on right of battle scene.
Citations: Aurigemma, 1954, 26, Tav. XV

IC112 Tuba on Sarcophagus
Find Spot: Room 6 of baths of Diocletion, Rome
Date of Illustration: ca. 200 AD
Description Tuba player blowing short instrument in battle scene on sarcophagus.
Citations: Aurigemma, 1954, 37, Tav. XVII

IC113 Tuba on Sarcophagus
Description: Tuba player blowing instrument to rear of scene with Achilles and Licomedes.
Citations: Aurigemma, 1954, 37, Tav. XVII

IC114 Tuba ? on Sarcophagus
Find Spot: Toscania
Current Location: Museo Vat. Etrusco
Description: Etruscan procession with two figures carrying ? tubae. These could be carrying fasces and not tubae.
Citations: Nogara, 1933, 66, Figure 27; Herbig, 1952, 45, Taf. 43, No. 81

IC115 Cornu on Sarcophagus
Find Spot: Vulci
Current Location: Boston Museum
Description: Cornu player carrying instrument over right shoulder, among group of figures on Etruscan sarcophagus.
Citations: Nogara, 1933, 89, Figure 41; Herbig, 1952, 13, Taf. 40b and c, No. 5

IC116 Cornu on Wall Painting
Find Spot: Tomba di Tarquinia detta del Tifone
Description: Fragment of wall painting with small portion of cornu remaining.
Citations: Nogara, 1933, 232, Figure 123

IC117 Lituus on Cist
Find Spot: Praeneste (Palestrina)
Date of Illustration: 5rd Century BC
Current Location: Museum in Berlin
Description: Lituus held over right shoulder of soldier. Incised on bronze cist.
Citations: Giglioli, 1935, 54, Tav. CCXCIV and CCXCIII; Ryberg, 1955, 20, Figure 13, Plate vi

IC118 Lituus/Tuba ? on Carving
Find Spot: Rome
Date of Illustration: Late republican, probably ca. 50BC
Current Location: Capitoline Museum, Rome
Description: Procession with two players blowing instruments, probably both tubae (Professor Ryberg says Litui) taking part in triumphal procession, depicted on Travertine fragments.
Citations: Ryberg, 1955, 36, Figure 19a

IC119 Tubae on Relief
Find Spot: Palazzo Cancelleria
Date of Illustration: ca. 50 AD
Description: Relief showing sacrificial scene with three tuba players blowing instruments into the air. One of instruments is shorter, possibly artistic licence.
Citations: Ryberg, 1955, 75, Figure 37a, Plate XXIII

IC120 Cornua and Tubae on Frieze
Find Spot: Tomb of the Servir C. Lusius Storax in Chieti
Date of Illustration: 50-74 AD
Current Location: Museo Nazionale, Rome ,
Description: Three cornu players on right and three tuba players on left blowing instrument upwards on scene from the Ludi of a Servir. 0n pediment of a tomb.
Citations: Ryberg, 1955, 98, Figure 47, Plate XXXI

IC121 Tuba on Relief
Find Spot: Amiternum
Date of Illustration: Early Flavian period, ca. 74 AD
Current Location: Museo Nazionale, Rome
Description: Tuba player blowing very long straight instrument held pointing downwards in a scene depicting a pomper and the ludi.
Citations: Ryberg, 1955, 99, Figure 48b, Plate XXXII

IC122 Lituus on Relief
Find Spot: Isernia
Description: Poor illustration of a lituus on a relief of the Suovetaurilia.
Citations: Ryberg, 1955, 35, Figure 18

IC125 Tuba on Relief
Find Spot: Necropolis Marritima, Pompeii
Date of Illustration: Before 79 AD
Description: Three tuba players in a procession on a relief from the Necropolis Marritima, Pompeii.
Citations: Ryberg, 1955, 101, Figure 50a.

IC124 Cornua and Tubae on Relief
Find Spot: Arch of Susa
Date of Illustration: 9 or 8 BC
Description Two cornu and two tuba players taking part in Suovetaurilia commemorating treaty with the Gauls.
Citations: Ryberg, 1955, 104, fig, 52a and c, Plate XXXIV

IC125 Tubae on Relief
Find Spot: Trajan's column, scene LIII
Date of Illustration: Before 110 AD
Description: Group of three tuba players on Trajan's Column in scene depicting Lustration of the camp.
Citations: Ryberg, 1955, 111, Figure 56, Plate XXXVII; Lehmann-Hartleben, 1926, Taf. 26;

IC126 Cornu on Relief
Find Spot: Column of Marcus Aurelius
Date of Illustration: 161-181AD
Description: Cornu player with instrument over right shoulder standing with group of other troups.
Citations: Ryberg, 1955, 114, Figure 58, Plate XXXIX

IC127 Tuba on Relief
Find Spot: Temple of Appollo, Rome
Date of Illustration: ca. 54 BC
Current Location: Museo dei Conservatori Rome
Description: A single tuba player blowing instrument which is slightly obscured by one attendant about to lift a ferculum carrying two captives.
Citations: Ryberg, 1955, 144, Figure 78, a, b, c, d; Masson, 1975, 125, fig, 99

IC128 Cornua on Relief
Find Spot: Trajan's column, scene C11
Date of Illustration: Before 110 AD
Description: Heads and instrument of two cornu players in scene representing arrival of Trajun at a Roman fortified outpost north of the
Danube. Probably during winter of 105-106 AD.
Citations: Ryberg, 1955, 125, Figure 65, Plate XLII1; Lehmann-Hartleben, Taf. 47

IC129 Tuba on Relief
Find Spot: Ephesus
Date of Illustration: Probably ca. 133 AD
Current Location: Kunsthistorisches Museum Vienna
Description: A single tuba player blowing an instrument at a sacrifice with tibia player slightly in front. Probably a vota publica on a scene from one of the ensemble of Antonine reliefs found at Ephesus.
Citations: Ryberg, 1955, 133, Figure 72b

IC130 Conch Shell on Sarcophagus
Find Spot: Tarquinia
Description: Etruscan warrior blowing conch shell in battle scene on a sarcophagus from Tarquinia.
Citations: Herbig, 1952, 62, Taf. 27, No. 119

IC131 Tuba on Sarcophagus
Find Spot: Tarquinia
Current Location: Florence
Description Tuba player on left in battle scene on Etruscan sarcophagus from Tarquinia.
Citations: Herbig, 1952, 26, Taf. 43b, N0. 26

IC132 Tuba on Sarcophagus
Find Spot: Viterbo
Description: Tuba player in battle scene on Etruscan sarcophagus from Viterbo.
Citations: Herbig, 1952. 76, Taf. 57c and 58c, No. 196

IC133 Cornu on Sarcophagus
Current: Location British Museum
Description: Cornu player with instrument over shoulder on Etruscan sarcophagus.

IC134 Cornu Player on Sarcophagus
Find Spot: Vulci
Description: Two cornu players in procession on Etruscan sarcophagus.
Citations: Herbig, 1952, 39, Figure 71b, Taf. 109b

IC135 Cornua on Wall Carving
Find Spot: Tomba dei Relievi in Caere
Date of Illustration: 3rd Century BC
Description Two cornua of archaic form carved on either side of doorway in tomba dei relievi.
Citations: Giglioli, 1935, Tav. CCCXLI

IC136 Tuba on Sarcophagus
Find Spot: Tarquinia
Current Location: Mus. Arch. Firenze
Description: Single tuba player on left of battle scene on Etruscan sarcophagus.
Citations: Giglioli, 1935, 67, Tav. CCCLI

IC137 Cornu on Wall Painting
Find Spot: Tomba del Tifone
Description: Badly damaged Etruscan painting showing two cornu players in a group of other people.
Citations: Giglioli, 1935, 72, Tav. CCCLXXXIX

IC138 Carnyx on Coin
Date of Illustration: 54-44 BC q
Current Location: British Museum
Description: Trophies displayed above Gaulish captive. On right above him is vertical carnyx. Reverse has inscription Caesar.
Citations: Powell, 1948, 256, Figure 5b; Masson, 1973, 145, Figure 110

IC139 Carnyx on Coin
Date of Illustration: 279-168BC
Current Location: British Museum
Description: Tetradrachm of Aetolia, Reverse represents Aetolia seated on a pile of Celtic and Macedonian shields. At her feet lies a carnyx with bell mouth pointing upwards.
Citations: Powell, 1948, 265, Figure 47; British Museum, Principal coins of the Greeks, Plate 36, No. 14

IC140 Trumpeter on Wall Painting
Find Spot: Marisa,Israel
Date of Illustration: 2nd Century BC
Description: Trumpeter blowing long single coned tuba in hunting scene. On wall painting in tomb at Marisa.
Citations: Peters & Thiersch, 1904, 60

IC141 Carnyx on Coin
Date of Illustration: 112-109BC
Description Warrior on chariot with carnyx held vertically in one hand and spear in other.
Citations: Piggott, 1952; Powell, 1948, 266, Figure 47b

IC142 Double Curved Tuba on Gravestone
Find Spot: Bonn,Germany
Current Location: Bonn
Description Realistic carving of a double curved instrument somewhat similar in form to a modern trombone. Has protective spike on protruding curve of instrument.
Citations: Behn, 1954, Abb. 179; Klar, 1971, Abb. 8

IC143 Cornu on Gravestone
Find Spot: Mantua
Description: Cornu held in left hand of figure with mouthpiece/mouthpipe in right hand, standing on gravestone of Coponius Felicio.
Citations: Behn, 1954, 139, Abb. 176

IC144 Tuba on Gravestone
Description Highly conical long tuba held by figure on gravestone from Chersones.
Citations: Behn, 1954, Abb. 172

IC145 Horn on Bronze Plate
Find Spot: Temple of Barateka, Este, Italy
Date of Illustration: Pre-Roman
Description: Horn blown by warrior carrying shield on bronze plate from Este.
Citations: Behn, 1954, 129, Abb. 167

IC146 Horn on Wall Painting
Find Spot: Sardinia
Date of Illustration: Pre-Roman
Description: horn blown by man on wall painting.
Citations: Behn, 1954

IC147 Horn on Dish
Description: Horn illustrated on Sassanian dish.
Citations: Behn, 1954, 77

IC148 Horn on Frieze
Find Spot: Narbonne T
Description: Horn illustrated on frieze at Narbonne apparently similar to those of "dying Gaul" (SR 16) and Celtic curved horn from Niece
(SD223)
Citations: Behn, 1954, 143

IC149 Shofar on Marble Slab
Find Spot: Necropolis at Beth She'arim, Israel
Date of Illustration: Probably about 200 AD
Description: Illustration of shofar among temple
objects in a necropolis at Beth She'arim, Shows shofar alongside an assemblage of Jewish emblems representing ritual objects and containing a Greek epigram.
Citations: Archaeological Discoveries in the Holy Land. 1968, 182

IC150 Horn on Frieze
Find Spot: Osuna
Date of Illustration: ca. 60AD
Current Location: Museo Arqueologico Nacional, Madrid
Description: Illustration of a young mounted rider holding a horn on a frieze from Osuna in Caesar's province of Further Spain.
Citations: Masson, 1973, 134, Figure 105;

IC151 Horn on Mosaic
Find Spot: Palazzo Baronale Palestrina
Date of Illustration: lst Century AD
Description: Player blowing large curved animal horn with prominent bell disc, ahead of a file of soldiers standing in front of a temple by the Nile, probably at Memphis.
Citations: Masson, 1973, 177, Figure 123

IC152 Trumpet on Relief
Find Spot: Grave of the Kegemni, Saqqara, Egypt
Date of Illustration: ca. 2500BC
Description Scene showing boat in a sacrificial procession crossing the Nile top of which is damaged. Trumpeter blowing instrument but only bell end of this visible. Said by Hickmann to be the earliest Egyptian illustration of a trumpet.
Citations: Hickmann, 1961, 40, Abb. 18

IC153 Tuba
Date of Illustration: lst Century AD
Current Location: Vatican Museum
Description: Tuba player in state sacrificial procession.
Citations: Baines, 1976, 55

IC154 Chatzotzerah on Mural
Find Spot: Synagogue of Dura-Europos
Date of Ilustration:. ca. 250AD
Current Location National Museum, Damascus
Description Illustration of chatzotzerah being blown in mural on synagogue of Dura-Europos.
Citations: Baines, 1976, 55, Figure 5f

IC155 Tuba on Stele
Date of Illustration: ca. 2500BC
Description: Scene on Stele showing soldier carrying long single cone tuba and Naram-Sin, King of Accad. Instrument has long slim form with slightly flared bell.
Citations: Gonen, 1975, 50;

IC156 Horn on Carving
Date of Illustration: Possibly ca. 700BC
Description: Illustration of a soldier blowing an animal shaped horn during a siege by Sargon, King of Assyria.
Citations: Gonen, 1975, 32;

IC157 Horn on Relief
Current Location: Copenhagen Museum
Description: Relief showing seated figure blowing animal shaped horn on upper part of frieze on Casali-Sarcophagus.
Citations: Mommsen, 1955, 344

IC158 Cornu on Gravestone
Find Spot: Via Salaria, Rome
Current Location: Gallaria Lapidaria, 1370, Vatican Museum
Description: Illustration of cornicen M. Antonius
Ianuarius ex. coh. Vll. Shows player blowing cornu.
Citations: Ammelung, 1903, 269, Taf. 28

IC159 Shofar on Carving
Find Spot: Synagogue at Capernaum
Date of Illustration: lst Century AD I
Description: Representation of a shofar on the capital of a synagogue at Capernaum.
Citations: Wulstan, 1973, 29

IC160 Cornu on Gravestone
Find Spot: Grumentum
Description: Cornu on gravestone of cornicen.
Citations: Fleischhauer, 1960, 502;

IC161 Salpinx on Onos
Description: lllustration of an archer blowing a salpinx pointing downwards on Onos in Eleusis 907 by the Sappho painter.
Citations: Haspels, 1936, 104, Plate 34, 1b

IC162 Salpinx on White Ground Oinochoai
Current Location: British Museum No. B629
Description Salpinx player on Oinochoai from the workshop of the Athena Painter.
Citations: None known.

IC163 Trumpet on Wall Painting
Find Spot: Thebes
Description: Trumpet player on Egyptian wall painting blowing instrument facing two groups of soldiers one above the other. Lower rank has hand axes and shields upper rank has bows.
Citations: Hickmann, 1945, No. 15, Figure 21

IC164 Trumpet on Wall Painting
Date of lllustration: 212AD
Description: Trumpet player holding instrument standing in front of Osiris.
Citations: Hickmann, 1946, No. 16, Figure 22

IC165 Trumpet on Clay lmpression
Find Spot: Northern Temple Nubia, Egypt _
Description: Trumpet player blowing instrument in front of a god,
Citations: Hickmann, 1946, No. 17, Figure 23

IC166 Trumpet
Find Spot: Thebes
Description: Solitary trumpet player.
Citations: Hickmann, 1946, No. 14

IC167 Trumpet on Stele
Description: Stele showing trumpet player Hosy (Player in the court of Ramses ll) with long slightly flared single cone tuba under left arm.
Citations: Hickmann, 1961, 122, Abb. 89

IC168 Lur on Rock Carving
Find Spot: Lykke, Tanum, Bohuslan, Sweden
Description: Rock carving showing four lur players.
Citations: Lund, 1977, Figure 5

IC169 Lurs on Rock Carving
Find Spot: Sagaholm
Description: Three lur players on ship
Citations lund, 1977, Figure 6

IC170 Lur on Rock Carving
Description: Two lurs in boat
Citations: Lund, 1977, fig, 13; Nordbladh, 1975

IC171 Lur on Rock Carving
Description: Two players blowing pre-lurs standing up in boat.
Citations: Lund, 1977, Figure 14; Nordbladh, 1975, Figure 25

IC172 Lur on Rock Carving
Description Problematic illustration of man standing in boat holding a straight ? lur.
Citations: Lund, 1977, Figure 15; Nordbladh, 1975, Figure 33

IC173 Lur on Rock Carving
Description: Two lur players on ship.
Citations: Lund, 1977, fig, 16; Nordbladh, 1975, Figure 49

IC174 Lur on Rock Carving
Description: Illustration of lur.
Citations: Lund, 1977; Nordbladh, 1975, Figure 72

IC175 Lur on Rock Carving
Description: Lur on Rock-Carving.
Citations: Lund, 1977; Nordbladh, 1975, Figure 98.

IC176 Lur on Disc
Find Spot: Uppsala
Date of Illustration: Early Iron Age
Description: Player blowing early Iron Age lur on circular disc made of glassy material.
Citations: Lund, 1977, 2, Figure 1; Lund, 177, Nordisk Musikarkeologi 62

IC177 Horn on Dish
Find Spot: Mazanderan, Iran
Date of Illustration: Late 7th Century AD
Current Location: British Museum
Description: Figure blowing horn with parallel tube and upturned bell having appearance of bark trumpet. On silver dish from Mazanderan.
Citations: Smirnov, 1909, Plate XXXVII; Dalton, 1964, 66, No. 221, Plate XXXIX; Kent, 1977, 150, No. 316.

IC178 Lur on Rock Carving
Find Spot: Kalleby, Tanum, Sweden
Description: Three lur players blowing lurs all point in same direction and cut across old carvings of ship.
Citations: None known.

IC179 Lur on Rock Carving
Find Spot: Engelstrup, 0ds herred
Current: Location National Museum Copenhagen
Description: Two lurs with bell discs played on ship. On small rock.
Citations: Glob, 1969, Figure 10a and b.

IC180 Lur on Rock Carving
Current Location: National Museum Copenhagen
Description: Carving on small rock in national Museum Copenhagen, showing two lurs with bell discs in side view on ships.
Citations: None known.

IC181 Salpinx on Cup
Current Location: Metropolitan Museum, New York
Description: A mantle-clad salpinx player carrying a spear, illustrated on the New York cup.
Citations: Smith, 1929, Figure B, C

IC182 Salpinx on Black Figured Plate
Current Location: British Museum, N0. B590
Description: Illustration of a hoplite blowing a salpinx on a black figured plate.
Citations: Smith, 1929, Figure E

IC183 Lur on Rock Carving
Find Spot: Jaegersborg, Dyrehave, Nordsjaelland No. 15
Description: Rock-carving showing two lurs on ship with bell discs, one in side view, one in front view.
Citations: Glob, 1969, Figure 14.

IC184 Lur on Rock Carving
Find Spot: Blåholt, Bornholm, No. 55
Description: Lur player standing on ship blowing pre-lur. Was probably other player on ship previously.
Citations: Glob, 1969, Figure 26.

IC185 Lur on Rock Carving
Find Spot: Hjels Sondermark
Description: Rock-carving showing man standing possibly blowing pre lur, however, also possible that this is representation of a man holding both arms in air but one arm now obliterated.
Citations: Glob, 1969, Figure 104

IC186 Lurs on Rock Carving
Find Spot: Slange-Fossumtorp, Bohuslan
Description: lllustration of two players on boat with large single curved instruments.
Citations: Glob, 1969, Figure 195

IC187 Lur on Rock-Carving
Find Spot: Hvarlos, Bohuslan
Description: lllustration of two lurs on ship in end View showing bell discs.
Citations: Glob, 1969, Figure 197.

IC188 Carnyx on Coin
Date of Illustration: lst Century AD
Description: Two carnyces among other trophies on Roman coin issued by Julius Caesar to commemorate his victories in Gaul and Britain.
Citations: Evans, 1864, 192

IC189 Carnyx on Coin
Description: Horseman galloping brandishing carnyx in right hand on coin of Tasc(iovanus).
Citations: Evans, 1864, 251, Plate V, No. 10

IC190 Carnyx on Coin
Description: Horseman galloping brandishing carnyx in right hand of coin of Task(iovanus).
Citations: Evans, 1864, 233, Plate V, No. 12

IC191 Horn on Coin
Description: Centaur blowing horn on Romano-British '
Coin with inscription Rev. "Tasciovani" obv. "Cunobelini".
Citations: Evans, 1864, 326, Plate XII, No. 1

IC192 Shell Trumpet on Relief
Find Spot: Bharahat
Date of Illustration: 2nd Century BC
Description: An end blown shell trumpet with a mouthpiece being blown by an ape on one of the reliefs of the Bharahat.
Citations: Sachs, 1940, 156

IC193 Animal Horn
Find Spot: Palace at Thebes
Description: Illustration of an animal horn instrument on the Palace at Thebes.
Citations: Hickmann, 1961, 161

IC194 Chatzotzerot on Coins
Date of Illustration: 132-135 AD
Description: Illustration of two Hazozerot on Bar Kokba coins shows single coned instrument with mouthpiece.
Citations: Sendrey, 1969, 64, Illus. Nos. 30 and 31

IC195 Celtic Curved Horn on Frieze
Find Spot: Narbonne
Description: Illustration of Celtic curved horn on frieze at Narbonne.
Citations: None known.

IC196 A Cornu on Carving
Find Spot: Trajan's column
Date of Illustration: ca. 110 AD
Description: Cornu player on scene XXVI of Trajan's column.
Citations: Lehmann-Hartleben, 1926, Taf. 15

IC197 Cornu on Carving
Find Spot: Trajan's colunm
Date of Illustration: ca. 110 AD
Description: Two cornu players on scene LXI of Trajan's column
Citations: Lehmann-Hartleben, 1926, Taf. 29

IC198 Cornu on Carving
Find Spot: Trajan's column
Date of Illustration: ca. 110 AD
Description: One, possibly two cornu players on scene CXXIII of Trajan's column.
Citations: Lehmann-Hartleben, 1926, Taf. 58

IC199 Cornu on Carving
Find Spot: Trajan's Column
Date of Illustration: ca. 110 AD
Description: Cornu on scene CXI of Trajan's column.
Citations: Lehmann-Hartleben, 1926, Taf. 51.

IC200 Cornua on Carving
Find Spot: Trajan’s column
Date of Illustration: ca. 110 AD
Description: Three cornua on scene CVIII of Trajan‘s column.
Citations: Lehmann-Hartleben, 1926, Taf. 50

IC201 Carnyces and Tuba on Carving
Find Spot: Trajan's colunm
Date of Illustration: ca. 110 AD
Description: Illustration of carnyces and tuba on base of Trajan‘s column.
Citations: Lehmann-Hartleben, 1926, Abb. 1

IC202 Lur on Rock Carving
Find Spot: Vitlykke, Sweden
Description: Rock-Carving of a player blowing an early single curved lur at Vitlykke, Sweden.
Citations: None known.

IC203 lur on Rock Carving
Find Spot: Vitlykke, Sweden
Description: Representations of lur players on ships,
Citations: None known

SPECIMEN DETAIL

These details are also provided on my web site http://www.hornandtrumpet.com, along with images where possible.

IRISH BRONZE-AGE HORNS

BASED ON CATALOGUE FROM COLES (1963)

Museums: N.M.I. : National Museum of Ireland, Dublin

B.M. : British Museum, London

SD1 Co. Antrim (1)
N.M.I. 1932: 6150. Ann Rep. N.M.I. 1931-2, Plate M, 2. I end-blow. Plain bell, ribs on tube, ribs at end, loop.

SD2 Battle, Sussex, England (1)
Lost. E.C. Curwen, The Archaeology of Sussex, 1954, Figure 65mn I end-blow with cast-on mouth tube. Grouped ribs and one loop on tube; ribs, zigzags and domes at bell.

SD3 Booleybrien, Co. Clare (1)
N.M.I. 1931: 220 (with 1931: 221-40)
II end blow. 4 cones and 4 holes at end, 4 cones at bell.
Assoc. 2 soc. axes, sword hilt, 2 rings, 11 links with bands, sunflower pin.

SD4A Near Clogh Oughter Castle, Corracanvy, Co. Cavan (3)
N.M.I. w6. McWnite, 100, p. xvi, 3; Wilde, 1861, 626,629,634
I end-blow. Grouped ribs and domes on tubes, zigzag grooves and domes at bell (cf.l)

SD4B Near Clogh Oughter Castle, Corracanvy, Co. Cavan (3)
N.M.I. W13. MacWhite, 100, Plate xvi, 2.
I side blow. Loop at end, loop near end, 12 small cones at bell replacing original 10, rope moulding at bell.

SD4C Near Clogh Oughter Castle, Corracanby, Co. Cavan (3)
N.M.I. W14. MacWhite, 100
I (bell only). 10 cones and rope moulding at bell.

SD5A Carrickfergus, (near), Co. Antrim. (3 of this kind).
Lost. Ulster J. Arch., VIII (1860), 101, pl.2, l.
Dublin Penny Journal, 1833-4, 27
I side-blow. Grooves and zigzags at bell, loops and rings (i.e.. like 16C and 16D).

SD6A Carrigogunnel, Co. Limerick (3)
N.M.I. W3. MacWhite, 101, Plate xvi, 8.
II end-blow. 6 cones at bell, 4 cones and 4 holes at end (cf.26)

SD6B Carrigogunnel, Co. Limerick (3)
N.M.I. W4. Macwhite, 101, Plate xvi, 9.
II end-blow, 4 cones and 4 holes at end, bell missing.

SD6C Carrigogunnel, Co. Limerick (3)
II tube, 4 holes each end, ribs or grooves and cones at end, ribs and cones at centre with loop, collar repair.
6A and 6C form one instrument.

SD6D Carrigogunnel, Co. Limerick (3)
Lost: Ousley, T.R.I.A. 2, 1788, 3-6.
Claimed to be II side-blow.

SD7A Chute Hall, Co. Kerry (6)
N.M.I. 1887: 36. MacWhite, Plate xv, I; Day, 1875, 425.
II end-blow, 4 cones and 4 holes at bell, and at end.

SD7B Chute Hall, Co. Kerry (6)
N.M.I. 1886: 35. Macwhite, Plate xv, 2.
II side-blow. 6 cones and 5 holes at bell, end repaired,

SD7C Chute Hell, Co. Kerry (6)
N.M.I. 1886: 39. MacWhite, Plate xv, 3.
II end-blow. 6 cones and 4 holes at bell, 4 cones and 4 holes at end.

SD7D Chute Hall, Co. Kerry (6)
N.M.I. 1886: 40. Macwhite, Plate xv, 4.
II tube, Ribs and loop at centre, ribs and cones at ends.
7D and 7E form one instrument.

SD7E Chute Hall, Co. Kerry (6)
N.M.I. 1886: 37. Macwhite, Plate xv, 4.
II end-blow. 4 cones and holes at end.

SD7F Chute Hall, Co. Kerry (6)
N.M.I. 1886: 38. Macwhite, Plate xv, 5.
II end-blow, 10 cones at bell, 6 cones and 4 holes at end.

SD7G Chute Hall, Co. Kerry (6)
N.M.I. 1886: 34. Macwhite, Plate xv, 5.
II end-blow. 10 cones at bell, 6 cones and 4 holes at end.

SD7G Chute Hall, Co. Kerry (6)
N.M.I. 1886: 34. Macwhite, Plate xv, 6.
II side-blow. 4 cones and 4 holes at bell, 2 loops, with rings.

SD8 Clough, Co. Antrim (1)
Ulster Museum, 470-1927
I side-blow. Grooves and zigzags at bell.

SD9A Between Cork and Mallow (15 or 16)
Cotelhele House, The Earl of Mount Edgecumbe collection
Vetusta Monumenta II, 1789, Plate XX, Figure V; Ulster J. Arch. , VIII, 1860, 101, Plate ii, 2. II side-blow. Probably 6 cones and 4 holes at bell, 2 loops.

SD9B Between Cork and Mallow (15 or 16)
Lost. Vetusta Mon. op. cit. Figure iii; Ulster J. Arch. op.cit. 3a right.
II end-blow. Probably 6 cones and 4 holes at bell, 4 cones and holes at end.

SD9C Between Cork and Mallow (15 or 16)
Cotelhele House, The Earl of Mount Edgecumbe collection
Vetusta Mon. op. cit. Figure iv; Ulster J. Arch. op. cit. 3a left.
II end-blow. 6 large cones at bell, 4 cones and ? holes at end.

SD9E Between Cork and Mallow (15 or 16)
Cotelhele House, The Earl of Mount Edgecumbe collection
Vetusta Mon. op. cit. Figure iv; Ulster J. Arch. op cit. 3a left
II end-blow, 4 small cones.

SD10 Co. Cork (1)
Lost. Dublin Penny Journal, 1833-4, 28.
Side-blow

SD11A ?Co. Cork (2)
N.M.I. 1062: 1888. MacWhite, Plate xvi, 5; Coffey, 1913, 87.
II end-blow. 6 cones and 4M holes at bell, 4 cones and holes at end.

SD11B ?Co. Cork
N.M.I. 1063: 1888. Macwhite, Plate xvi, 4.
II end-blow, 6 cones at bell, 4 cones and holes at end.

SD12 Crookstown, Co. Cork (1)
Lost. Day 1875, 424
Probably II end-blow

SD13 Derrynane, Co. Kerry (I)
N.M.I. W12. MacWhite, Plate xvii, 2; Evans, 1881, Figure 443
II side-blow. 6 cones and 5 holes at bell, collar repair at end, ring on loops.

SD14 Dowris, Whigsborough, Co. Offaly (24)
N.M.I.: B.M. J.R.S.A.I. 54 (1924) 14; Armstrong, 134-42, Plate iii; B.M. 1920, 105-7, Plate viii; Kemble, 1863 Plate xiii; Macwhite, 101-3, Figure 8.
Assoc. tools and weapons, crotals, beaten bronze buckets and cauldrons.

SD14A Dowris, Whigsborough, Co. Offaly (24)
B.M. 83, 2-18, 2.
I end-blow. Three holes at bell (two filled with metal including one spike) loop on tube, rib at end.

SD14B Dowris, Whisborough, Co. Offaly (24)
B.M. 54, 7-14, 176
II end-blow, 4 holes at end, no cones.

SD14C Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1A Armstrong, Figure 1, 1.
I side-blow. Spikes at bell, broken at mouth-hole.

SD14D Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. no. 2. Armstrong, Figure 1,2.
I end blow. 4 spikes at bell, ribs on tube, loop, repaired.

SD14E Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA.57, 1.A. no. 4. Armstrong, Figure 1, 3.
EI end-blow. Spikes at bell, loop and domes on tube, collar at end.

SD14F Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57, 1. A. no. 3. Armstrong, Figure 1, 4.
I end-blow. Spikes at bell, 4 domes along each side of tube, ribs and loop on tube.

SD14G Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1,5. .
I side-blow. 4 spikes at bell, 2 loops, collar at end.

SD14H Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1,6.
II end-blow. 6 cones at bell, probably 3 holes at end originally.

SD14G Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1,5.
I side-blow. 4 spikes at bell, 2 loops, collar at end.

SD14H Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1.6.
II end-blow. 6 cones at bell, probably 3 holes at end originally.

SD14I Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1, 8.
I end-blow. 2 holes at bell (repaired), collar repair on tube, loop near repaired end.

SF14J Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. no. 1. Armstrong, Figure 1.9.
I end-blow. 8 bosses and 2 holes at bell, heavy collar-repair on tube.

SD14K Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1, 10.
I side-blow. 4 spikes and 2 holes at bell, loop on tube, end broken.

SD14L Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1, II
I side-blow. Spikes at bell, loop on tube, rib and formerly loop at end.

SD14M Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure I, 12.
I side-blow, Modern collar at bell, and end, loop on tube, rib and loop at end.

SD14N Dowris, Whigsborough, Co. Offaly (24)
N.M.I. W.1. Armstrong, Plate iii.
II end-blow, 6 cones at bell, 4 cones and holes at end.

SD14O Dowris, Whigsborough, Co. Offaly (24)
N.M.I. W.11. Armstrong, Plate iii.
I side-blow. Small loop at end.

SD14P Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1,7.
I tube. Ribs and 2 holes at ends.

SD14Q Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1, 13.
I tube. Collar effect at ends, broken.

SD14R Dowris, Whigsborough, Co. Offaly (24)
N.M.I. SA 57. 1.A. Armstrong, Figure 1, 13.
I end-blow. Ribs at end, ribs and two loops on tube, bell broken.

SD14S Dowris, Whigsborough, Co. Offaly (24)
B.M. 54, 7-14, 178. Kemble, 1863, Plate xiii, 5; B.M. 1920, Plate viii, 4.
I end-blow. Spikes at bell, domes along tube sides, ribs and loop on tube, ribs at end.

SD14T Dowris, Whigsborough, Co. Offaly (24)
B.M. 54, 7-14, 174. Kemble, 1863, Plate xiii, 6.
II end-blow. Cones at bell, cones and holes at end.

SD14U Dowris, Whigsborough, Co. Offaly (24)
B.M. 54, 7-14, 180. Kemble, 1863, Plate xiii, 9.
I side-blow. Fragment only; loop at end (perhaps part of 14C).

SD14V Dowris, Whigsborough, Co. Offaly (24)
Destroyed; formerly B.M. 1883, 2-18, 1. B.M. 1920, pl.viii,8.
I side-blow. 4 spikes at bell, 2 loops near end.

SD14W Dowris, Whigsborough, Co. Offaly (24)
B.M. 1883, 2-18, 3.
I tube. Collar effect at ends, ribs and 2 holes at each end.

SD14X Dowris, Whigsborough, Co. Offaly (24)
B.M. 54, 7-14, 179
I side-blow. Fragment only; loop on tube, loop at end (perhaps part of 1MC) 4

SD14Y Dowris, Whigsborough, Co. Offaly (24)
B.M. 54, 7-14, 181
I side-blow. Fragment of end.

SD14Z Dowris, Whigsborough, Co. Offaly (24)
B.M. 54, 7-14, 177
I end-blow. 4 spikes at bell, 3 domes on each side of tube. loop near end, rib at end.

SD14Z1 Dowris, Whigsborough, Co. Offaly (24)
B.M. 54, 7-14, 175
II end-blow. Plain bell, 5 holes at end as repair, broken in two pieces.

SD14Z2 Probably Dowris
Formerly Day Collection. Cat. Day Sale, Lot 334.
II end-blow. 6 cones at bell, 4 cones and holes at end.

SD15 Drimoleague, Co. Cork (1)
Formerly B.M. Reliquary and Ill. Arch.5, 1899, 116 fig.I.
II side-blow. Cones at bell.

SD16A Drumbest, Kilraghts, Co. Antrim (4)
N.M.I. 1893: 17. U.J.A. VIII, 1860, 99, pl.I, I.
I end-blow with cast-on mouth-tube. Loops and ribs on tube, grooves at bell.
SD16B Drumbest, Kilraghts, Co. Antrim (4).
Ulster Museum, Belfast. Wilde, '1861, 626.
I end-blow with cast-on mouth-tube. Loop and ribs on tube, grooves near bell.

SD16C Drumbest, Kilraghts, Co. Antrim (4)
Yorkshire Museum. Raine, Handbook to the Antiquities in the grounds and museum of the Yorkshire Philosophical Society, 206-7.
I side-blow, Broken near plain bell and mouth-hole, loops and rings near end (cf.16D).

SD16D Drumbest, Kilraghts, Co. Antrim (4)
Ulster Museum Belfast. Ulster J. Arch. VIII, 1860, Plate I, 2.
I side-blow, Plain, 2 loops and rings.

SD17A Drunkendult, Co. Antrim (2)
N.M.I. 1930: 107. Ulster J. Arch. N.S. VIII, 1902, II.
I side-blow. Loop near end, spikes at bell.

SD17B Drunkendult Co. Antrim (2)
N.M.I. 1930: 108. MacWhite, 99
I tube. 4 holes at bell, rib and 4 holes at end.

SD18A Dungannon, Co. Tyrone (8, 4 of each kind).
Lost. Macwhite, Figure 9, 2.
I side-blow, Rib and 2 loops near end, zigzags and ribs at bell.

SD18B Dungannon, Co. Tyrone 8, 4 of each kind).
Lost. Macwhite, Figure 9, 3.
I end-blow Ribs and loop on tube, ribs and zigzags near bell.

SD19A Dunmanway, Co. Cork (2)
B.M. 54, 12-27, 45. Kemble, 1863, Plate xiii, 7.
II side-blow, 6 cones and 4 holes at bell, 2 loops near end.

SD19B Dunmanway, Co. Cork (2)
B.M. 54, 12-27, 46. Komoio, 1863, pi. xiii, 8.
II tube. Ribs and cones at centre and at ends.

SD20 ?Dunmanway, Co. Cork (1)
Ulster Museum 192-1913.
II tube. Loop, ribs and cones at centre, including repair; ribs and holes at end; fragment only.

SD21 Innermessan, Wigtownshire (1)
N.M.A. Scotland DO 27: P.S.A.S. XXIII (1888-89) 224
Side-blow, Fragment of mouth-hole

SD22A Kanturk, Co. Cork (1)
Pitt-Rivers, Museum, Oxford, 1315: 3017
II tube. Fragment only, end with 4 holes and 4 cones. 22A and 22B probably form one instrument.

SD22B Kanturk, Co. Cork (1)
Pitt-Rivers Museum, Oxford, 1315: 3017
II end-blow. 6 cones and 4 holes at bell, holes at broken end.

SD23 Co. Kerry (near Millstreet, Co. Cork) (1)
Ashmolean 1927: 2926
II end-blow. 6 domes and 4 holes at bell, 5 domes and holes at end.

SD24A near Killarney, Co. Kerry ('a number').
Lost. Ulster J. Arch. VIII, 1860, Plate ii, 4.
II end-blow. Cones at bell and end.

SD24B near Killarney, Co. Kerry ('a number')
Ashmolean 1927: 2927.
II end-blow. 6 cones at bell, 4 cones and holes at end.

SD24C near Killarney, Co. Kerry ('a number').
Ashmolean, 1927: 2928.
II end-blow. 6 ribbed cones at bell, probably 4 ribbed cones and holes at collared end.

SD24D near Killarney, Co. Kerry ('a number').
Ashmolean 1927: 2929
II tube. Loop, ribs and domes at centre; ribs, collar and domes at ends with 4 holes; one end repaired.

SD25 Lough Gara (Inch Island) Co. Sligo (1)
N.M.I. E20: 587
I side-blow. Fragment of end

SD26 Lisroe, Co. Kerry (1)
N.M.I. 1882; 266
II end-blow. 6 cones at bell, 4 cones and holes at end (cf.6A).

SD27A Macroom, Co. Cork (2)
N.M.I. W2; D647. Macwhite, p;. xvii, 4; Wilde, 1861, 634.
II end-blow. 6 ribbed cones and 4 holes at bell, 4 ribbed cones and 4 holes at collared end.

SD27B Macroom, Co. Cork (2)
N.M.I. W10; D654 Macwhite, pl.xvii, 5.
II side-blow, 6 ribbed cones and 4 holes at bell, end missing.

SD28 Co. Leitrim (? several)
Verschoyle-Campbell collection
I side-blow. Zigzag decoration at bell.

SD29A Moyarta, Co. Clare (3)
N.M.I. 1907: 101. MacWhite, Plate xiv, 3; Coffey 1913, 85.
II end-blow. 4 cones at bell, 4 cones and 4 holes at end.

SD29B Moyarta, Co. Clare (3)
N.M.I. 1907: 102. MacWhite, Plate xiv, I.
II end-blow. 4 cones and 4 holes at bell, ribbed rim, 4 cones and 3 holes at end.

SD29C Moyarta, Co. Clare (3)
N.M.I. 1907: 103. Macwhite, Plate xiv, 2.
II side-blow. 6 cones (now 5) and 4 holes at bell, loop at end, loop and ring on tube

SD29D Moyarta, Co. Clare (3)
N.M.I. 1907: 104. MacWhite, Plate xiv, 3.
II tube. Loop and ribs at centre, 4 cones at each end, 3 and 4 holes at ends respectively.

SD30 Portglenone, Co. Derry (1)
Q Ulster Museum, 190-1913. Day, 1875, 423, Figure 5.
I side-blow. Plain bell, loop near end, end broken.

SD31 Roscrea, Co. Tipperary (1)
N.M.I. W5. MacWhite, Plate xvii, 3; Wilde, 1861, 633
I end-blow. 4 ribs at bell.

SD32 Scrabby Bog, nr. Garrison, Co. Fermanagh (1)
N.M.I. 1921: 11. MacWhite, Plate xiv, 7.
I end-blow. Ribs on tube.

SD33 Toome, Co. Antrim (1)
Ulster Museum 516-1937
II side-blow. 1 cone survives on bell, broken end.

SD34 South of Ireland (1)
B.M. Kemble, 1863, Plate xiii, 10
II tube.

SD35 Ireland (1)
N.M.I. W16
Side-blow fragment.

SD36A Ireland (2)
N.M.I. 1882: 225. MacWhite, Plate xvi, 6; Coffey, 1913, 87.
I side-blow. Ribs and grooved zigzags at bell, loop near end.

SD36B Ireland (2)
xN.M.I. 1882: 226. Macwhite, Plate xvi, 7.
I side-blow. Grooves and zigzags near bell, 2 loops at end.

SD37A Ireland (3)
N.M.I. 1881: 317. MacWhite, Plate xiv, 6; Coffey, 1913, 87.
I side-blow. Grouped ribs on tube, 2 loops at end, grooves at bell.

SD37B Ireland (2)
N.M.I. 1881: 318. MacWhite, Plate xiv, 5.
I end-blow. Grouped ribs at bell and on tube, collar repair near end.

SD37C Ireland (3)
N.M.I. 1881: 319. MacWhite, Plate xiv, 4.
Probably I end-blow. Fragment, ribs and grooves near loop.

SD38 Ireland (1)
Horniman Museum. Cat. Day Sale, Lot 336.
Y Fragment only, bell plain.

SD39. Ireland (1)
N.M.I. R.S.A.I. 31.
I end-blow, Fragment, loop near end.

SD40 Ireland (1)
Alnwick casue 444. Cat Ant. Aln. Cas. 1880, 84.
Side-blow. 6 cones and grouped grooves at bell, broken at mouth-hole.

SD41 Ireland (1)
Alnwick Castle 445. Cat. Ant. Aln. Cas. 1880, 84.
II end-blow, 6 cones and probably 2 holes at bell, formerly 4 holes at end.

SD42 Ireland (1)
Alnwick Castle 446. Cat. Ant. Aln. Cas. 1880, 84.
Fragment of tube.

SD43 Ireland (1)
Alnwick Castle 447. Cat. Ant. Aln. Cas. 1880, 84.
II end-blow, Broken bell, repaired end with 5 holes.

SD44 Ireland (1)
Horniman Museum. Cat. Day Sale, Lot 336.
? II. Bell fragment with cones.

SD45 No location known.
B.M. (no number)
Probably I. Fragment of plain horn.

SD46 No location known.
B.M.
I side-blow. 2 grooves at bell, 2 holes at bell, broken across mouth-hole.

SD47 No location known.
Cork Public Museum.
II end-blow. Cones at bell and end, 4 holes at end.

SD48 No location known.
Cork Public Museum.
II end-blow. Cones at bell and end, repaired at end.

SD49 No location known.
N.M.I. W15; D657. Macwhite 100, Plate xvi, 1.
I side-blow. End only, with loop.

SD50 No location known (?Dowris)
N.M.I.
I tube. Grooves collars at each end, 2 holes at each end.

SD51 No location known (?Co. Cavan)
Public Library, Armagh.
I side-blow. Fragment, loop on knobbed end, loop near end, ?grooves/lines near bell.

SD52 No location known.
Public Library, Armagh.
Q I end-blow. Fragment, grouped ribs on tube and near end.

SD53 Near Derry (1)
Eden Minns collection.
I side blow. 8 low bosses on bell, grooves in a linear pattern. Loops at tip and on tube yard. Coles (1967) p.115.

SPECIMEN DETAIL

These details are also provided on my web site http://www.hornandtrumpet.com, along with images where possible.

CATALOGUE OF LURS: BASED ON BROHOLM (1949)

SD101/2 Brudevaelte
Find Spot: Brudevaelte, Lynge Parish, Lynge—Frederiksborg
Date of Find: 1797
Current Location: National Museum Copenhagen, No. 8116
Condition: Complete
Musical Characteristics: G1, C2, E2, C5, G3, C4, E-flat4, G4, B-flat4, C3, D3.
Description: Right/left-wound lurs. Six sections,trombone-type mpce. 3 eyes on tube, lock with tenon. Tube 2.24/3*m* long, tube yard 0.99/1.01*m* bell-yard 1.25/1.22*m*. Bell diameter 49/47*mm*.
Bell disc 194 mm diameter,2 eyes on rear side

SD102 only. Disc has 6 bosses and six pips with 2 concentric circles spaced between these 5 on periphery. 2 pendants on eyes on bell disc.
Citation: SD101 Hammerich, 1893, 166, fig.7; Broholm, 1949, 13, Figure 14, Plate 2
SD102 Bronsted, 1939, 187, Figure 175; Broholm, 1949, 14, Plate 3.

SD103/4 Brudevaelte
Find Spot: Brudevaelte, Lynge Parish, Lynge Frederiksborg
Date of Find: 1797 f
Current Location: National Museum, Copenhagen, No. 8115/8114
Condition: Complete
Musical Characteristics: B-flat1, G-flat1, B-flat2, E-flat3, B-flat3, Eb-flat4, G4 , B-flat4, D-flat5, E-flat5, F5 , G5 , C6 , B-flat6.
Description: Right/left wound lur, tube yard 3 sections 0.75/0.76*m* long, mouthpipe has 5 eyes. Trombone-type mpce, bell yard in 3 sections 1.21/1.21*m* long. Bell disc has 7 bosses, `28 pips and 3 concentric circles: pattern of x 3 between bosses and complete ring around bell opening.

SD105: Five flat pendants on mouthpipe eyes
SD104: Only four pendants, one empty eye. Bell disc cracked.
Citations: SD105: Bronsted, 1939, 189, Figure 176; Broholm, 1949, 14, Plate 3 (left); SD104: Hammerich, 1893, 161, Figure 6; Bronstedt, 1939, 189, Figure 176a.

SD105 Brudevaelte
Find Spot: Brudevaelte, Lynge Parish, Lynge Frederiksborg
Date of Find: 1797
Current Location: National Museum, Copenhagen, No. 8117
Condition: Complete

Musical Characteristics B-flat1, G-flat1, B-flat2, E-flat3, B-flat3, E-flat 4, G4 , B-flat4, D-flat 5, E-flat5, F5, G5
Description: Right-wound lur 1.92 m long overall. Tube yard
0.8 m long in 5 sections. Mouthpipe has 5 eyes
which carry 5 pendants. Mouthpiece shallow trombone-type with flat rim. Bell yard 1,12*m* long divided into 5 sections,repair, possibly in ancient times. Bell disc 285 mm diameter with 8 large hemispherical bosses with 56 pips and treble concentric circles. 24 of these on rough circle around periphery of disc, 16 on circle around bell mouth and 16 in pairs between bosses.
Citations: Broholm, 1949, 15, Figure 15, pls. 5 & 6.

SD106 Brudevaelte
1 Description , A left-wound lur found with SD101-5 but presented in 1845 to the Imperial collections in St. Petersburg. Now in the Eremitage at Leningrade. Reputedly the pair to SD105.

SD107/8 Blidstrup
Find Spot: Moor in Blidstrup Parish, Holbo County.
Date of find: 1858
Current Location: Largely destroyed in a fire in 1859
Description: Tube yard with spiral decoration around as SD117/8. Trombone-type mouthpiece, mouthpipe with 6 eyes. Bell discs 290*mm* diameter with 11 large hemispherical bosses and 20 "knobs"
Citation: Hammerich, 1893, 176.

SD109 Høng
Find Spot: Probably a moor in Høng, Finderup Parish, Love County
Current Location: Private collection
Condition: Fragmentary
Description: 600 mm long fragment of tube from bell yard of left-wound lur. Divided into 5 sections by 4 bands. Remains of a permanent lock joint.
Citations: Broholm, 1949, 16, fig, 2.

SD110 Dramstrup
Find Spot: Peat-bog in Dramstrup, Nørre Jaernløse Parish, Merløse County
Date of Find: 1850
Current Location: National Museum, Copenhagen, No. 11136-37
Condition: Very fragmentary
Description: Very small fragments of a tube and chain
Citations: Hammerich, 1893, 176

SD111/2 Boslunde
Find Spot: Boslunde, Boslunde Parish, Slagelse County
Date of find: 1838
Current Location: National Museum, Copenhagen
Condition: Very fragmentary
Description: Left/Right wound lur, tube yard probably in four segments, Trombone-type mouthpiece. Mouthpipe has seven eyes. Demountable lock with triangular tenon. Bell yard divided into six segments, cast in three tube units with meander joints. Bell disc 292*mm* diameter with eight bosses decorated at top with shallow cylinder. 118 of these subsidiary elements spaced 4 x 8 around bell aperture, 8 x 8 around periphery of disc and a pattern I of three and a single unit between the bosses.
Citations: Hammerich, 1893, 174 ff; Schmidt, 1915, 123; Broholm, 1949, 19.

SD113/4 Lommelev
Find Spot: A bog in Lomelev, Nørre Kirkeby Parish, Falster's Northern County
Date of Find: 1846
Current Location: National Museum, Copenhagen, No. 9433-34
Condition: Fragmentary
Description: Left/right wound lurs, tube yard complete, horn type mouthpiece. Lock has separate tenon and locking eye. Bell yard with meander joints.
Citations: Hammerich, 1893, 175; Schmidt, 1915, 117; Broholm, 1949, 19-21, Figure 4, 12(3), Plate 10.

SD115/6 Radbjerg
Find Spot: Radbjerg moor, Veggerløse Parish, Falsters Southern County
Date of Find: 1894
Current Location: National Museum, Copenhagen, Ref. No. B5790-94
Condition: Damaged
Description: Tube yard in 5 segments separated by rings with double bands. Trombone-type mouthpiece. Lock with triangular tenon, sets instrument in one plane,of curvature only. Bell yard,
two irregular meander joints. Bell disc 213*m* diameter with eight large hemispherical bosses and no other decoration.

SD115 Mouthpipe has 6 eyes each with pendant
SD116 No eyes remain although two pendants found with instrument
Citations: Schmidt, 1915, 124; Broholm, 1949, 21/2, Plate 12.

SD117/8 Tellerup
Find Spot: Peat Bog, Tellerup field, Ørslev Parish, Vends County
Date of Find: 1808
Current Location: SD117 National Museum, Copenhagen, No. 378
SD118 Private Collection on island of Funen
Condition: Complete
Musical Characteristics A1 , D2, F2 , D3, A3, D4, F 4, A4, C5, D5, E5, F5, A5.
Description: Right/left wound lur. Trombone-type mouthpiece, overalllength 2,06/2,08*m*. Tube yard 0.82/0.83*m* long, decorated with rifled bands made up from 7 threads. Five small eyes on mouthpipe. Bell yard 1.24/1.25*m* long. Lock with eye and tenon.

SD117 Bell disc 253*mm* diameter, eight large hemispherical bosses held in place by a wedge pushed through two eyes cast integrally on these.

SD118 Bell disc similar to above but bosses are made separately and cast-on to the surrounding disc.
Citations: Hammerich, 1893, 193; Schmidt, 1915, 124; Broholm, 1949, 25, pl,13, 14.

SD119/120 Rørlykke
Find Spot: Rørlykke moor, Tryggelev Parish, Langelands Southern County
Date of Find: 1886
Current Location: National Museum Copenhagen, Mus. No, B3671-72
Condition: Complete
Description: Right/Right wound lur, of integral construction with wide cone angle and integrally-cast bell disc. Tube units joined by meander joints. Poor quality casting - numerous section failures.
Citations: Hammerich, 1893, 173; Schmidt, 1915, 59; Broholm, 1949, 23/24, Plate 15.

SD121 Hove
Find Spot: Hove, Hove Parish, Vandfuld County
Date of Find: 1940 V
Current Location: National Museum, Copenhagen, Mus.No. B 13666
Condition: Fragmentary
Description: A 290*mm* long fragment of tube yard. Lock - male part - with eye and triangular tenon
Citations: Broholm, 1949, 24, Figure 5.

SD122 Nyrup
Find Spot: Nyrup, Gislum Parish, Gislum County
Date of Find: 1910
Current Location: National Museum, Copenhagen, Mus. No. B 11274
Condition: Fragmentary
Description: Tube yard with horn-type mouthpiece, with wide rim. Broken-off lock
Citations: Broholm, 1949, 24, Figure 6.

SD125 Dauding
Find Spot: Dauding, Graedstrup Parish, Trysting County ‘
Date of Find: Not known
Current Location: National Museum, Copenhagen, Mus. No. B 11273
Condition: Fragmentary
Description: 210*mm* portion of mouthpipe with horn-type mouthpiece
Citations: Broholm, 1949, 24, Figure 32.

SD124/5 Folrisdam
Find Spot: Nedergaard's Field, Folrisdam, Graedstrup Parish, Tyrsting County
Date of Find: 1865
Condition: SD124 Complete; SD125 Damaged but complete
Musical Characteristics: Gl, D2, G2, D5, G3, D4, G4, B4, D5, F5, G5.
Description: 1.45*m* long instrument with two yards joined together by a permanent lock which has an integrally-cast mount. Chain attached to this passes up to mount near bell end. Mouthpiece of trombone type. Bell disc 153*mm* diameter decorated by 2 rings of small hollow knobs.
Citations: Hammerich, 1893, 172; Schmidt, 1915, 128; Broholm, 1949, 26/7.

SD126/7 Ødstedlund
Find Spot: Ødstedlund, Ødsted Parish, Jerlev County
Date of Find: 1875
Current Location: National Museum, Copenhagen, No. B936
Condition: Very fragmentary
Description: Small fragments of two lurs, including two pieces of tube, 225 and 210*mm* long.
Citations: Broholm, 1949, 26, Figure 7

SD128/9 Maltbaek
Find Spot: Maltbaek moor, Malt Parish, Malt County
Date of Find: 1861 and 1865
Current Location: National Museum, Copenhagen, No. 21246
Condition: Complete
Musical Characteristics: E1, B1, E2, B2, E3, B3, D4, G4, B4, D5, E5, F5
Description: Right/left wound lurs, one with complete carrying chain (128) 1880*mm* long, tube and bell yards joined with permanent lock which carries a ring mount, trombone type mouthpiece, bell disc 176*mm* diameter with punched and incised decoration.
Citations: Hammerich, 1893, 168 Schmidt, 1915, 116 Broholm, 1949, 26, pl, 19 and 20.

SD130 Jaernhyt
Find Spot: Jaernhyt, Hammelev Parish, Gram County
Current Location: Haderslev Amts Museum, No. 3131
Condition: Very fragmentary
Description: Fragment of the tube of a lur
Citations: Hammerich, 1893. 143 Broholm, 1949, 27.

SD131/2 Revheim
Find Spot: Revenes moor, Revheim, Haaland Parish, Norway.
Date of Find: 1894
Current Location: Stavanger Museum, No. 1880
Condition: Complete
Musical Characteristics: F1, C2, F2, C3, F5, C4, F4, A4, C5, D5, E5, F5, G5.
Description: Right/left hand lur. 1630*mm* long. Tube yard 665*mm* long, joined to 965*mm* long bell yard with lock with triangular
tenon. Bell disc 142 *mm* diameter with 7 small hemispherical bosses. 3 small eyes on back of bell disc.
Citations: Oldeberg, 1947, 37, 38, Figure 20; Broholm, 1949, 27, Plate 21 and 23

SD133/4 Rossum
Find Spot: Rossum, Brandby Parish, Kristians County, Norway
Current Location: Universitetets Oldsakssamling, Oslo, No. 19023
Condition: Fragmentary
Description: SD155 - two fragments of a lur, one 270 - 286*mm* long fragment of bell section including lock.
Joints made by rivetting plus casting on. SD134 - 130*mm* long fragment of bell section.
Citations: Oldeberg, 1949, 37, 60, 61, Figure 19, 40 and 42; Broholm, 1947, 28, Figure 12.

SD135 Gullåkra
Find Spot: Gullåkra, Brågarp Parish, Dara County, Sweden
Current Location: Lunds University Historical Museum, No. 4372
Condition: Almost complete
Description: Right wound lur, 1100*mm* long with tube and bell yards cast together without a lock. Chain complete from bell to centre of instrument body. Mouthsupport about 2/3 missing. No bell disc but has integrally cast annular flange around bell mouth.
Citations: Hammerich, 1893, 188 ff. Schmidt, 1915, 111, no. 16 Oldeberg, 1947, 24, Figure 3 Broholm, 1949, 29, Plate 24, 25, Figure 11

SD136 Skåne
Current Location: Private Collection
Condition: Fragmentary
Description: Two fragments of bell yard, one has integral flange around bell mouth.
Citations: Schmidt, 1915, 114/5, no, 17 Oldeberg, 1947, 30, Figure 7 Broholm, 1949, 30.

SD137 Hindby
Find Spot: Hindby, Fosie or Vestra Skräflinge Parish, Oxie County, Sweden
Current Location: Lund University, Historical Museum, No, 6619
Condition Very fragmentary
Description: Fragments of lur from bell mouth to lock.
Citations: Schmidt, 1915, 122, no. 25. Oldeberg, 1947, 24, Figure 1 – 2 Broholm, 1949, 30.

SD138 Påarp
Find Spot: Påarp, Karup Parish, Sweden
Current Location: Statens Hist. Museum, Stockholm, No. 10775
Condition: Fragmentary
Description: Fragment of lur, 1640 mm long with both ends missing. Of integral construction, no lock. Remnants of chain.
Citations: Schmidt, 1915, 115, no, 8 Oldeberg, 1947, 29-30, Figure 5-6, Figure 49.

SD139/40 Borreby
Find Spot: Borreby, Borreby Parish, Sweden
Current Location: Statens hist. Mus. Stockholm, No. 5531
Condition: Fragmentary
Description: Fragments of two lurs. On convex side are shaped features. Fragment of bell yard contains a lock with an eye and a triangular slot. 1/3 of bell disc remains with three bosses.
Citations: Schmidt, 1915, 108; Oldeberg, 1947, 25, Figure 4, p. 72-73, Figure 54-58.

SD141 Froarp
Find Spot: Froarp, Asarum Parish, Sweden
Current Location: Statens hist. Mus. Stockholm, No. 10039
Condition: Fragmentary
Description: Two fragments of bell of lur, one 410*mm* long, one 540*mm* long.
Citations Schmidt, 1915, 121, no. 24; Oldeberg, 1947, 30-32, fig, 8-9, p. 51, Figure 30-31; Broholm, 1949, 31.

SD142/3 Långlots Norregård
Find Spot: Långlots Norregård, Őand
Current Location: Statens hist. Mus. Stockholm, No. 10019
Condition: Fragmentary
Description:
SD142 Tube in four pieces but complete. Horn shaped mouthpiece. five eyes on mouthpipe. Four still carrying almost rectangular pendants. Lock with triangular tongue and remnants of organic material, probably resin.
SD143 Parts of left wound lur

Five eyes on mouthpipe. Lock with triangular tongue. When found, was wrapped in band of bast-like material together with fragments of birch bark.
Citations: Schmidt, 1915, 108, no. 9-10; Oldeberg, 1947, 31-36, Figure 10-16; Broholm, 1949, 32

SD143a Nya Åsle
Find Spot: Åsle Parish, Västergötland, Sweden
Current Location: Statens hist. Mus. Stockholm, No. 4127
Description: Fragments of a bell disc.
Citations: Oldeberg, 1947, 36, Figure 17; Broholm, 1949, 32.

SD143b Hjärpetan
Find Spot: Hjärpetan Grava Parish, Värmland, Sweden
Current Location: Statens hist. Mus. Stockholm, No. 170438
and 17143
Description: Fragments of a lur
Citations: Oldeberg, 1947, 37, 61, Figure 18, 41, 43; Broholm, 1949, 32.

SD144/5 Daberkow
Find Spot: Klostergut Daberkow, Vorpommern
Date of Find: 1912
Current Location: Mus. fur Volkerkunde, Berlin
Description: Right/left wound lurs. Tube and bell yards joined by lock with triangular slot. Bell disc with two concentric rings of small concentric circles.
Citations: Schmidt, 1915, 85; Broholm, 1949, 33

SD146 Hof zum Felde
Find Spot: Hof zum Felde, Grevesmuhlen, Germany
Current Location: Schwerin Museum, UK
Condition: Fragmentary
Description: Fragments of bell yard of lur
Citations: Schmidt, 1915, 108, no. 13.

SD147 Lübzin
Find Spot: Lübzin, Sternberg, Germany
Current Location: Schwerin Museum
Condition: Fragmentary
Description: Three fragments of lur with lock lacking triangular tongue. Remnants of carrying chain. Bell disc with punched decoration.
Citations Schmidt, 1915, 120/1.

SD148 Garlstedt
Find Spot: Garlstedt, Niedersachsen, Germany
Date of Find: 1830
Current Location: Landesmuseum für Niedersachsen, No. 5361
Condition: Fragmentary ‘
Description: 21 Fragments of lur including lock with triangular tongue and corresponding bell fragments. Bell disc 265*mm* diameter with 8 large bosses having concentric circles on top.
Citations: Broholm, 1949, 34.

SD149 Neu Schwaneburg
Find Spot: Neu Schwaneburg, Latvia
Condition: Fragmentary
Description: Two fragments of lur including lock
Citations: Oldeberg, 1947, 38/9, Figure 23; Broholm, 1949, 34.

SD150 Zealand
Find Spot: Zealand?
Current Location: British Museum?
Description: Said by Broholm (1949, 27) to be a fragment of a Danish lur found in a moor in Zealand. From collection of J.J.A. Worsaae
Citations: British Museum: Guide to the Bronze Age, 1920, 134.

SD151/2 Fogdarp
Find Spot: Fogdarp, Bosjokloster Parish, Central Scania, Sweden A
Date of Find: 1972
Current Location: Lund University Hist. Museum
Description: Bell discs of lurs. 205 mm diameter with 10 hemispherical bosses.
Citations: Larsson, 1973, 169.

SD155 Saint-Germain
Description: Lur said to be in collection of Musée des Antiquités Nationales, Saint-Germain-enlarge, France
Citations: Verbal information.

SPECIMEN DETAIL

These details are also provided on my web site http://www.hornandtrumpet.com, along with images where possible.

SD201 Tutankhamen, Silver trumpet
Date of Find: 1923
Location of Find: Tomb of Tutankhamen
Dating of Item: c. 1350BC, 18th Dynasty based on Conventional Egyptological dating
Current location: National Museum, Cairo
Condition: Complete
Musical Characteristics: A-flat3, C5.
Description: 582 *mm* long. Conical mouthpipe, wrought/brazed, silver, 474*mm* long, 17*mm* to 26*mm* diameter, conical/slightly flared bell, silver 112*mm* long with 82*mm* diameter bell. Bell decorated with names of the Gods, Re, Amun and Ptah and with a Lotus leaf design. Measurements from Hickmann (1946). Gold leaf at mouthpipe/bell junction and mouthsupport. This is an added ring with tube end swaged over it.
Related material: Similar to Sd202 and SD207.Provided with close-fitting wooden stopper.
Citations: BM (1972) item 45; Buchner (1973) No. 25; Kirby (1946); Hickmann (1946) p. 120, Abb. 88; Kirby (1952) p. 250-55; Edwards (1972); Hickmann (1949).

SD202 Tutankhamen, Bronze/Gold trumpet
Date of Find: 1923
Location of Find: Tomb of Tutankhamen
Dating of Item: 1350BC, 18th Dynasty. Based on Conventional Egyptological dating
Current Location: National Museum, Cairo
Condition: Complete
Musical Characteristics: B-flat; D5
Description: 494*mm* long; Conical mouthpipe (wrought/brazed) bronze, 403*mm* long x 0.25*mm* thick (13*mm* diameter to 25*mm* diameter) conical bell, bronze joined by rivets 81*mm* long by 0.125*mm* thick. (25*mm* diameter to 84 *mm* diameter) Bell decorated with Kings name and representations of Re, Amun and Ptah. Measurements from Hickmann (1946) Gold leaf at mouthpipe bell junction and mouthsupport. This is an added ring with tube end swaged over it.
Related material: Similar to SD20 and SD217 Provided with a close-fitting wooden stopper.
Citations: BM (1972) item 45; Buchner (1973) no. 25; Kirby (1946); Hickman (1946) p. 120, Abb. 88; Montagu (1976) p. 115-117; Kirby (1952) p. 250-255; Edwards (1972); Hickmann (1949)

SD205 Saalburg Lituus
Date of Find: not known
Location of Find: River Rhine, near Dusseldorf
Dating of Item: Celtic, probably Late Iron-Age. Based on Iconography
Current Location: On loan to Landesmuseum,Bonn, from Saalburg Museum
Condition: Complete
Musical Characteristics: G3 A4 E5 A5 C 6 D 6
Description: Conically-bored instrument. Lost-wax cast in three parts in bronze. 738 mm long. Tapering from 5*mm* (throat) to 103*mm* bell. This curves through 90° and is

slightly flared. Made up of mouthpipe and tuning,piece and bell yard. Tuning piece has two male ends which fit into other pieces and is soldered there. Carrying mounts: on mouthpipe and bell yard. Eye-shaped cross section.
Related material: Similar to SD204, 232, 240, 241, 242 and 248. Type illustrated on IC150
Citations: Behn (1912) p. 38, Abb, 3; Behn (1954) Abb. 137 Klar (1971), 303, Abb. 1.

SD204 Wiesbaden, Celtic Lituus
Find Spot: Not known, probably in a River
Date of Find: Not known.
Dating of Item: Celtic, Late Iron-Age Based on Iconography
Current Location: Stadtisches Museum Wiesbaden, Inv.Nr. 1536
Condition: Fragmentary
Musical Characteristics N/A
Description: Fragment of bronze tube, cast in bronze in split mould on the instrument curve, approx. 240*mm* long, diameter of tube varies from 25 to 39 mm approx. Round cross-section.
Related Material: Similar to SD203, 232, 240, 241, 242 and 248. Type illustrated on IC150
Citations: Klar 1971, 303, Anm.9

SD205 Neuvy en-Sullias Tuba
Find Spot: Near Neuvy-en-Sullias
Date of Find: 27 May 1861
Dating of Item: La Tene (End 4th century BC). Based on Associated finds
Current Location: Musée Historique & Archéologique De L'orleanais
Condition: Complete
Musical Characteristics: Not known
Description: Conical-bored instrument, wrought construction with cast mouthpiece and ferrules: in bronze, in four yards joined by cast errules. Cast decorated tip end into which cast mouthpiece fits.1.44*m* length tube varying from 10*mm* to 58*mm* diameter. Possibly had conical "flare" to bell end. Said (Bragard) to have a telescopic bell.
Related Material: Similar to SD206
Citations: Mantellier, 1865, 171 ff. Plate XIII; Behn, 1954, Taf. 81, Abb. 186; Broholm, 1949, 102; Baines, 1976, 64, Figure 7; Bragard, 1968, 38 (Superficial).

SD206 Saumur Tuba
Find Spot: Near Saumur
Date of Find: Not known
Dating of Item: La Tene (End 4th century BC) Based on Similarity to SD205
Current Location: Castle at Saumur
Condition: Complete
Musical Characteristics: Not known
Description: Instrument probably wrought with cast parts, in bronze, as SD205 but has large diameter elaborately decorated boss immediately down-stream of mouthpiece. Overall length 1.60*m*. Said (Bragard) to have a telescopic bell.
Related Material: Very similar to SD205
Citations: Bragard, 1968, 38 (superficial); Behn, 1954, 144; Baines, 1976, 64, Figure 7.

SD207 Carnyx
Find Spot: Said to be found in Dacia, Rumania
Citations: Bragard, 1968, 58

SD208 Carnyx
Find Spot: Said to be found in Paplagonia, Asia Minor
Citations: Bragard, 1968, 58.

SD209 Bacchic Horn
Find Spot: Fayum, Egypt
Date of Find: Not known
Dating of Item: lst century AD Based on Not known
Current Location: Museum of Fine Arts, Boston, U.S.A.
Condition: Complete
Musical Characteristics: Not known
Description: "Red earthenware bugle with low relief representing a young Bacchus, Silenus and bunches of grapes. Circular embouchure, oval bell opening: conoidal bore, very rough inside. Length 195*mm*, width 60*mm*, embouchure 1 17*m* , Bell orifice length 40*mm*"
Related Material: None
Citations: Bessaraboff, 1941, 156, no. 154.

SD210 Numancia Clay Horns
Find Spot: Numancia, Spain .
Date of Find: 1905
Dating of Item: Prior to 155 AD. Based on Stratigraphy, documentary accounts
Current Location: Museo Numantina
Condition: Fragmentary
Musical Characteristics: Not known
Description: Curved tube and integral bell of instrument formed in clay with painted decoration.
Related Material: Similar to SD264, 265
Citations: Bragard, 1968, 38 (Superficial); Comision Ejecutiva, 1912, 40, Plate LV; Behn, 1954, Taf. 81, Abb. 185.

SD211 Loughnashade Horn
Find Spot: Loughnashade, Co. Armagh
Date of Find: 1798
Dating of Item: lst century BC, based on Bell disc decoration
Current Location: National Museum of Ireland, Dublin
Condition: Almost complete I
Musical Characteristics: Not playable
Description: 1.27*m* long bronze fabricated instrument with rivetted seam. Instrument made up of 28.5*mm* diameter tube yard and a bell yard that tapers from 28.5 to 80*mm* diameter. A bell disc was found with the instrument - not attached, is 190 *mm* outside diameter and decorated with repoussé La Tene decoration. Tube riveted along inner curve with both internal and external rivetting strips. Wrought boss.
Related Material: Similar to SD223, 224, 225, 229, IC148 and SR16.
Citations Fox, 1946, 45, Plate XII; Wilde, 1861, 87, 625.

SD212 Caere Lituus
Find Spot: Caere (Cervetri)
Date of Find: 1827
Dating of Item: 4th century BC, based on associated finds, iconography
Current Location: Vatican Museum
Condition: Complete
Musical Characteristics: in G?, plays six notes
Description: Long, small diameter tube, approx. l*m* length fitted into semicircular bell yard - overall length 1.4*m*.
Related Material: Similar to SD231, IC2, IC6.
Citations: Wellesz, 1969, 407; Bate, 1966, Plate 9(A); Baines, 1976, 65.

SD213 Tattershall Ferry Carnyx
Find Spot: River Witham nr. Tattershall Ferry, Lincolnshire
Date of Find: 1768
Dating of Item La Tene, based on Iconography
Current Location: Destroyed
Description: Wrought construction tube, soldered. Made up of two yards: tube yard parallel, appears to have oblique termination at tip; bell yard conical turns through approx. 90°.
Related Material: Bell yard similar to SD215. Overall morphology similar to carnyx iconography.
Citations: Phillips, 1934, 105; Tylecote, 1962, 145; Behn, 1954, Abb. 191.

SD214 Le Mans Carnyx fragment
Current Location: Museum of Le Mans
Citations: Wellesz, 1969, 22.

SD215 Durnau Carnyx fragment
Find Spot: Durnau, Schwabisches Oberland
Date of Find: not known
Dating of Item: Mid lst century BC, based on not known
Current Location: Federseemuseum, Bad Buchau
Condition: Fragmentary
Description: 340*mm* long curved bell yard from 20*mm* to 85*mm* diameter, made of two sheets of bronze rivetted together. Outer diameter of curve has a ridge where seam edges meet.
Related Material: Similar in morphology to SD213 and to iconography of carnyx.
Citations: Piggott, 1959, 22.

SD216 Etruscan Cornu
Find Spot: Not known
Date of Find: Not known
Dating of Item: Etruscan, ID based on Morphology
Current Location: Museum of Villa Giula, inv. no. 51216
Condition: Complete
Musical Characteristics: Not known
Description: Conical bored instrument of open 'C' form with cross-brace. 1.34*m* long, 450*mm* diameter curvature, tube diameter from 35 to 110*mm*.
Related Material: Similar to IC143
Citations: Fleischhauer, 1960, 501; Baines, 1976, 60 Plate II.

SD217 Louvre Egyptian Trumpet
Find Spot: ? Egypt
Date of Find: Not known
Dating of Item: Roman Egypt, ID based on Not known
Current Location: Louvre Museum
Condition: Fragmentary
Description: 540*mm* Copper tube; opens out from 15*mm* to 160 *mm* diameter. Rapidly opening flared bell.
Related Material: None, only vaguely similar to SD201/2.
Citations: Hickmann, 1946; Boreux. Guide Catalogue du département des antiquites égyptienne du Musée National du Louvre, Paris, 1932, 634.

SD218 River Erne Horn
Find Spot: River Erne, Coolnashanton, Fermanagh
Date of Find: Not known
Dating of Item: Possibly early Medieval, ID based on Decoration on bronze bands
Current Location: Ulster Museum
Condition: Almost complete
Description: Wooden horn bound with bronze bands.
Related Material: Similar in construction to SD252. Similarity in binding to SD251.
Citations: Waterman, 1969, 101

SD219 Bronze Age Horn Lund
This entry transferred to SD155

SD220 Klein-Winternheim tuba
Find Spot: Klein—Winternheim, Mainz
Date of Find: Not known
Dating of Item: Roman, based on Associated finds, iconography
Current Location: Altertumer Sammlung, Mainz
Condition: Almost complete
Description 1.57*m* long conical tube made in sheet iron 2.5 *mm* thick. Maximum diameter of tube 105*mm*. Found with votive offerings.
Related Material: Similar to IC144
Citations: Behn, 1912, 36.

SD221 Wismar horn fittings
Find Spot: Wismar, Mecklenburg-Schwerin
Date of Find: 19th Century
Dating of Item: Early Bronze Age, based on Morphology and decoration
Current Location: Schwerin Museum, Nr. 80
Condition: Complete
Description: Mouthsupport, central ring and bell garland for a horn cast in bronze using lost wax. Bell garland is decorated with motifs typical of Nordic Bronze Age
Related Material: Morphologically similar to SD222
Citations: Oldeberg, 1947, 9; Behn, 1954, Abb. 4; Sprockhoff, 1956, Abb. 60a; Broholm, 1949, 79, Figure 30.

SD222 Teterow horn fittings
Find Spot: Teterow, Mecklenburg-Schwerin
Date of Find: 19th century
Dating of Item: Early Bronze Age, based on Morphology, similarity to SD221
Current Location: Schwerin Museum, Nr. 2375
Condition: Complete
Description: End fitting for a horn with mouthsupport. Cast by lost wax in Bronze.
Related Material: Similar to SD221, 227
Citations: Broholm, 1949, 100; Oldeberg, 1947, 142; Schmidt, 1915, 143, Abb. 30/31

SD223 Nizza Horn
Find Spot: Said to be Nice
Date of Find: Prior to 1910
Dating of Item: Celtic, La Tene? based on Similarity to SD211
Current Location: Deutsches Museum, Munich
Condition: Almost complete I
Description: Wrought bronze tube, method of seam manufacture not visible. 0.917*m* long bell yard opening out from 27.5 to 100*mm* diameter tube yard of 0.976*m* long parallel with 25*mm* diameter. Two strips cover seam along outer radius of instrument.
Related Material: With exception of tube seam, similar to SD211, SD224, SD225, SD229. Similar to IC148 and SD16.
Citations: Behn, 1954, 143, Taf. 81, Abb. 184; Bragard, 1968, 38 (Superficial).

SD224 Rosscrea Trumpet Tube
Find Spot: Possibly Rosscrea
Date of Find: Not known
Dating of Item: La Tène, based on Similarity to SD211
Current Location: National Museum of Ireland, Dublin
Condition: Complete
Description: Rivetted bronze tube with two cast bosses. 0.882*m* long bronze tube, 51.5*mm* diameter with cast bosses at either end of tube.
Related Material: Similar to SD211, SD223, SD225, SD229, IC148 and SR16.
Citations: None known.

SD225 Ardbrin Trumpet
Find Spot: Ardbrin Crannog, Anaghclone, Co. Down
Date of Find: 1809
Dating of Item: La Tène, based on Similarity to SD211
Current Location: National Museum of Ireland, Dublin
Condition: Complete
Description: Tube yard of 22*mm* diameter x 1.07*m* long and bell yard tapering from 22,4 to 88*mm* diameter x 1.49*m* long. Tube rivetted along inner curve to internal rivetting strip.
Related Material: Similar to SD211, SD223, SD224, SD229, IC148, SR16.
Citations Wilde, 1861, 630, Figure 531; Fox, 1946, 45. pi. XII.

SD226, Deskford Boars Head
Find Spot: Deskford Liecheston, Banffshire
Date of Find: Not known
Dating of Item: 1st·century AD, based on Design Style
Current Location: National Museum Antiquities of Scotland, Edinburgh
Condition: Fragmentary
Description: Boars head made of rivetted sheet, identified by Piggott as the termination of a Carnyx.
Related Material: Some similarityto iconography of carnyces
Citations: Piggott, 1959, 24 ff.

SD227 Bochin Horn Fittings
Find Spot: Bochin, Lenzen, Westprignitz, Brandenburg
Date of Find: 19th Century
Dating of Item: Early Br0nze Age, based on Decorative motifs
Current Location: Schwerin Museum
Condition: Fragmentary
Description: Small fragment, cast in bronze of bell fitting for a horn.
Related Material: Similar to SD221, SD222
Citations: Coles, 1963, 344; Schmidt, 1915, 148, Abb. 36; Oldeberg, 1947, 9.

SD228 Latdorf Mouthsupport Ring
Find Spot: Latdorf, Saale
Dating of Item: Bronze Age pre-stage
Current Location: Bernburg Museum
Condition: Fragmentary
Description: Fragment of bronze tube with a bent over edge or rim. On the inside at the edge where the rim is the tube has an irregular ring of resin as well as remnants of wooden pegs.
Citations: Coles, 1963; Schmidt, 1915, 142; Oldeberg, 1947, 11; Olshausen, 1891, 847

SD222 Llyn Cerrig Trumpet
Find Spot: Llyn Cerrig Anglesey
Date of Find: 1945
Dating of Item: La Tène, based on Associated finds and similarity to SD211
Current Location: National Museum of Wales, Cardiff
Condition: Fragmentary
Description: A 555*mm* fragment of rivetted bronze tube, seam of wavy form featuring internal rivetting strip. Cast boss at one end of tube.
Related Material: Similar to SD211, SD223,
Citations: Fox, 1946, 44.

SD230 Water Newton Mouthpiece
Find Spot: Water Newton i
Current Location: Peterborough Museum
Description: Mouthpiece in bronze
Citations: Webster, 1960, 91, No. 230; Artis, 1828, Plate XXXVI, No. 1.

SD231 Caere Lituus
Find Spot: Caere (Cervetri)
Date of Find: 1827 ?
Dating of Item: 4th century BC, based on Associated finds, conography
Current Location: Museo Etrusco Gregoriano, Saal III, Vitrine H. nr. 14.
Musical Characteristics: In G, sounds 2nd to 8th harmonics
Description: 1.60*m* long instrument, presumably similar construction to SD212.
Related Material: Similar to SD212, IC2, IC6.
Citations: 1960, 501.

SD232 Hannover Lituus
Find Spot: Near Hannover, Germany
Date of Find: 1857
Dating of Item: Possibly Celtic, Late Iron Age, based on Iconography
Current Location: not known `
Condition: Probably complete
Constructional Details: Cast Materials Bronze
Description: Conically bored instrument, 992*mm* long. Bell opening 107 mm. Bell turns through 90°. Conical mouthpiece apparently surrounded by a cast lead ring. Carrying. rings on tube and bell yards. Central ferrule Eye-shaped cross-section.
Related Material: Similar to SD203, 204, 240, 241, 242, 244, and 248. Type illustrated in IC150.
Citations: Olshausen, 1891, 857, Figure 4; Behn, 1912, 38, Abb. 4 (d).

SD233 Assyrian Shell Trumpet
Description Assyrian shell tritonium variegatum identified by Dr. F.W. Galpin as an end-blown shell trumpet.
Citations: Sachs, 1940.

SD234 Tepe Hissar Trumpet
Find Spot: Tepe Hissar, level Illc
Dating of Item: ca. 2000BC, based on Associated Finds
Current Location: Lost
Description: Short silver instrument which appears to have mouthpiece tube and bell.
Related Material: SD235, SD236, SD237.
Citations: Piggott, 1967, 96, Figure 23.

SD235 Tepe Hissar Trumpet
Find Spot: Tepe Hissar level IIIc
Dating of Item: ca. 2000BC, based on Associated Finds
Current Location: Lost
Description: Short silver instrument which appears to have mouthpiece,tube and bell.
Related Material: SD234, SD236, SD237.
Citations: Piggott, 1967, 96, Figure 23.

SD236 Asterabad Trumpet
Find Spot: Asterabad
Dating of Item: ca. 2000BC
Based on Similarity to Tepe Hissar Material
Current Location: Lost
Condition: Fragmentary

Description: Part of golden trumpet with tube yard, boss and flared bell.
Related Material: SD254, SD235, SD237.
Citations: Piggott, 1967, 96, Figure 24.

SD237 Asterabad Trumpet
Find Spot: Asterabad
Dating of Item: ca. 2000BC, based on Similarity to Tepe Hissar material
Current Location: Lost
Condition: Fragmentary
Description: Part of golden trumpet with mouthpiece, tube yard, boss and fragment of flared bell.
Related Material: SD234, SD235, SD236.
Citations Piggott, 1967, 96, Figure 24.

SD238 Klagenfurt Cornu
Find Spot: Baths District of Virunum
Dating of Item: Roman, based on Similarity to other Roman material.
Current Location: Landesmuseum für Kärnten, Klagenfurt, Austria.
Condition: Fragmentary
Description: Fragment of bell of cornu with bell end and annular bell disc.
Citations: Klar, 1971; Schenk, 1946, 35, Abb, 1.

SD239 Naples Cornu
Current Location: Museo Nazionale, Naples, No. 71.329
Condition Complete?
Description: one of two cornua in the Museo Nazionale
Citations: Fleischhauer, 1960, 502.

SD240 Celtic ? Lituus
Find Spot: Near Goedereede
Dating of Item: Celtic, Late lron-Age, based on lconography
Current Location: Town Hall, Goedereede, Holland
Condition: Complete, repaired
Musical characteristics: A3, A4, E5, A5
Constructional Details: Cast, phobably two-part mould with wrought additions. Materials Brass
Description: Conically-bored instrument, 78*m* long of roughly octagonal cross-section. Mouthpiece of wide throat of 8.9 mm passing into bore - terminates at bell 100 mm A/F. Bell turns through approx. 60°. Instrument made in three pieces: mouthpipe + central yard + bell yard. Central part now repaired with sheet. Carrying mounts on tube and bell yards probably rivetted on.
Related Material: Similar to SD203, 204, 232, 241, 242,
Citations: Trimpe-Burger, 1960-61, 202, Afb. 6.

SD241 Caprington Horn
Find Spot: Coilsfield, in Kyle, Ayrshire
Date of Find: Before 1654
Dating of Item: Celtic, Late Iron Age, based on Iconography
Current Location: Caprington Castle, nr. Kilmarnock
Condition: Complete
Musical Characteristics: C#4, C5, G#5, C#6.
Constructional Details: Cast, split mould. Materials Bronze: 90.26% Cu. 9.61% Sn.
Description: Conically bored instrument 635*mm* long, tapering from 4*mm* (throat) to 102*mm* diameter. This curves through approx. 75° and is slightly flared. Conical mouthpiece. Instrument now in two pieces with brass sleeve (probably modern) joining these together. Carrying mounts on tube and bell yards. Round cross section.
Related Material: Similar to SD203, 204, 232, 240, 242 and 248. Type illustrated on IC150.
Citations: Behn, 1912, 38; Cochran-Patrick, 1878, 74-5; The New Statistical Account of Scotland, Vol. V, 1845, W. Blackwood and Sons.

SD242 Charlottenburg Lituus
Find Spot: River Main, between Florsheim and Russelsheim.
Dating of Item: Celtic, probably Late Iron Age, based on Iconography
Current Location: Charlottenburg Museum, Berlin
Condition: Complete
Constructional Details: Cast, lost wax. Materials Bronze
Description: Conically-bored instrument 702*mm* long tapering from 4.5*mm* (throat) to 114*mm* diameter bell. This curves through 90° but remains basically conical. of integral construction. Carrying mounts on mouthpipe and bell yard. Eye shaped cross-section.
Related Material: Similar to SD203, 204, 232, 240, 241 and 248. Type illustrated on IC150.
Citations: F Klar, 1971, 308-9, Abb. 3; Behn, 1912, 38.

SD243 Naples Cornu
Find Spot: Pompeii
Dating of Item Prior to 79 AD
Current Location: Saal LXXIX, Museo Nazionale in Naples, No. 71.330
Condition: Complete
Description: Cornu with a diameter of 1.26*m* in G. Total length 3.33 m.
Citations: Klar, 1971; Fleischhauer, 1960, 502.

SD244 Köslin Horn
Find Spot: Gollenberg, near Köslin, now Kozsalin, Poland
Date of Find: Before 1586
Dating of ltem: Possibly Celtic, Late lron Age, based on lconography
Current Location: Not known
Condition: Possibly complete although repaired
Constructional Details: Cast. Materials Bronze
Description: Conically bored instrument 820*mm* long opens out to bell which turns through 90°. No mounts, one loop on inner curve of bell.
Related Material: Similar to SD203, 204, 232, 240, 241, 242 and 248. Type illustrated on 1C150.
Citations: Behn, 1912, 38-9; Spielberg, 1922; Olshausen, 1891, 860-1; Noak, 1872, 217.

SD245 Lydney Mouthpiece
Find Spot: Lydney
Date of Find: 1928
Dating of Item: Roman, based on Similarity to other material
Condition: Complete
Description: Mouthpiece made of bronze. Complete in itself showing no signs of attachment to remainder of instrument.
Citations: Report on the excavation of the pre-historic, Roman and Post Roman site at Lydney Park, 1932, 81, Figure 16, No. 47.

SD246 Heddenheim Mouthpiece
Find Spot Heddenheim, Germany
Dating of Item: Roman, based on Similarity to other material
Description: Roman mouthpiece, complete, no evidence of having been joined to rest of instrument.
Citations: Report on the excavation of the pre-historic, Roman and Post Roman site at Lydney Park, 1932, 81, Figure 16, No. 47.

SD247 Waldmössingen Mouthpiece
Find Spot: Waldmössingen, Germany
Dating of ltem: Roman, based on Similarity to other material
Description: Roman mouthpiece, complete, no evidence of having been joined to rest of instrument.
Citations: Report on the excavation of the pre-historic, Roman and Post Roman site at Lydney Park, 1932, 82; Lief, p. 7, Taf. lll, VI.

SD248 Bonn Bell End
Current Location: Rheinisches Landesmuseum Bonn
Description: Bronze bell of conical form with downstream end bent through about 120°. Described by Klar as Lituus bell but is more conical and less curved than the typical litui of this area.
Citations: Klar, 1971, 307.

SD249 Stenstugan Horn
Find Spot: Stenstugan, Lindholm, Barva Parish, Sodermanland, Sweden
Current Location: Statens Historiska Mu. Stockholm, No. 6626
Condition: Fragmentary
Description: Mouthpipe and bell made of sheet as fittings for animal horn some of which remains attached to metal parts.
Citations: Oldeberg, 1947.

SD250 Wooden Instrument from Becan
Find Spot: Becan, Co. Mayo, lreland
Current Location: National Museum of Ireland
Condition: Fragmentary
Description: A wooden instrument of straight form nearly two metres long with a bell diameter of 83*mm*. Made of two halves of willow held together by spiral bronze band.
Citations: Oldeberg, 1947, 81; Waterman, 1969, 101.

SD251 Killyfaddy, nr. Clogher, Co. Tyrone
Dating of Item: not known, possibly end of Bronze Age or
Lron Age
Based on: Morphological similarity to Iron-Age rivetted horns
Current Location: National Museum of Ireland, Dublin
Condition: Fragmentary
Description: 2.7*m* long parallel wooden tube, 50*mm* outer diameter, made in four roughly equal yards. These made by hollowing out in two parts then putting together and binding with bronze strip. This
nailed into wooden yards.
Related Material: Morphological similarity to Iron-Age rivetted horns: SD211, 225, 224, 225, 229. Similarity in construction with
SD218 and 251.
Citations: Wilde, 1857, 244; Schmidt, 1915, 130; Oldeberg, 1947, 81.

SD252 Diamond Hill Wooden Instrument
Find Spot: Diamond Hill, Killashandra, Co. Cavan, Ireland
Description: Side-blown wooden instrument of Yew with bore formed from a slot cut on the inner curve.
Citations: Oldeberg, 1947,81.

SD253 Colchester Mouthpiece
Find Spot: Colchester
Dating of Item: Roman, based on Similarity to other material
Description: Mouthpiece of a Roman trumpet
Citations: Webster, 1960, 75, Plate IV

SD254 Great Chesterford Mouthpiece
Find Spot: Great Chesterford, Essex
Dating of Item: Roman, based on Similarity to other material
Current Location: British Museum
Condition: Complete
Description: Mouthpiece 159 mm long with wide shallow 24*mm* diameter cup.
Citations: BM Guide, 1922, 22.

SD255 Castle Cary Mouthpiece
Find Spot: Castle Cary on the Antonine Wall
Dating of Item: Roman, based on Associated material
Current Location: National Museum of Scotland, Edinburgh ·
Condition: Complete
Description: Mouthpiece with 24*mm* diameter rim, 20*mm* diameter cup, 11*mm* deep and throat 5.5*mm*.
Citations: Klar, 1971, 334, Abb. 4e; Liversidge, 1972, 358.

SD256 San Cerbone Ivory Horn
Find Spot Room: 2 of the Podere di San Cerbone, Populonia
Dating of Item: Etruscan based on Stratigraphical position
Condition: Fragmentary
Description: Fittings with fragments of ivory horn attached, made of gold with incised decorations.
Related Material: SD275
Citations: Minto, 1943, 128, Figure 15; Ducati, 1927, 172, Tav. 58, No. 174.

SD257 San Cerbone Bronze Horn
Find Spot: Room 2 of Tomb at the Podere di San Cerbone, Polulonia
Dating of Item: Etruscan, based on Stratigraphical position
Condition: Appears complete from illustrations
Description: Curved bronze horn made in form of animal horn with clearly formed mouthpiece.
Citations: Minto, 1943, 145, Tav. XXI, No. 2,

SD258 Ras Shamra Ivory Horn
Find Spot: Ras Shamra
Dating of Item: Etruscan, based on Similarity to SD256 and SD275
Description: Ivory horn from Ras Shamra
Citations: Minto, 1943, 128.

SD259 Terremaren Clay Horns
Find Spot: Terremaren (Po Valley, Northern Italy)
Date of Find: Pre-Roman
Description: Clay instrument of animal horn form, 450*mm* long with obliquely cut tip. Sounds fundamental + 2nd harmonic with great difficulty.
Citations: Behn, 1954, 127;

SD260 Naples Cornu
Current Location: Museo Nazionale, Naples
Description: Cornu Ill (No other information)
Citations: Klar, 1971, 311.

SD261 Naples Cornu
Current Location: Museo Nazionale, Naples
Description: CornulV (No other information)
Citations: Klar, 1971, 311.

SD262 Boston Salpinx
Dating of Item: Ascribed by Museum to 5th century BC but probably later V
Current Location Museum of Fine Arts, Boston
Description: Single coned tuba made up of 15 sections of ivory with bronze strengthening rings and bronze bell. Overall length 1.57*m*,
slight flare on bell. Mouthsupport.
Citations: Bate, 1966, 94; Caskey, 1937, 525, figs. 2, 5, 4, 5.

SD265 Nemzeti Tuba
Find Spot: Zxambek
Current Location: Nemzeti Museum, Budapest
Condition: Most of tube and bell yards present. Mouthpiece missing.
Description: Single coned tuba, 1.56*m* long with 95*mm* bell diameter.
Citations: Baines, 1976, 63.

SD264 Numancia Clay Horns
Find Spot: Numancia, Spain
Date of Find: 1905
Dating of Item: Prior to 133 AD, based on stratigraphy, documentary accounts
Current Location: Museo Numantino
Condition: Fragmentary
Constructional Details: Formed in clay, painted decoration.
Description: Bell of instrument, very fragmentary.
Related Material: Similar to SD210, 265.
Citations: Bragard, 1968, 38 (Superficial); Comision Ejecutiva, 1912, 40, Plate LV; Behn, 1954, Taf. 81, Abb. 185.

SD265 Numancia Clay Horns
Find Spot: Numancia, Spain
Date of Find: 1905
Dating of Item: A Prior to 133AD, based on Stratigraphy, documentary accounts
Current Location: Museo Numantino
Condition: Fragmentary
Constructional Details: Formed in clay, painted decoration
Description: Bell of horn, opens out rapidly to cup-shaped form.
Related Material: Similar to SD210, 264.
Citations: Bragard, 1968, 38 (Superficial);
Comision Ejecutiva, 1912, 40, Plate LV; Behn, 1954, Taf. 81, Abb, 185.

SD266 Numancia Clay Horns
Find Spot: Numancia, Spain
Date of Find: 1905
Dating of Item: Prior to 155 AD, based on Stratigraphy, documentary accounts
Current Location: Museo Numantino
Condition: Fragmentary
Constructional Details: Formed in clay, painted decoration
Description: Straight bell end of horn, slightly flared. 155*mm* long x 95*mm* diameter. Elaborately painted with geometrical designs.
Related Material: Somewhat similar to SD210, SD264, SD265,
Citations Bragard, 1968, 38 (Superficial); Comision Ejecutiva, 1912, 40, Plate XXXVl—B; Behn, 1954, Taf. 81, Abb. 185.

SD267 Trumpet ? Tube Mohendjo-Daro
Find Spot: Five feet below surface, Room 9, Block 12, Section C DK Area, Mohendjo-Daro
Description: Piece of bronze tube, 572*mm* long by 20 diameter by 2.8*mm* thick. One end complete, has edge turned down outside the tube for a distance of 8.1*mm*. Other end of tube missing.
Citations: Marshall, 1931, 506, Plate CXLIV, No. 1.

TSD268 Trumpet ? tube Mohendjo-Daro
Find Spot: 6 feet below surface, Room 105, House XII, Block 2, HR Area, Mohendjo-Darol Description Small portion of copper tube 72 mm long by 5 mm thick.
Citations: Marshall, 1931, 507, Plate CXLIV, No. 10.

SD269 Clay Instruments, Cyprus
Description Clay instrument(s) found in Cyprus lacking bells.
Citations: Hickmann, 1961, 40.

SD270 Megaphone Kvalsund
Find Spot: Kvalsund, Norway
Dating of Item: 500-600 AD (Iron-Age)
Current Location: Historisk Museum, Bergen, No. B 7600/91
Description: Funnel shaped wooden megaphone, narrow opening cut off squarely. Two bands encircle the wide end immediately under
a large opening. Found in a bog among the remains of two boats. Overall length 725*mm*, thickness of wall 6*mm*, largest diameter 250*mm*, smallest diameter 60*mm*.
Citations: Lund, 1974, 19; Shetelig and Johannessen, 1929, 39, 70, Figure 18, No. 91.

SD271 Konsterud Cowhorn
Find Spot: Konsterud, Visnum sn, Värmland, Sweden
Dating of Item: 500BC-0AD
Current Location: Värmlands Museum, Karlstad, No. 19969
Description: Cowhorn with five fingerholes with tip cut off. Hole at exit for carrying strap, two rings carved around mouthpiece end, further ornamented with engraved lines. Bogfind. Overall length 275 mm.
Citations: Lund, 1974, 19

SD272 Sandbäcksmyren Cowhorn
Find Spot: Sandbäcksmyren, Hedemora sn, Dalarna, Sweden
Dating of ltem: 900AD (Viking Period, lron-Age
Current Location: Dalarnas Museum, Falun, No. 7279
Description: Cowhorn with four fingerholes, two decorations around exit, remains of two holes for carrying strap. Tip cut off squarely. Bogfind. Overall length 222*mm*.
Citations Lund, 197%, 20.

SD273Virunum Cornu
Find Spot: Baths district of Virunum
Current Location: Landesmuseum fur Kärnten, Klagenfurt, Austria
Description: Fragment of Cornu
Citations: Klar, 1971; Schenk, 1946, Abb. 1.

SD274 Ovilaba Cornu
Find Spot: Wels, Austria
Description: Fragmentary parts of bell yard and bell of cornu.
Citations: Kaff, 1952, 54.

SD275 Barberini Ivory Horn
Description: Etruscan ? ivory horn fittings similar to San Cerbone horn.
Citations: Minto, 1943, 128.

SD276Bonn Mouthpiece
Dating of Item: lst Century AD
Current Location: Landesmuseum, Bonn, No. 16077n
Description: Fairly large instrument mouthpiece.
Citations: None known

SD277 Bonn Mouthpiece
Dating of Item: 2nd Century AD
Current Location: Landesmuseum, Bonn, No. 26525n
Description: Instrument mouthpiece.
Citations: None known.

SD278 Edinburgh Mouthpiece
Current Location: National Museum Scotland, Edinburgh, No. D0 10
Description: Mouthpiece of Celtic lituus type, integrally cast, external form horn-shaped.
Citations: None known.

SPECIMEN REPRESENTATION

These details are also provided on my web site http://www.hornandtrumpet.com, along with images where possible.

SR1 Terracotta Trumpet
Find Spot: Mont Ventoux, France
Dating of Item: Roman
Current Location: British Museum, No. 1904 2-4-40
Description: Terracotta model or actual trumpet of single cone form with developed mouthpiece.
Citations: None known.

SR2 Bronze Statue, Side-blown Salpinx Player
Find Spot: Campania
Dating of Item: 470BC
Current Location: British Museum, Ref. Bronzes 223, Temple Bequest
Description: Small model blows instrument of salpinx form, holding to left. Bell end of instrument of cono-cylindrical form.
Citations: None known.

SR3 Cornu shaped Fibula
Dating of Item: Roman, based on Similarity to extant Roman instruments
Description: Roman fibula in form of a cornu with a large diameter flared bell and cross-brace with pointed ends, protruding from tube curve. Slight 'G' form to mouthpipe.
Citations: Behn, 1954, Abb. 143.

SR4 Statuctte of Trumpeter
Find Spot: Hradiště, near Stradonice, Moravia, Czechoslovakia
Dating of Item: lst Century BC
Current Location: National Museum, Prague
Description: Small statuette of player blowing up-curving instrument with prominent bell feature.
Citations: Déchelette, 1927, 685, Figure 500

SR5 Removed, as not relevant to PVAs

SR6 Removed, as not relevant to PVAs

SR7 Removed, as not relevant to PVAs

SR8 Removed, as not relevant to PVAs

SR9 Removed, as not relevant to PVAs

SR10 Removed, as not relevant to PVAs

SR11 Removed, as not relevant to PVAs

SR12 Removed, as not relevant to PVAs

SR13 Bronze figure of Trumpeter
Find Spot: Mylasa, Caria, Anatolia
Dating of Item: Early lron-Age, c. 800BC
Current Location: British Museum No. 130909
Description Figure: holds single cone tuba with slight flare in left hand, other hand on hip.
Citations: Rimmer, 1969, 29, Plate Vlllb,

SR14 Removed, as not relevant to PVAs

SR15 Hittite Figure blowing Horn
Description: Seated figure blowing short, very-conical single-cone tuba, held in left hand.
Citations: Behn, 1954, Abb. 91.

SR 16 Statue of Dying Gaul
Find Spot: Pergamon
Current Location: Museo Capitolino Rome
Description: Statue of Gaul sitting on shield, around periphery of which are two Celtic curved horns
Citations: Powell, 1948, 255, Plate 3

APPENDIX II

STATISTICAL ANALYSIS OF THE LUR DATA

Measurements of instrument segment lengths (y) and tube diameters (x) were subjected to analysis in order to obtain an indication of the inter—relationship between these. From simple graphical analysis it was apparent that a simple function of the form $y = mx + c$ represented this relationship quite closely. In order to investigate this more fully, the data was subjected regression analysis to obtain an equation for the "best-fit" line and a value for the correlation coefficient 'r'. A standard calculator program was used which minimised $(mx + c - y)^2$ to find the slope and zero intercept of the line. The correlation coefficient 'r', was calculated, again using a standard calculator program which gave a value of

$$r = \frac{\sum xy - \sum x \sum y\, n^{-1}}{\sqrt{\left(\left(\sum x^2 - \left(\sum x\right)^2\ n^{-1}\right)\left(\sum y^2 - \left(\sum y\right)^2 n^{-1}\right)\right.}}$$

Standard errors (syx) of the data from the best straight line were calculated using the equation

$$r = \frac{\sqrt{(y - yest)^2}}{N}$$

This analysis is based on direct use of the data as measured. However, the data itself is subjected to errors in collection, mainly arising from operation of the measuring devices used. In addition, given error-free measurement, variation from uniform straight-lines would be apparent, having arisen during manufacture. If the two sources of error are designated E_m (modern error) and E_a (ancient error) the equation defining the tube form would become:

$$y = mx + c + E_m + E_a$$

The ancient error itself could be sub-divided in

E_{a1} = error in evaluation of the mathematical function

$$y = mx + c$$

E_{a2} = error in ability to assess the attained dimensional accuracy

E_{a3} = error arising from the limitation in manipulative ability of the manufacturer.

APPENDlX III

PERCEPTION EXPERIMENTS

The Scandinavian Lurs exhibit various features whose presence is difficult to explain without some objective basis for assessing the degree of similarity of one instrument to another and the uniformity of the morphological form of individual instruments.

All of the features are interdependent and many can be expressed as secondary derivitives of other primary ones. For example, a variation of taper can be expressed as variation of end diameters of a given length of taper.

Neglecting their interdependence the features of interest are:-

l. Degree of roundness of individual elements of instruments.

2. Similarity of diameters between individual instruments of a pair.

5. Similarity of diameters throughout the whole group of lurs.

6. Similarity of slopes (derivative of length and diameters) between individual instruments of pairs.

5. Uniformity of individual slopes on elements of instruments.

6. Similarity of slopes between adjacent segments of individual instruments.

Interpretation of these features involves a judgement to be made as to their mode of manufacture, i.e. to determine if the consistent features were created simply by assessing diameter and slope by visual and tactile stimuli-or by techniques similar to those of modern engineering, i.e. gauging or measurement. Were figures to be available that defined the perceptual ability of the human to discriminate small differences of morphology, it would be possible to arrive at a value for the probability of these instruments having been made using only subjective (non—comparative) measurement in the derivation of their form.

As the manufacturer would have a wide range of stimuli, visual,

tactile etc. available, any work to arrive at values for this discrimatory ability would need to allow the subjects the same range of stimuli. Such experimentation differs from that normally carried by perceptual psychologists as the interpretation of data where more than one modality has been allowed to vary is complex when carried out rigidly. However, as a manufacturer would have available whatever techniques could be devised at the time to determine values for morphology any experiment carried out must allow the same latitude.

A search of the published literature was carried out in an attempt to locate any work that has been previously carried out in this field and thus help to establish an objective basis for assessing the dimensional acuity and stability of the perceptual process.

As no previous work appears to have been carried out to determine values for such features as outlined above, an experiment was designed in an attempt to determine whether such values can be determined with any degree of objectivity and what the magnitude of these values is.

However, as the experiment was being designed, it became apparent that the multi-modal testing proposed was quite novel. Hence, lacking any basic data upon which to base the design of the test specimens, a whole preliminary series of experiments would be required prior to the design of the experiment proper. lt was decided to abandon this attempt to establish these figures as part of this study and to carry it out at a later date.

Much work had been done, including detailed design of the experiments prior to the realisation of the magnitude of the task. This appendix outlines some of the thinking that went into the design of just one experiment, that testing for roundness discrimination.

DEPARTURES FROM ROUNDNESS

These can be described in two ways,as the difference between the largest and smallest radii of the measured profile measured from one or other of the centres:

i) the centre for which the radial difference has the smallest value

ii) the centre of a circle from which the sum of the squares of a sufficient number of equally spaced radial ordinates has a minimum value.[239]

Error in roundness may take many forms and as “natural" resulting from a hand manufacturing process is generally non-uniform. However, in order to be able to carry out an experiment that comes to a conclusion, however incomplete, it is necessary to manufacture specimens with limited, deliberately built in and quantifiable error. Were this limitation accepted, an almost infinite number of specimens would be required to obtain the required information.

A circle can be defined as a polygon with an infinite number of sides, the planeness of these being undetectable because of their size. However, as the number of sides decreases and hence, their size increases, they become individually detectable and the object is no longer perceived as circle, in the limit, with three plane sides, being perceived as a triangle and, with two curved sides, being perceived as an oval. This type of error is likely to occur where a circle is produced by the working of a tool backwards and forwards in the direction

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[239] Definition from BS3730:1964 "Methods for the assessment of departures from roundness.”

of its longitudinal axis. lt is noticably present on many round objects made by hand and in particular is quite readily detectable on the Gullåkra instrument.

However, in the forms examined, the degree of regularity in their shape is very much less than the regular polygon exhibits and the variations from this model are described below, the reference letters also refer to Figure 1:

a) Sides do not meet each other, i.e. angle subtended at centre not 360°.

b) Pairs of sides are replaced by a single side.

c) Sides are of totally irregular size.

d) The intersection of sides blends in with these, i.e. the edge is removed by a radius whose size can vary.

e) Unlike on a polygon the sides are not plane surface but may be curved or otherwise irregular in shape.

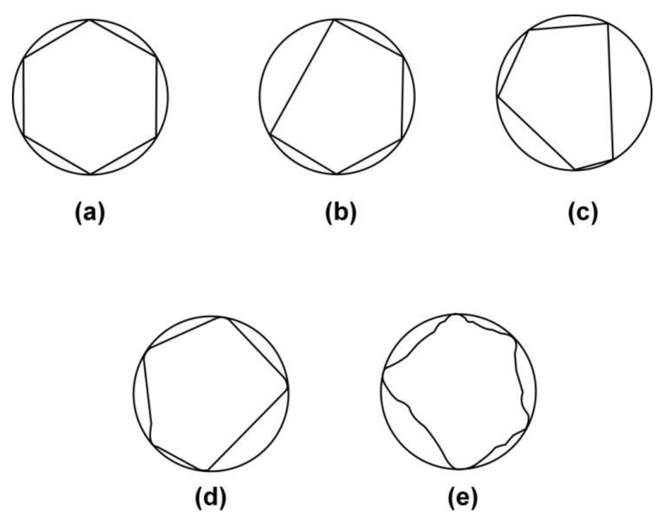


Figure 1: Departures from Roundness

Obviously, samples cannot be made to test for all the above conditions over a range of absolute errors, so some judgement must be made as to which elements will be incorporated in the design of the specimens.

A basic specification was evolved for the specimen design as follows:-

The specimens should:

a) be all of the same weight

b) be all of the same length

c) present no clear visual clues to roundness on their end

faces

d) contain no regular error that can be more readily detected by virtue of this regularity

e) individually, be of roughly the same out-of-roundness when viewed from different angles, i.e.

f) present no edges between any element of true diameter and error surface, i.e. be smoothly radiused in.

In an ideal situation the number of sides (N) of the generating polygon upon which the form was constructed would be an experimental variable as it is quite likely that absolute values of the detectable increment would vary with N.

Detail manufacturing drawings were produced based on these criteria.

APPENDIX IV

Definition of terms used to describe instruments in this study. In order to avoid the use of terms such as "top" and "bottom" which would have the tendency to relate the surfaces concerned to the cope and drag of a mould, the terms obverse and reverse have been used, as illustrated below, Figure 1.

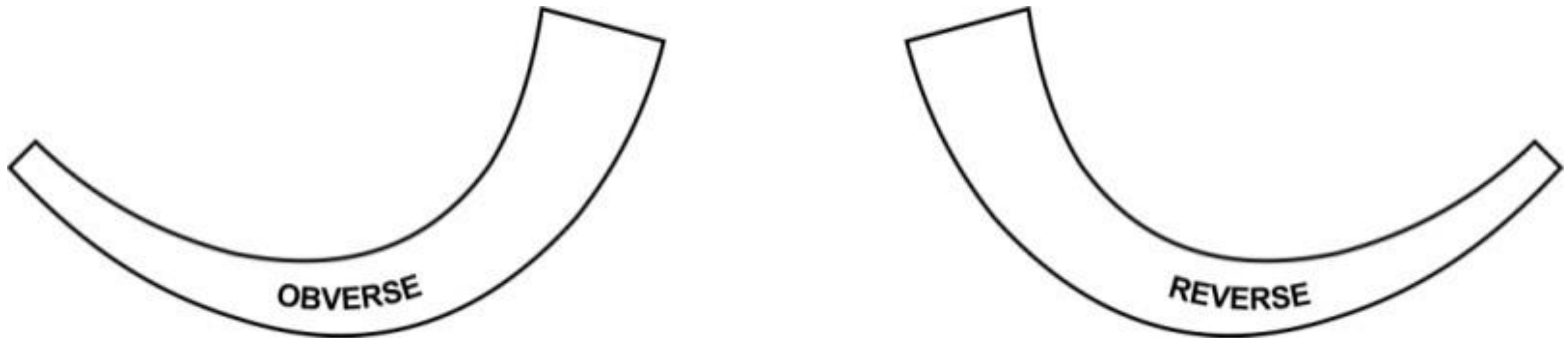


Figure 1: Terms to Define the Sides of an Instrument

The terms "tip-end" and "bell-end" have been used to refer to the blowing end and air-exit ends of instruments by analogy to animal-form instruments - See Figure 2. Separate structural units of instruments have generally been referred to as "yards" except in the case of that yard with an integral mouthpiece where the term mouthpipe has been applied. The terms "downstream" and “upstream" have been used by reference to the air flow in the instrument. See Figure 2.

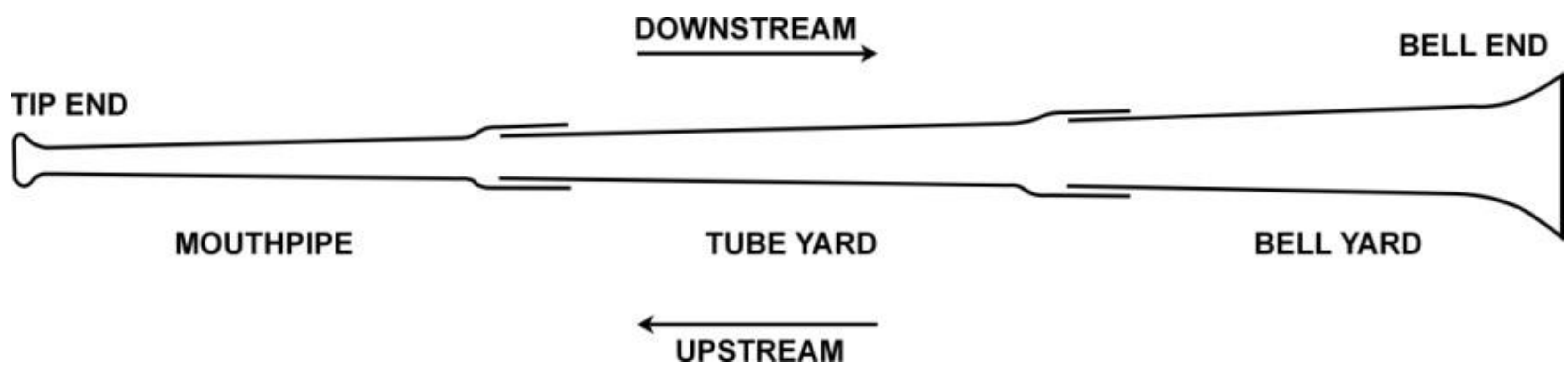


Figure 2: Terms used to Describe Instrument Elements

Mounting features have been termed "loops", "mounts", "rimgs" and "ring mounts" as illustrated on Figure 3.

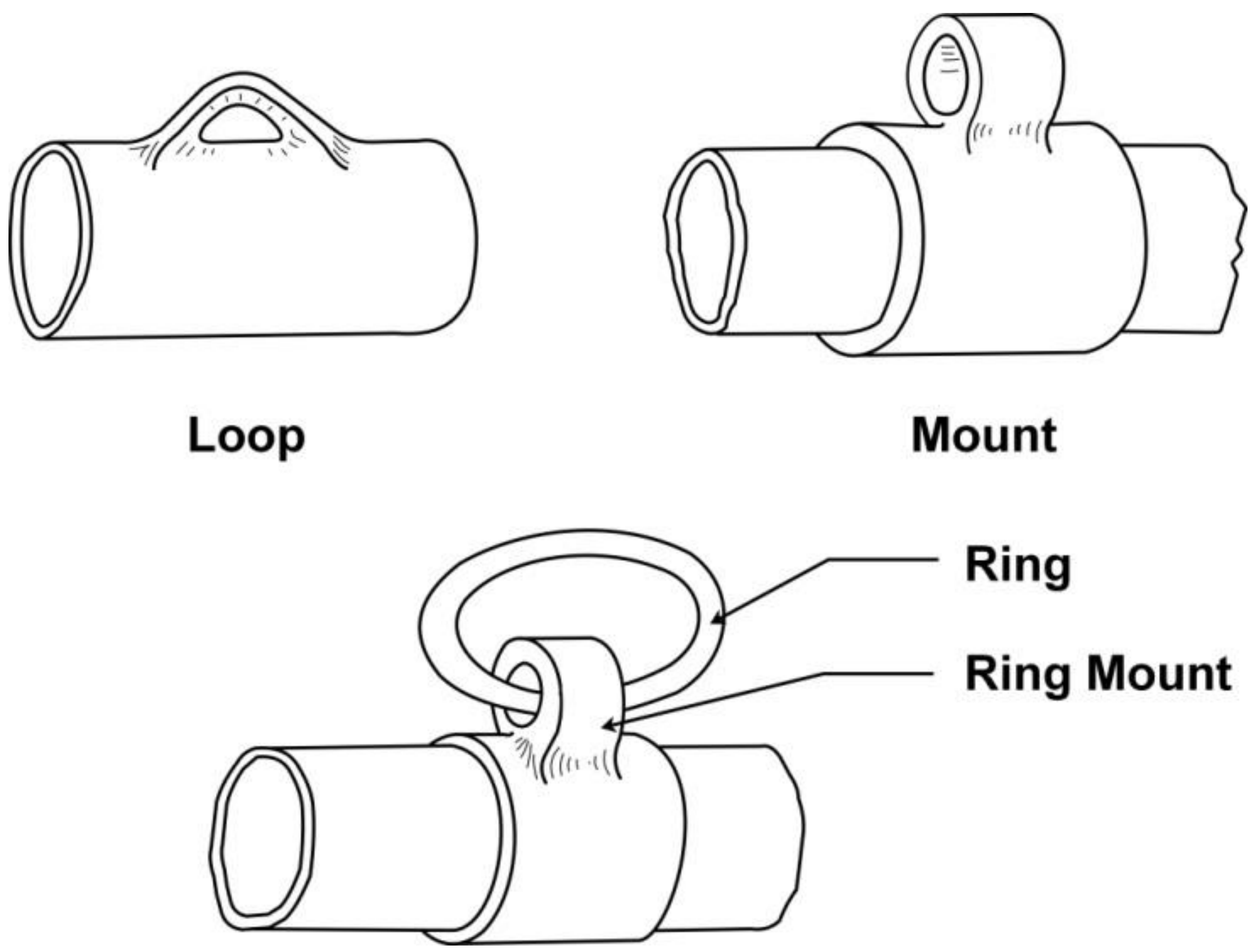
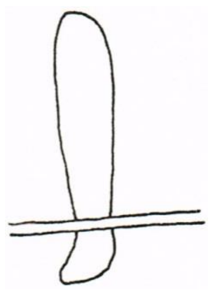


Figure 3: Mounting Feature Terminology

BRITISH MUSEUM REPORT ON DUNMAMWAY SSD IQAQ

Report of Research Department

"Examination of the radiograph suggests that the suspension loop
was probably cast in position as a lump of metal projects through
the main horn as follows:-



Microscopic examination of the suspension ring also suggests that it was cast in position, although no dendrites could be detected on the surface.

Emission spectroscopy showed that the metal in the area of the joint has the same qualitative composition as the suspension ring, indicating that solder or brazing alloy was not used in the construction at this point."

RF file 3577 3.6.74