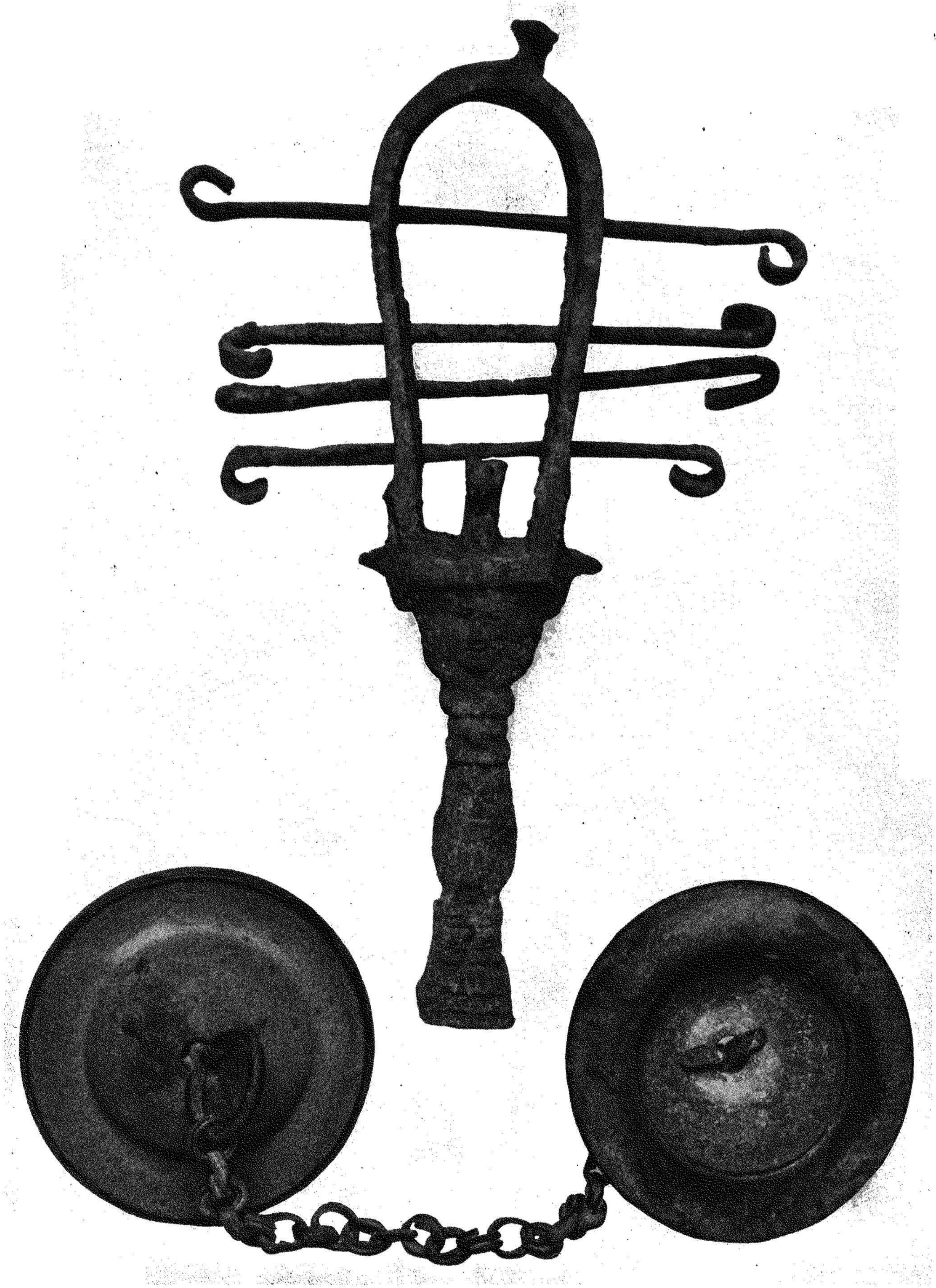

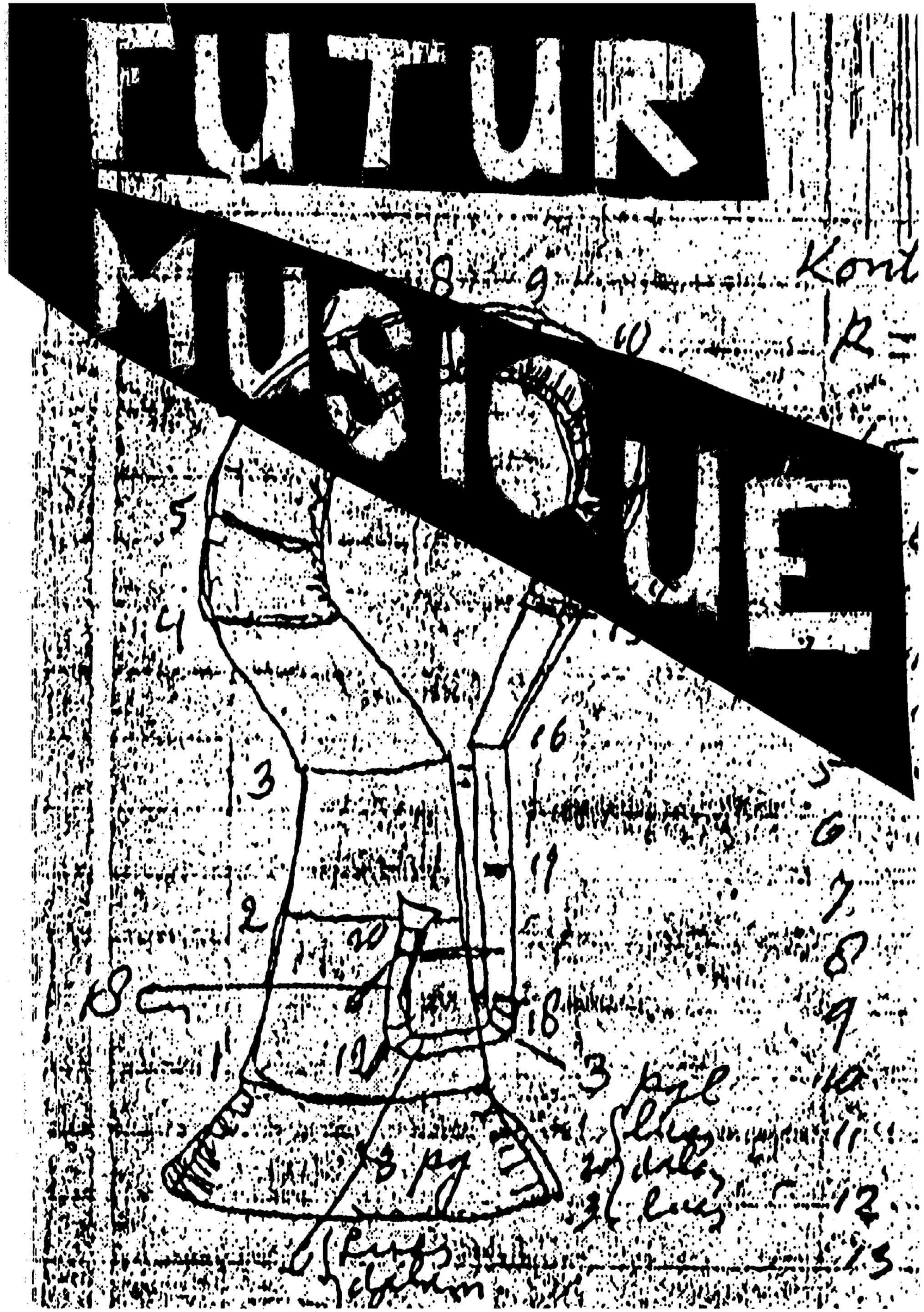
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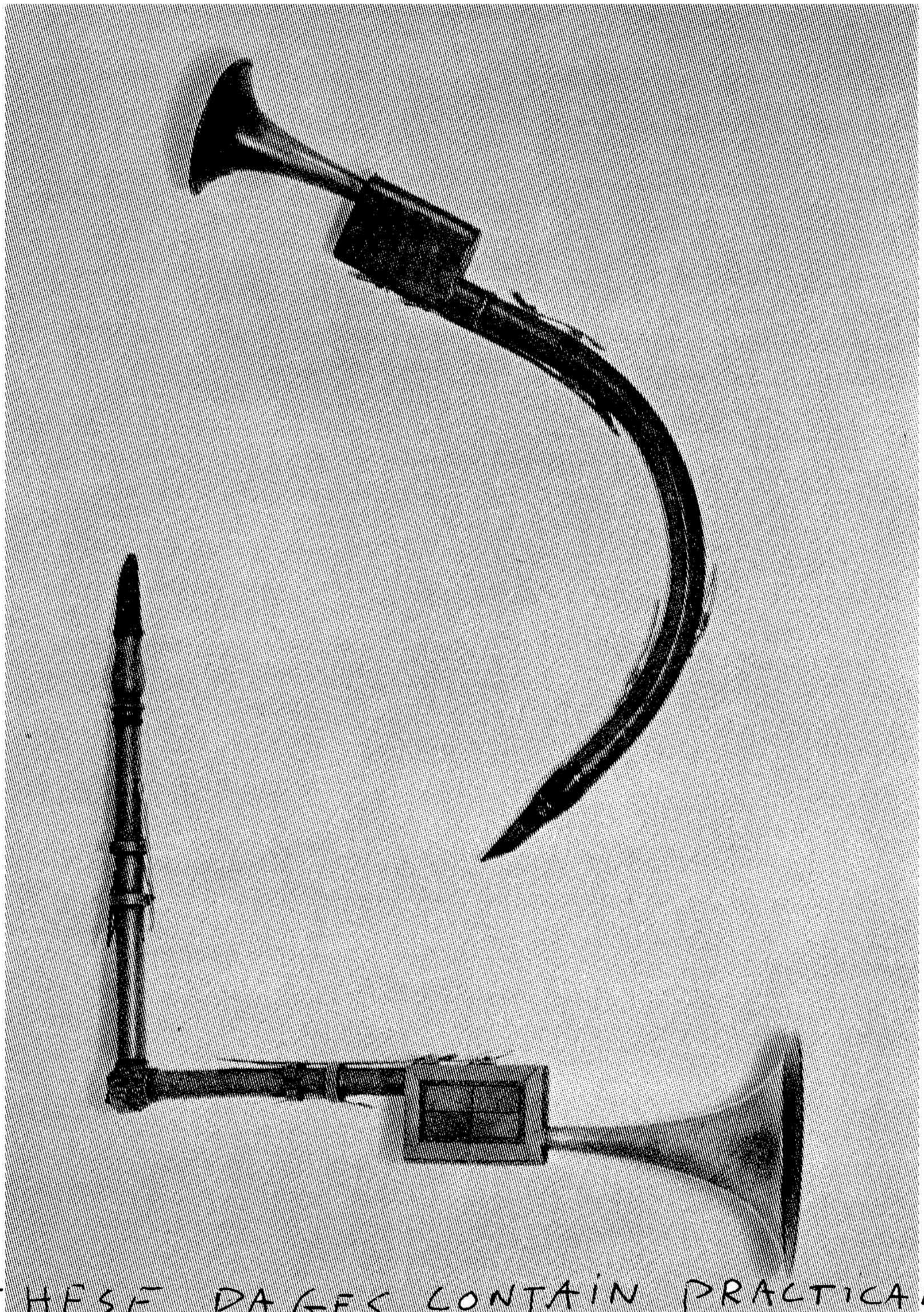

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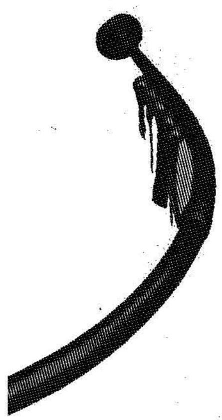


## APPROBATION.

J'AI lu par l'ordre de Monseigneur le Chancelier un Manuscrit intitulé : *le Clavessin Electrique*, & j'ai cru qu'il méritoit d'être imprimé. A Paris, ce 12 Juillet 1760.

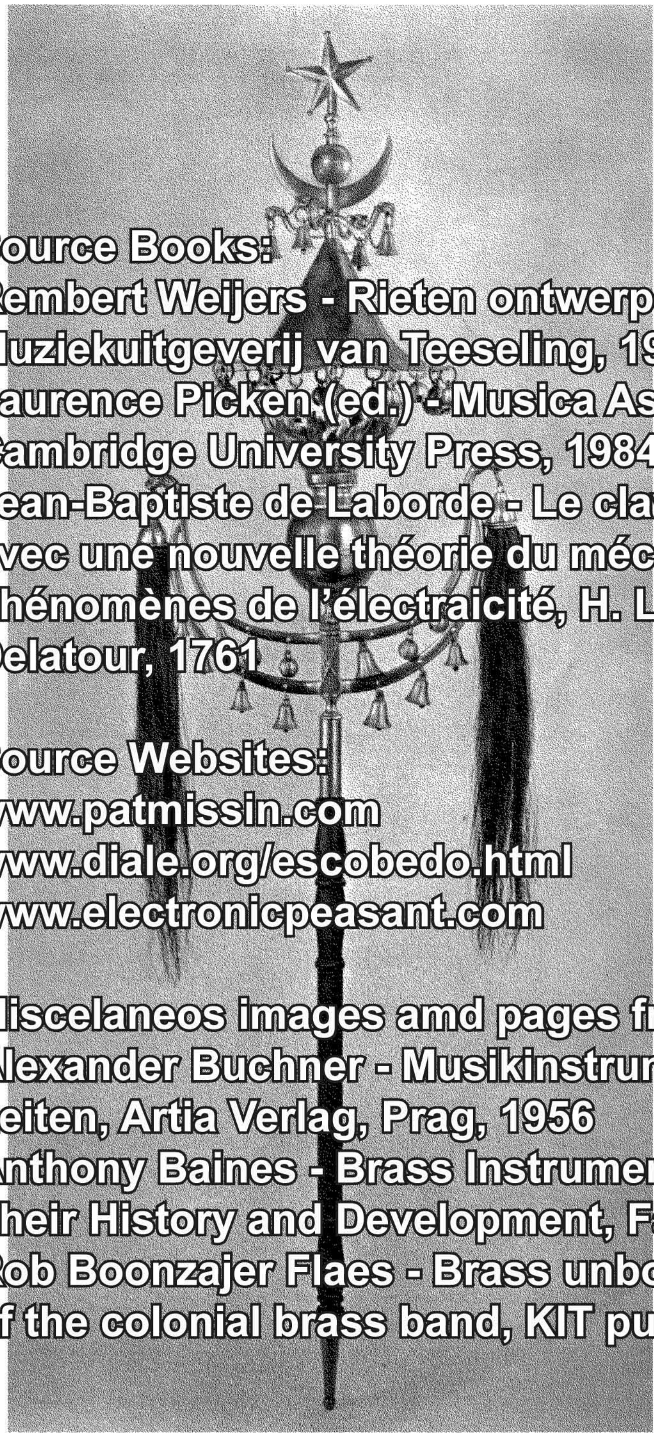
CLAIRAUT.

## *Approbation du R. P. Provincial.*

JE soussigné, Provincial de la Compagnie de Jesus, en la Province de France, suivant le pouvoir que j'ai reçu de notre R. P. Général, permets au P. Jean-Baptiste de la Borde, de la même Compagnie, de faire imprimer un Livre intitulé, *le Clavessin Electrique*, qu'il a composé, & qui a été vu & approuvé par trois Théologiens de notre Compagnie. En foi dequoi j'ai signé la présente permission. A la Fleche, ce 2 Juillet 1760.

MATTHIEU-JEAN-JOSEPH ALLANIC, de la Compagnie de Jesus.

CONTACT VIA WOODSTONE KUGELBLITZ



262 Schellenbaum, sogenannter chinesischer Hut aus dem 18. Jahrhundert.


**Source Books:**
Rembert Weijers - Rieten ontwerpen en maken, Muziekuitgeverij van Teeseling, 1978
Laurence Picken (ed.) - Musica Asiatica 4, Cambridge University Press, 1984
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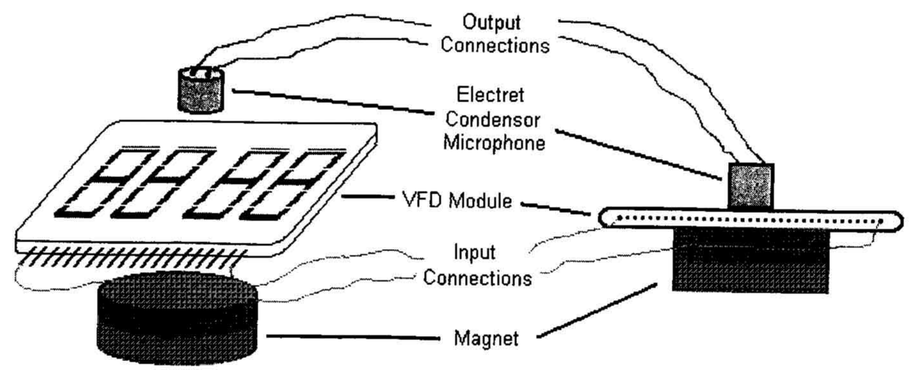
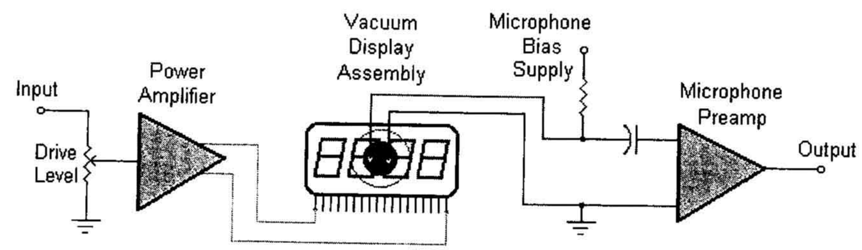
# The basic VFD ring modulator




The cathode resistance of a typical VFD just happens to be in the range of about 4 - 20 ohms, a reasonable match for almost any amplifier. Connecting to the cathode is straightforward, as it is usually wired to the two outside pins of the display. This can be easily verified with an ohm meter. If an audio signal from an amplifier is connected across the cathode and a strong magnet positioned against the display, the cathode wires can be made to vibrate in a similar way to the wires vibrating the cone of a speaker. In fact, if you look closely, the vibration of the cathode wires is clearly visible! A small microphone element held against the display picks up the sound of these vibrations, and the whole assembly is then placed in a soundproof box to minimise crosstalk.

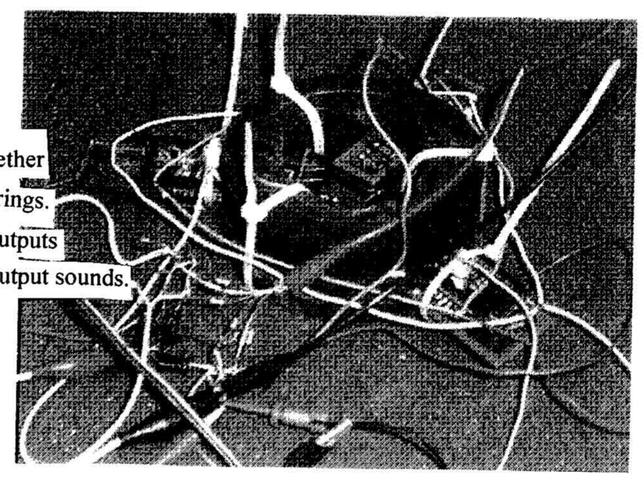
# Basic ring modulator wiring




A VFD ring modulator can be easily wired up using common audio components. More complex systems are only limited by one's imagination!

# Multi-display modulator

This unit consists of six different VFD tubes wired together and sandwiched between some large woofer magnet rings. Using a variety of different displays and mixing their outputs together results in a wider, more interesting range of output sounds.

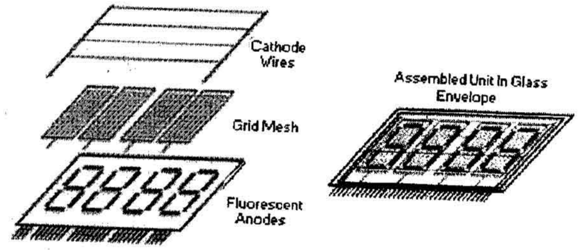


It's interesting to note that this entire assembly was built from 100% salvaged components. Magnets from old woofers, the bigger and stronger the better displays from dead

# VFD Ring Modulator

Here is a vacuum tube project that anyone can build, using easily available inexpensive parts, that involves no dangerous high voltages. Best of all, every part needed for this project can be obtained for free with a little ingenuity.

The heart of the ring modulator consists of what's called a vacuum fluorescent display tube. These glass tubes are used as displays in VCRs, tape decks, cd players, and microwave ovens, to name just a few.




Internal components of a typical VFD

These displays are actually a bunch of tiny triode tubes packaged together. In the front of the display is a self- heating cathode consisting of thin wires strung horizontally across the tube. Behind these are the grids, constructed of an extremely fine mesh that allows light to pass right through. In the back are the anodes, shaped in the desired display patterns and coated with a fluorescent paint, similar to the coating inside the face of a TV tube. In normal operation, electrons emitted from the cathode pass through the grids and strike the fluorescent anodes, causing them to glow.

An interesting characteristic of VFDs is the mechanical resonance produced by the vibration of their cathode wires. If you hold one of these displays up to your ear and tap it, you will hear a ringing sound as the wires vibrate, much like the strings of a guitar. Different displays have different natural resonances, so each different type sounds unique. If we excite these wires with an audio signal, their ringing resonance will be "modulated" on to that signal, therefore we have a type of "ring modulator". ;-)

VCRs, CD players, etc,
and electret condensor
microphones from
old portable
tape units.



Wanneer de geschiedenis van het rietinstrument precies begint is onbekend; misschien bij iemand uit de oertijd, die ontdekte dat grassprietjes geluid maken wanneer je er op een bepaalde manier op blaast. Voor ons begint de historie bij de vroegste sporen, die gevonden zijn in egyptische graven van ± 2000 jaar v. Chr. in de vorm van reliëfafbeeldingen en grafvondsten. Volgens deze afbeeldingen werden de vroege rietinstrumenten meestal bespeeld als dubbelinstrumenten; d.w.z. twee pijpen van riet werden gelijktijdig bespeeld, zoals bijv. de zummara (fig. 1) welke al te vinden is op een reliëf uit de 5e dynastie (± 2400 v. Chr.). Deze zummara treft men nog steeds aan in Egypte en Irak. Hij bestaat uit twee evenwijdige rietpijpen met in elk zes gaten; in iedere pijp steekt een enkelriet. Het instrument wordt bespeeld door met één vinger zowel een gat van de rechter als van de linkerpijp af te dekken. Het enkelriet (fig. 2) bestaat uit een stukje riet dat aan de bovenzijde gesloten is (door het af te zagen boven de knoop of af te dichten met bijv. bijenwas) en waar een spaander uit losgesneden is.
Deze spaander wordt afgeslepen tot de goede stemming bereikt is. Een dergelijk type riet treft men ook aan in de brompijpen van doedelzakken.

*Brompijp, zummara, hornpipe en volks klarinet*
Bij de materiaalkeuze (rietlengte en diameter) gaan we uit van het door de bouwer bijgeleverde riet. Men zaagt bamboe pijpjes van gelijke hoogte en diameter. Stond het oude riet te hoog, dan langere en bredere bamboepijpjes, stond het te laag dan kortere en smallere. Ieder soort bamboe en riet mits stevig genoeg is te gebruiken. Zelfs in nederland vindt men rietsoorten die voldoen (goed om je heen kijken).

*fig. 1a. dubbelriet instrumenten uit Egypte ± 1500 v. Chr.*

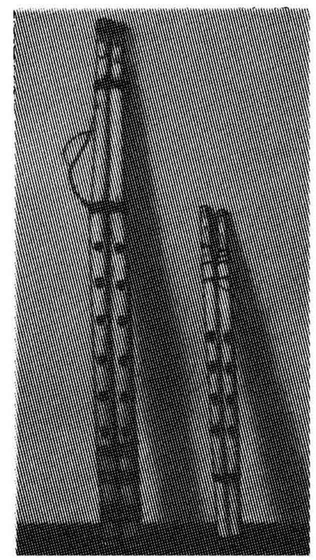


*fig. 1b. hedendaagse zummara (links) en hedendaagse mashûra (rechts)*

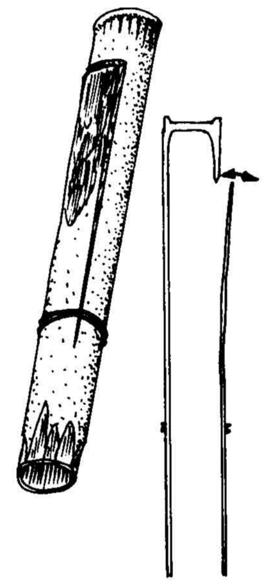
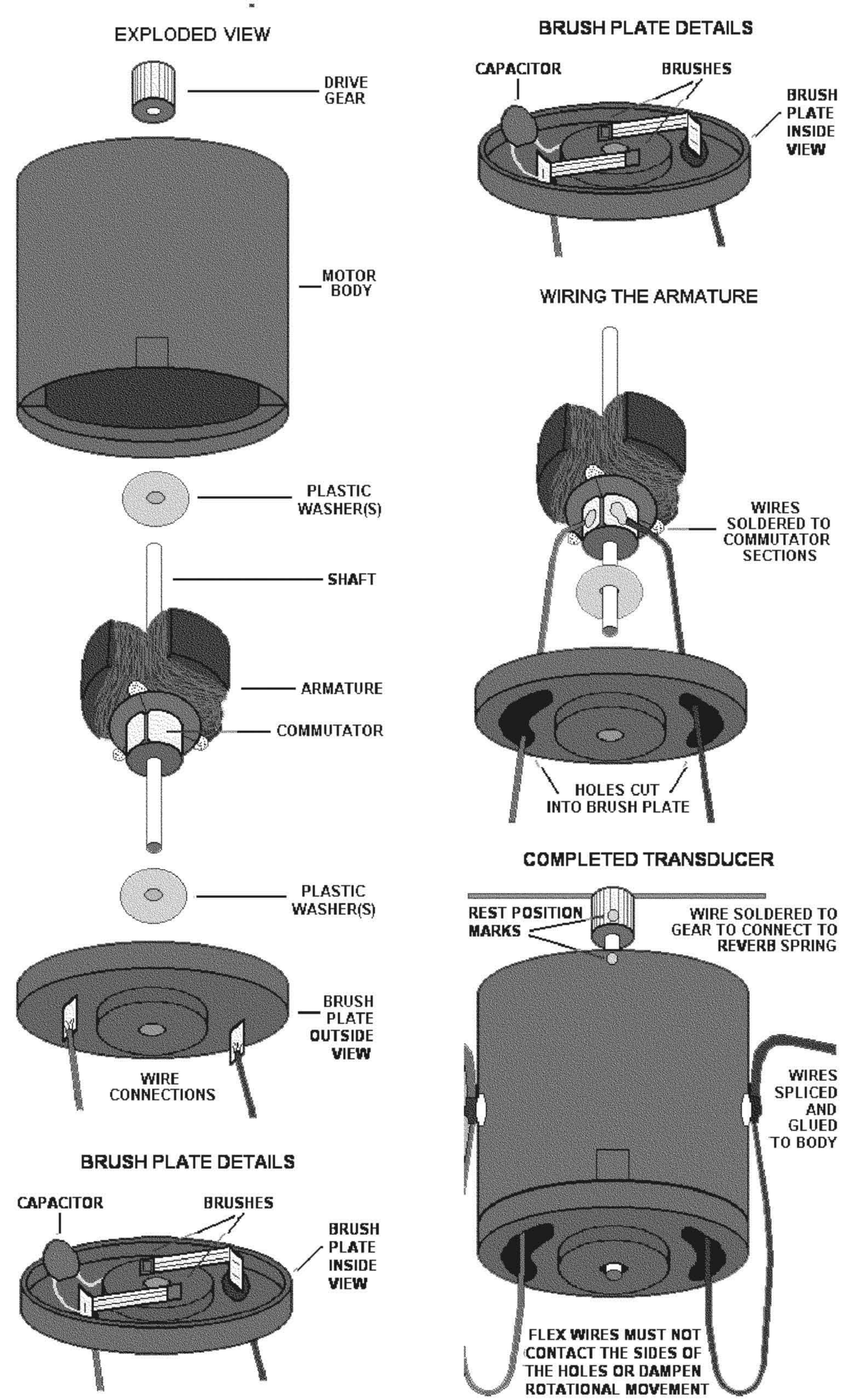


*fig. 2. enkelriet.*

Allereerst brandt men de binnenzijde van het pijpje uit met een gloeiende breinaald of spijker. Eén zijde van het pijpje sluit men luchtdicht af met bijv. zegellak of vloeibaar hout. De andere kant maakt men passend in de brompijp. Is het riet te dik dan neemt men een smaller pijpje, of men snijdt het bij tot het past. Meestal is het te smal. Dan maakt men aan de basis een aantal kerven circulair om het riet over een lengte van ± ½ cm. Dit strijkt men dun in met velpon en bindt het vervolgens af met garen totdat het riet goed in de brompijp past.
Enkele mm. onder de zegellak-dichting snijdt men met een dun zeer scherp mes (schalpel of scheermes) onder een lichte hoek het riet-pijpje in (fig. 81). Vanuit beide kanten kan men onder een hoek van 45° naar deze kerf toesnijden (fig. 82) zodat men een bredere kerf krijgt met wanden van 45°.
Deze kerf mag het holle binnenste van het riet *net* bereiken, er mag echter *geen* echte opening ontstaan. Dit kan men voorkomen door het riet onder een kleine hoek (fig. 81) in te snijden. Heeft men de holle binnenkant bereikt, dan zet men het mes loodrecht op deze kerf in het riet en snijdt op geleide van de nerfrichting van de basis (draadwinding) van het riet toe. Dit doet men aan beide kanten van de nerf (fig. 83). Hierdoor komt de lip welke het geluidvormend deel vormt (het labium) vrij. Dit labium zal gelijk terugveren tegen de schacht en daardoor nog geen geluid kunnen voortbrengen. Om dit op te lossen zijn meerdere methodes.
Men schuift een haar tussen de schacht en het labium naar de basis toe, hierdoor tilt men het labium los, en het kan trillen. Nadeel is dat het hele labium los staat en er veel lucht verloren gaat door de ruime spleet (fig. 84). Beter is het labium in het midden vast te houden en langzaam verend dit bovenste deel naar buiten te buigen (fig. 85). Dit zal men in het begin vaker moeten doen omdat het riet ertoe neigt terug te veren. Een andere (oosteuropese) methode is het labium in het midden te verhitten waardoor het bovenste vrije deel naar buiten kromt (fig. 86) maar dit vereist veel ervaring, dus veel mislukte rieten.
Ook aan de basis kan men het labium verend uitbuigen. Om de opening te beheersen kan men dan zeer strak een draadwinding om de basis leggen. Door deze nu naar boven te schuiven drukt men het labium weer dicht. Met behulp van deze winding beïnvloedt men ook sterk de stemming, nl. een kort trillend gedeelte (winding hoger) geeft hogere stemming en vice versa. Vaak hoeft men het labium nauwelijks af te werken, maar voor sommige kleinere en zachtere doedelzakken is dat wel nodig. Het beste kan men dan gelijkmatig vijlend, schrapend of schurend naar de top van het labium toe werken. De basis en het middendeel moeten stevig blijven, omdat het riet anders te snel dichtklapt. Een dunner labium geeft een luide klank en is vaak iets hoger. Een klompje was of lak op het labium geplakt maakt de stemming lager.



Welcome to the DIY rotary transducer page. You are a brave soul who dares to tread this path!

The motors that are most suitable are unregulated direct current permanent magnet motors. Motors which contain mechanical or electronic speed regulators are not suitable unless the regulators are completely removed first. Motors of a smaller size and lower armature mass generally work better than larger, heavier types, and motors with a higher operating voltage (higher impedance) will perform better than lower voltage units. A brass metal drive gear or pulley attached to the motor shaft is important for connecting the transducer to the reverb spring.

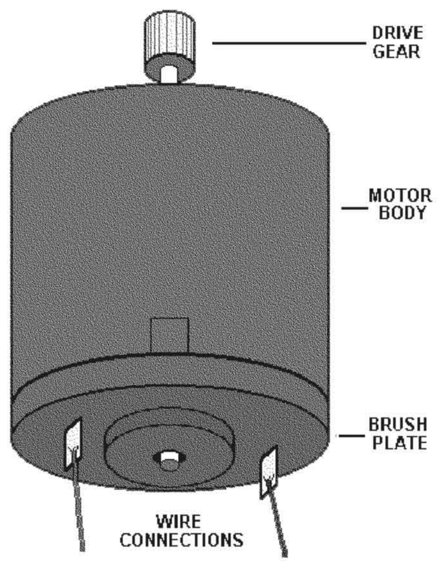
Experimentation with different motor samples is worthwhile, as each type of motor has a different output spectrum and level. It's also important to find a type of motor that you can successfully dissassemble, modify, and reassemble without too much trouble and without damaging any of the parts. Good mechanical skills are essential for this type of work, and excellent soldering abilities are a must.

The first step is dissassembling the motor. The method used will depend on the type of fastening that your particular motor uses. Some are held together with tiny screws, some use metal tabs bent over and others are crimped or soldered together. Whatever type you have, keep in mind that you want to be able to reassemble the motor again, so be careful about damage. As well, only take apart what you need to, in order to access the commutator of the motor and the brush plate. A gear or pulley can be difficult to remove from the armature shaft, heating it may help, or just leave it in place if you can. Sometimes metal that has been crimped over must be filed or ground away instead of prying it back out. A high speed hobby grinder can work well for this as well as other parts of this procedure. Don't be overly concerned with damaging the actual motor brushes as they will be removed and discarded anyways.

Once you have access to the brush plate, remove the brushes and all of the metal or electronic parts associated with them. This should leave the space around the commutator empty, ready for you to run wires through. Plan how you can run two thin wires from the commutator area separately to outside of the motor in such a way that they will not touch the motor or brush plate even if the motor is moved through at least 1/4 turn of rotation. This can best be done through slotted holes cut through the brush plate at appropriate points. Make whatever modifications are required to achieve this.

Next, find or buy some light gauge multiple strand flexible wire, around 24 - 30 awg. The fine wire used on many tape heads and disk drive heads works well, as does record player tone arm wire. Carefully remove any plastic washers that are on the armature shaft so you don't damage them when you are soldering. The commutator is a series of copper sections wrapped around the shaft, there are usually three sections in a small motor. If your motor has more than three sections, then you can still use it, however some experimentation may be required.

TYPICAL SMALL DC MOTOR




Carefully strip and tin the ends of two of the wires. Solder each wire to a different section of the commutator, making sure that you do not short out any of the sections. Use just enough solder for the connection, do not allow any extra to collect. After the solder has cooled reinstall the plastic washers on the shaft and thread the wires each out it's own hole in the brush plate. Clean any debris from inside the motor and reassemble, making sure to put all washers back where they came from.

Now we need to determine the maximum output position of the motor. Connect an AA battery across the two wire leads and slowly rotate the motor. **DANGER!! Only connect the battery for a few seconds at a time, longer periods can overheat and burn out the motor windings!!** As you turn the motor you will feel it pushing in one direction and then the other, and in between these positions it will not want to move at all. Choose the center of the strongest pushing in either direction and mark that spot between the gear or pulley and the motor body. This is the normal "resting" position that you always want the transducer to be in. Align both of the wires so that as they run from the armature to the outside that they have maximum freedom of movement as the motor turns in either direction from the resting position, and that they do not rub on anything. Allow an inch or two for a loop to flex and then anchor each wire to the motor body. This is a good place to splice to a heavier gauge wire to connect the transducer to the outside world.

Finally, solder a wire or other mechanical linkage to the drive gear or pulley in the appropriate orientation for your reverb spring. This may have to be done after the transducer is mounted in place on a frame, for clearance reasons. Make sure that you file the surface of the gear or pulley and use a higher powered iron for easy soldering. When the transducer is connected to a reverb spring, mount the spring so it's weight natuarally "holds" the transducer in the correct resting postion. Do a final position alignment on the flex wires and you are done!

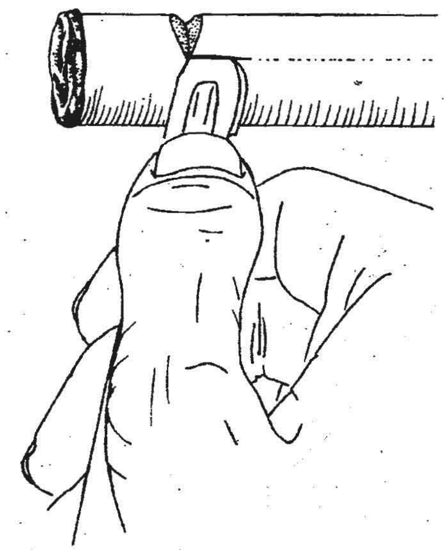


*fig. 83. Vrijmaken van het labium.*

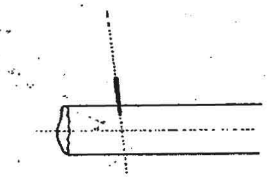


*fig. 81. Insnijden van een enkelriet.*

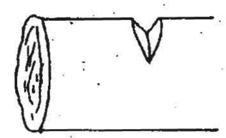


*fig. 82. Kerf in een enkelriet.*

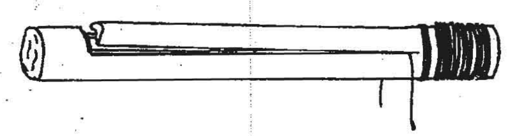


*fig. 84. Een haar tilt het labium op.*

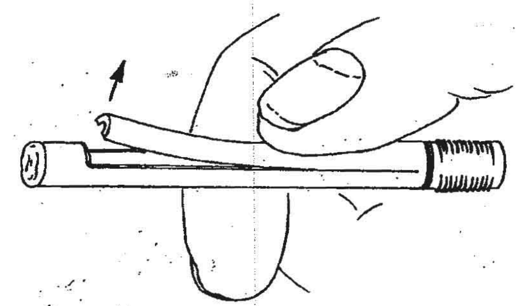


*fig. 85. Door rekken maakt men het labium vrij.*

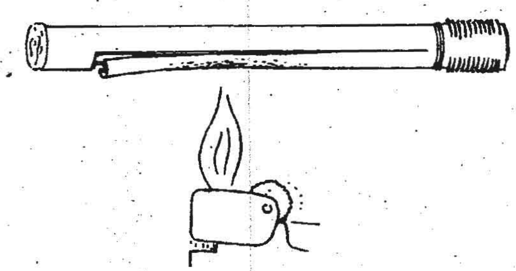


*fig. 86. Door schroeien maakt men het labium vrij.*

**Conch.** Three principal kinds of marine mollusc are used for making shell trumpets: *Triton* ('trumpet shell') with long-pointed apex like a giant whelk; *Cassis* ('helmet shell', also used for

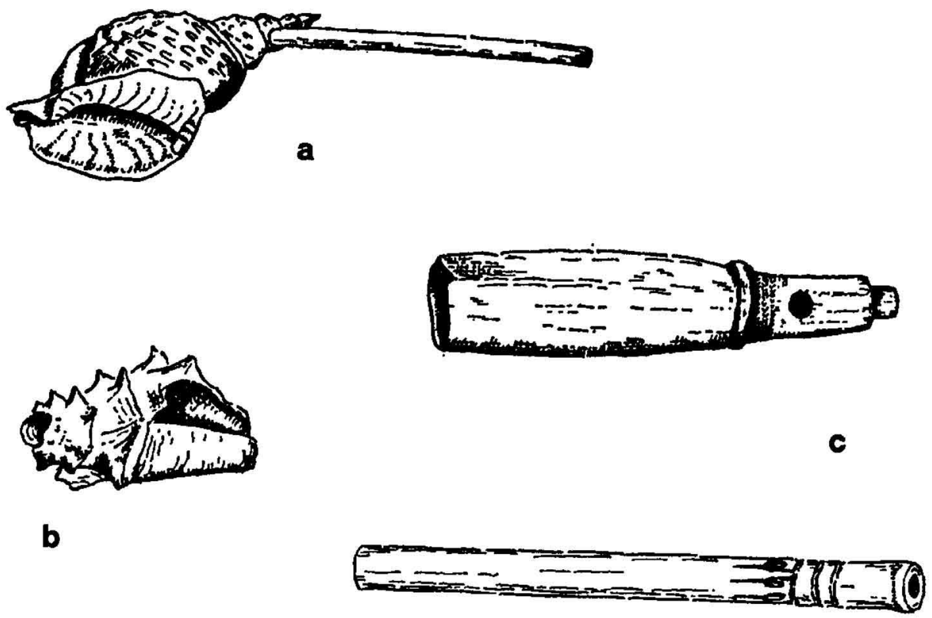
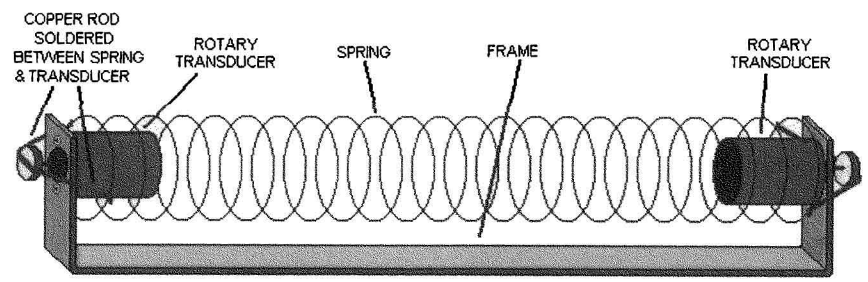



**Fig. 3 a.** Side-blown *Triton* with wooden mouthpipe, Polynesia; **b.** End-blown *Strombus*, Europe; **c.** two wooden conch substitutes, New Guinea.

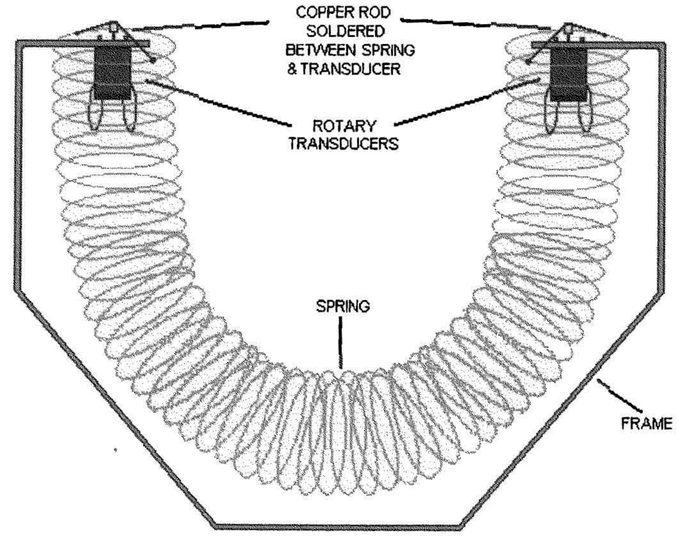
cameo-making) with a thick brim surround; and *Strombus* ('true conch') with short sharp point encircled by spiky rings and one of the best-known to European peoples past and present (Fig. 3, b).

The next challenge is how to make the mechanism smaller, and more robust. After experimenting with various possible mechanisms, small dc permanent magnet motors proved to be superior to all other tested transducer types. One advantage they have is they are a rotary device to begin with, so they are easy to use as a rotary transducer.
However, in order for one to use these as transducers, they require modifications. To do this, the electrical brushes must be removed and bypassed with a direct flexible wire link to the armature. This can be a delicate and challenging task. To see what is involved, check out Building a DC Motor Rotational Transducer but be careful, it's not for the faint of heart!

**Basic Delay Line**

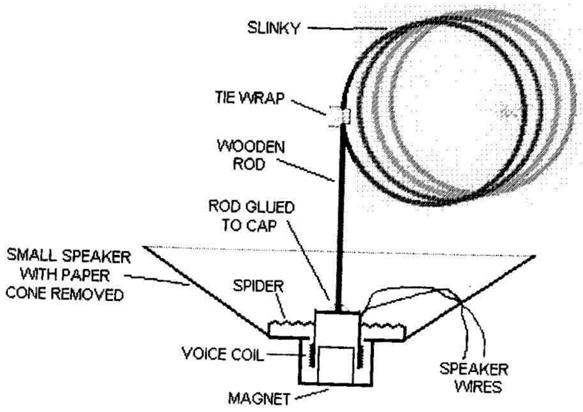


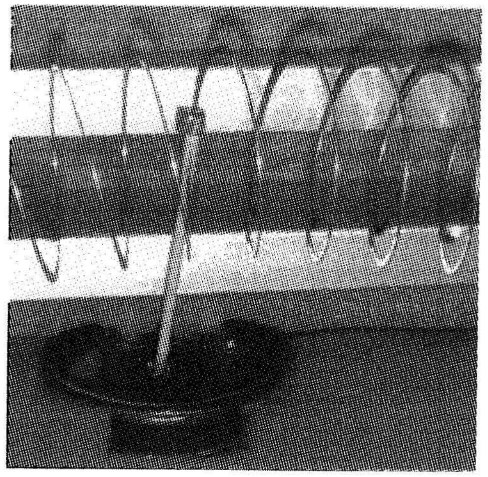

**Longer Delay Configuration**




The electrical application of these transducers is basically the same as for the previous speaker drivers. They sound similar as well, and function well in driving the spring. As pick-ups they are sufficient, but their low impedance presents gain problems. Future research may find a better solution here.

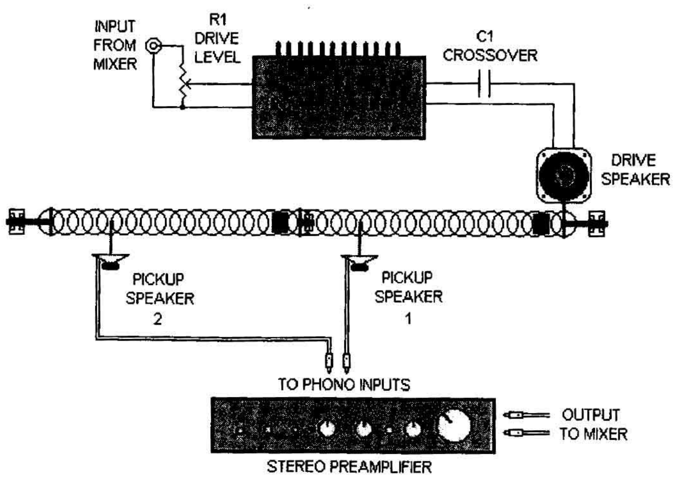
**PICKUP SPEAKER DETAIL**



similar to a speaker crossover (C1) helps to prevent an overload of bass energy. A 4.7 uF capacitor is a good starting point for experimentation here.
The pickup speakers drive a regular phono preamplifier quite well, as there is sufficient gain, although the RIAA equalisation does cause a bit of loss in the higher frequencies. The high frequency response does roll off quite quickly, but the bass response can be quite scary at times, as well as the many other "interesting" sounds that can be created by overdriving, adding external vibrations, etc. And the delays are nice and long compared to conventional spring reverbs, the sounds are somewhat like the resonance of a very large indoor arena.

**BASIC SYSTEM WIRING**



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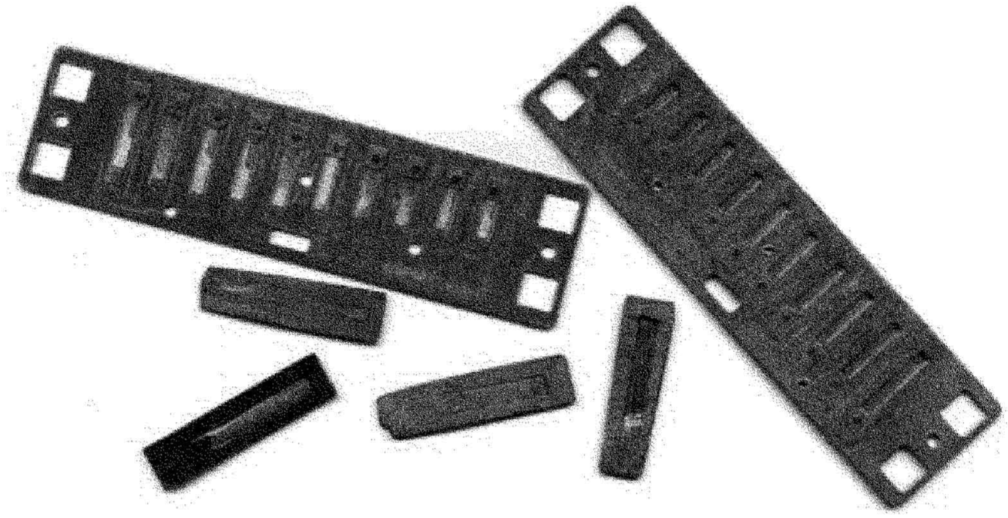
# A BRIEF HISTORY OF MOUTH BLOWN FREE REED INSTRUMENTS



Reeds from a sheng and a diatonic harmonica

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## INTRODUCTION

Considering how widespread instruments such as the harmonica, the accordion and the reed organ have been over the last century and a half (the harmonica is often described as the most popular instrument in the world, in terms of units manufactured and sold each year) and the long history that free reed instruments have had in Asia, surprisingly little has been written about them. Much of what has been written is grossly oversimplified and often simply inaccurate. The usual "history" relates that a *sheng* was brought over to Europe in the 18th century and this started a wave of experimentation that lead to the development of instruments such as the reed organ, the harmonica, the concertina and the accordion. Whilst this is not exactly untrue, it ignores many facts - the free reed had been described in the West prior to this event, the sheng is just one of many free reed mouth organs from Asia and the mouth organ is just one of a wide variety of free reed instrument types. I am hoping that the articles presented here will go some way to filling the gaps in the history of mouth blown free reed instruments (there have been several books written on the reed organ and the various bellows-driven free reed instruments), although I make no pretence at completeness.

Many problems have faced organologists (those who study musical instruments) who have enquired after the Asian free reed instruments. One is that similar names are often used for both free reed instruments and non free reed instruments. For example, in various parts of South East Asia, the word *pi* is used to denote various oboe-like double-reed instruments, as well as various free reed pipes.

Similarly, the word *klui* is used in Thailand as a generic term for pipes, including both free reed pipes and simple flutes. Also, many free reed instruments, particularly free reed pipes, when they are being played can look very much like flutes or clarinet-type instruments.

The instruments in this article are presented starting with the more simple ones and working toward those of greater complexity. This does not necessarily assume that the instruments described evolved in this manner. Although it is likely that in many cases complex instruments evolved from more simple ones, it is also entirely possible that certain instruments are in fact simplified versions of more complex ones. I would also like to point out that I ascribe no superiority to those instruments of more complex construction - the music played on the simple *enggung* can often be as moving as the music played on the more "sophisticated" sheng.

It may also be worth noting that the way in which words from Asian languages are rendered in the Western alphabet can vary a great deal and there are also many different languages and dialects found in most countries in Asia. For example, the people called the *Hmong* are often known by the Chinese name *Miao*. In older Western texts, this was often spelled *Meo*, or *Miau*, although Hmong people themselves render their name in the Western alphabet as *Hmoob*. Likewise, the traditional mouth organ of the Hmong is known to them as the *qeej*, which is sometimes rendered phonetically in the Western alphabet as *gaeng* or *kheng*. The same instrument is frequently called by its Chinese name of *lusheng*, or by variations of other names commonly used for mouth organs in South East Asia, such as *khaen*, *ken*, *kyen*, *khîn*, *k/nh*, etc. Obviously, this can get quite confusing, so I apologise in advance. In some cases I have chosen to use Han (Mandarin) Chinese names as a sort of standard term for certain instruments - I would like to make it very clear that in so doing, I mean no disrespect to any of the various minority groups in China or the rest of Asia. (Note: On some pages I also give instrument names using Asian characters. If you do not have Asian character sets installed in your browser, they may appear as little square boxes, question marks or blank spaces.)

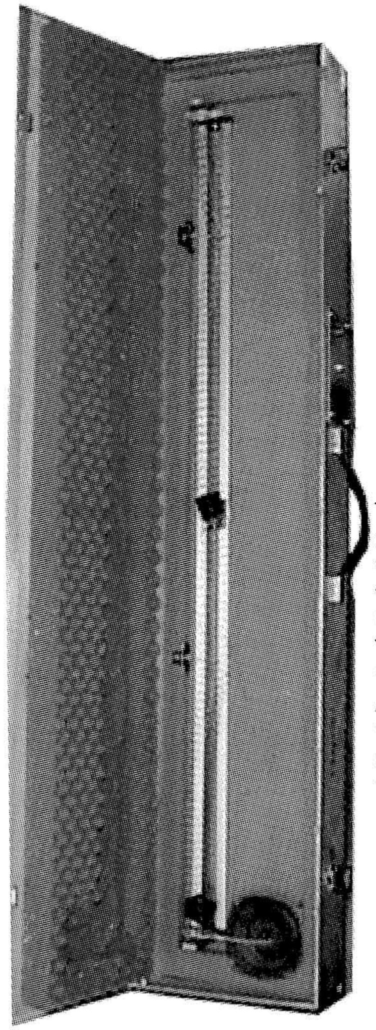
Finally, unless stated otherwise, all pictures used in this article are of instruments from my own collection

# WHAT IS A FREE REED?

There are several different types of reeds used in wind instruments, probably the most common being the beating reed, as used in clarinets, saxophones, etc. These reeds are usually made from a thin piece of cane, or synthetic equivalent, fixed at one end over an opening in the flat surface of a mouthpiece. As the name suggests, the reed is slightly wider than this opening and when the player applies pressure, the reed beats against the mouthpiece and sets into motion a column of air whose pitch is determined by open fingerholes, or some similar mechanism. These are often called single reeds, in contrast with the double reeds of instruments such as the oboe, where the reed is in two parts which beat against each other. (To be accurate, rather than literally beating against the mouthpiece, or against the other half of the reed, beating reeds actually beat against a cushion of air on the surface of the mouthpiece or between the two halves of a double reed, but let's not complicate matters too much here.)

In contrast a free reed is a small strip of material (most commonly of metal, but in some cases made of plastic or vegetable matter such as bamboo) also fixed at one end, but which is set in or over a slot that is fractionally wider than the reed itself. As a result, when pressure (or suction) is applied, the reed swings freely though the slot to set up a vibrating column of air which gives voice to the instrument.

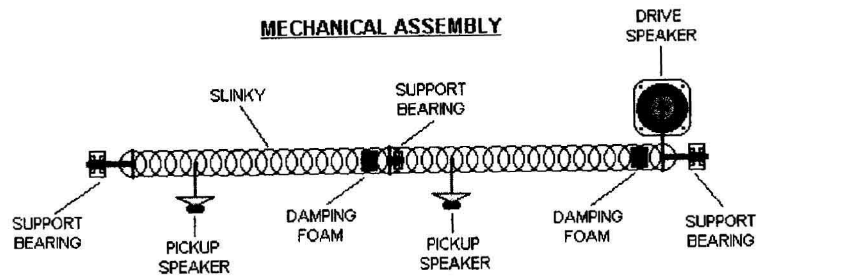




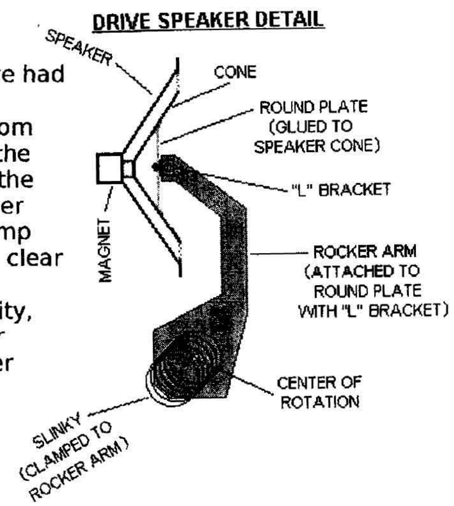
# Slinky Spring Reverb

There are a number of different ways to send vibrations travelling down a spring, but most spring reverbs use torsional (rotational) motion, which is less sensitive to interference from external vibrations. Here is an experiment that The Peasant did with a Slinky Jr (R) and some old speaker drivers which delivers loooonng delay low frequency DIY reverb for almost no cost.
The reverb assembly consists of a 1 5/8 inch diameter Slinky Jr spring suspended on a four foot long frame, mechanically coupled to speaker drivers as transducers, and installed in a foam lined packing case.

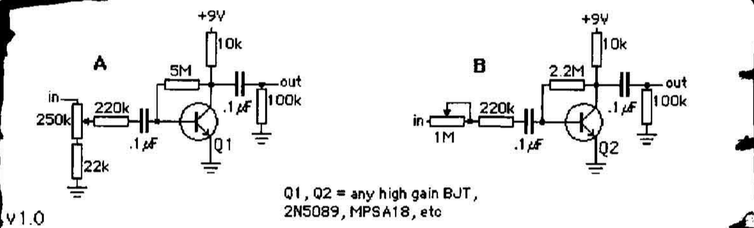
The spring is mounted with tiny ball bearings to allow for free rotational movement. A four inch full range speaker drives one end of the spring while smaller speakers pick up the delayed vibrations at two other points further along the spring. A couple of pieces of foam rubber are inserted inside the spring to control a low rumbling bass resonance in the slinky. The drive speaker has a round plate glued to the cone with silicone rubber, which is then coupled to a rocker arm with an "L" bracket and small bolts. All of these parts are made from plastic to prevent magnetic interference with the drive speaker. The other end of the rocker arm is clamped to the slinky near the end bearings. These bearings (BTW, most old VCR transport mechanisms have a few of these bearings buried inside) hold the rocker arm center of rotation at the center of the slinky's diameter, for most efficient transfer of drive speaker linear vibration to slinky torsional motion.




Further down the slinky are the pickup speakers and more support bearings.
The pickup speakers are smaller 1 1/2 inch full range drivers that have had their cones removed with a knife to control microphonics. They are mechanically coupled to the spring through short wooden rods (cut from small cleaning swabs/Q-tips) glued with silicone rubber to the cap of the speaker voice coil. The other ends of the wooden rods are split down the center for about 1/2 inch with a sharp knife and then clamped on either side of the flat side of the slinky spring with a small tie-wrap. This clamp as well as other attachment points on the assembly were coated with clear nail polish to control unwanted vibration.
The most basic wiring setup can be done using almost any type, quality, and combination of common audio components. A low wattage power amplifier is all that's required to drive the spring, and a high-pass filter



# Boost-O-Rama

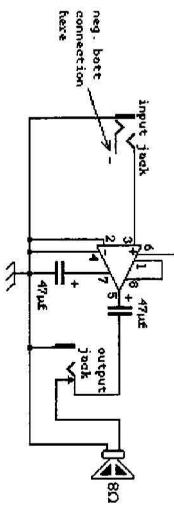



v1.0
5/03

Either of these simple clean boosts are capable of nice, jangle-y loud boost. Both are designed to give subtle, sweet overtones, yet still sound clear and loud. The main difference in the two is how the gain control is implemented. The "A" version uses a voltage divider volume control on the input, with a input impedance a little over 100k. Low enough to tame some of the high end, but not too low. The "B" version uses a series resistance on the input, with a variable input impedance depending on the gain setting... input Z falls as the gain is turned up. Either is a nice stand alone booster and a good alternative to the typical boosters out there.

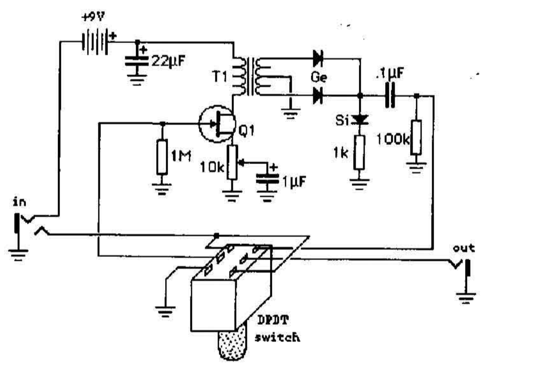
## Smokey Amp clone

IC = JRC386D (NJM386D)




The JRC386D aka NJM386D (used in the Smokey) seems more stable and easier to tame than the National Semiconductor LM386. If yours is unstable, oscillates, or unusually yucky sounding, use the inverting input (pin 2) and ground the non-inverting input (pin 3). This may help. For less distortion, run at 12 Volts. for variable gain, put a switch between pins 1 and 8.

## Jawari




v6.3
10/02

The Jawari is based on a pre-internet experiment I did. The word, "jawari" refers to the setup of the bridge on the Indian sitar, the characteristic which imparts a unique, buzzing quality.

This circuit, is similar in principle to octave-up effects, but the difference here is that gain is deliberately kept low. This difference is in dramatic contrast to the high gain used in most octave-up circuits, which helps increase sustain and bring out the upper harmonic.

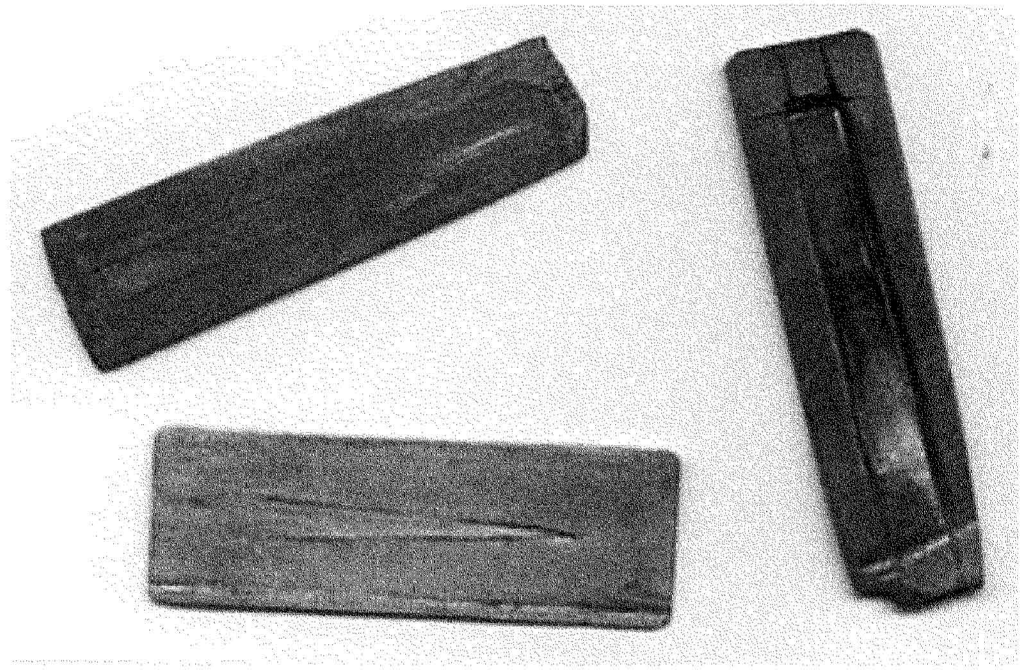
Rather, this circuit exhibits a sustain reducing effect, in combination with a dramatic and dynamic timbre change, coaxing the tonalities of those stringed instruments from the East (like Neptune, NJ*) out of a normal electric guitar. It's especially suited to single note lines using the bridge pickup, or two out-of-phase pickups.

Q1 is a J201
T1 is a 10k:10k audio transformer Mouser 42TM018 or 42TL218
The Ge diodes are 1N34
The Si diode is 1N4148

* Neptune, NJ was the home of the old Danelectro factory, original manufacturer of the Coral electric sitar, among other things.



The free reed can be further divided into two distinct types. The older type, as used in traditional Asian free reed instruments, can be described as idioglottal - that is to say that the tongue of the reed is cut from the surrounding reedplate.

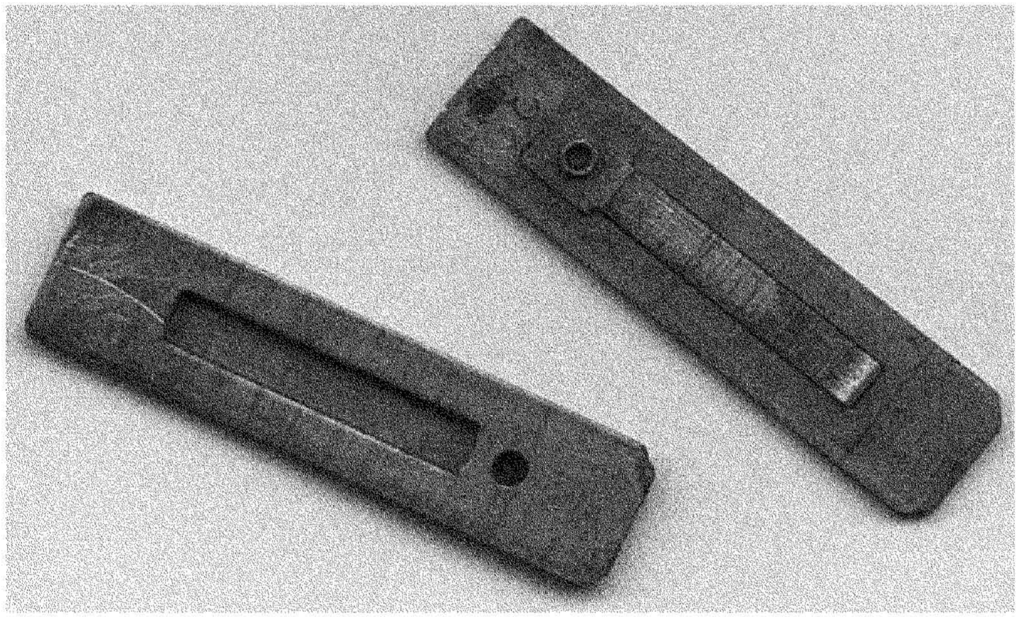


The tongue of the reed can be either rectangular or triangular, usually (though not always) lies flush with the reedplate and usually (though not always) responds to both positive and negative pressure (blowing and drawing). This type of free reed needs to be connected to an appropriate resonator in order to sound and the pitch produced is dependent upon both the natural pitch of the reed and the size and shape of the resonating chamber.

The more recent type of free reed as used in Western instruments such as the harmonica, accordion, concertina, etc., can be described as heteroglottal - that is to say the reed is attached to a separately made reedplate, either with one reedplate per note, or with one reedplate having multiple slots and corresponding reeds.

(Many toy instruments use reeds and reedplates made from a single piece of injection molded plastic. Although these could in a sense be considered idioglottal, as the reeds and reedplate are generally molded from a single piece of plastic, because of how they function it make more sense to think of them as heteroglottal free reeds.) This type of free reed is usually rectangular (or very slightly tapering) and is almost always set slightly above its slot, so that it normally responds only to one direction of airflow, separate reeds being required for blowing and drawing. The pitch of the note produced by this type of free reed is usually very close to the natural pitch of the reed and any resonating chamber attached to it normally tends to have only a very small effect on the pitch, although it can substantially modify the timbre of the sound produced.

In both cases, the sound heard is that of the column of air set into motion by the reed, rather than the sound of the reed itself, the method of tone generation being similar in many respects to that of a siren. (In certain electro-acoustic instruments, such as the Hohner Pianet, metallic reeds similar to those described in the previous paragraph are plucked by various methods and the sound of the reeds themselves is fed to an amplifier. However, these are best considered to be something akin to lamellophones, rather than free reed instruments.)



# ORIGINS OF THE FREE REED

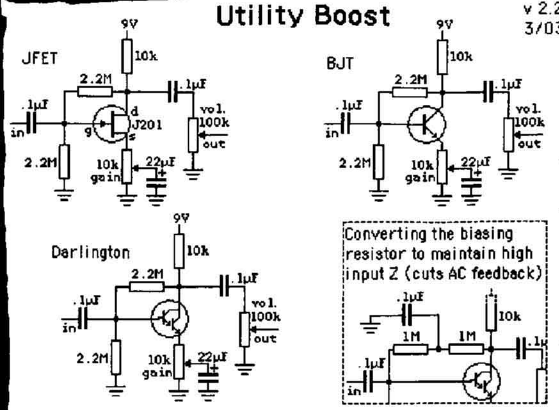
Exactly when and where the free reed was invented will never be known, although it is almost certain to have happened in South East Asia, perhaps as far back as the Stone Age. The free reed is most likely to have evolved from the mouth-resonated plucked idiophones (or lamellophones) generically termed guimbardes and more commonly known as Jews harps, or jaw harps. Like free reeds, guimbardes can be both heteroglottal and idioglottal in construction. The variety most commonly found in the West is the heteroglottal type, where the reed or tongue is attached to a separately made frame. These are also found in Asia, however idioglottal types are almost as common, where the entire instrument is made from a single piece of wood, bamboo, metal, or whatever. Although the mouth technique is similar for both types of instrument, the heteroglottal type is sounded by plucking the tip of the reed directly, whereas with the comparatively delicate idioglottal types the reed is sounded by plucking the frame with a finger tip, or by jerking a piece of string attached to the frame.

Idioglottal guimbardes are widespread throughout Asia and the Pacific Islands in a variety of shapes and sizes. At some point (very possibly in several different places at several different times), it was discovered that if you make the reed of the guimbarde small enough, it is possible to set it into motion merely by blowing it, thus the free reed proper was born. As an example, here is a *hun toong* from Thailand played first by plucking it, then by sounding it by breath:



## Utility Boost

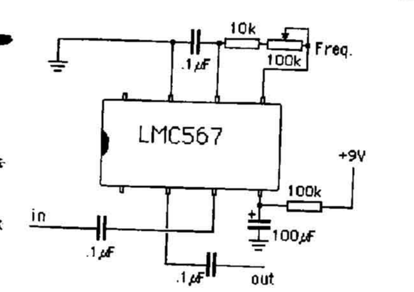
v 2.2
3/03




Simple booster/preamp for electric guitar or anything. J201 version is fairly clean even at max gain, high input Z, breaks up nicely. BJT version has lower input Z, more gain, breaks up more harshly (MPSA18, 2N3904, NTE103 tested). Darlington version is like BJT, high gain, breaks up harshly, but with higher input Z. Each circuit draws less than 500µA. Same circuit works with J201, MPSA18, 2N3904, NTE103, MPSA13, MPSA14.

## Thing Modulator

v 1.1
8/02



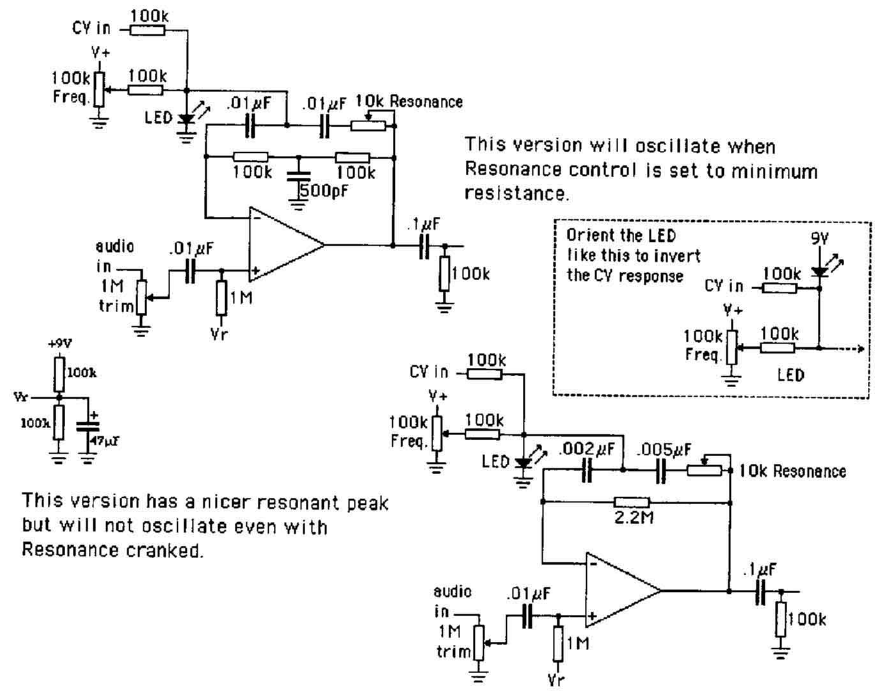

The Thing Modulator is inspired by the old Hemmo circuit. With the desire to make the thing shut up when I'm not playing, I found that using both a LMC567 (a CMOS 567) and a 100k/100µF RC network on the power pin go a long way to supressing the onboard oscillator, for a very simple, very low power (<100µA) pseudo ring modulator. Not perfect, but better. If you have access to a LMC567, it's worth a try.

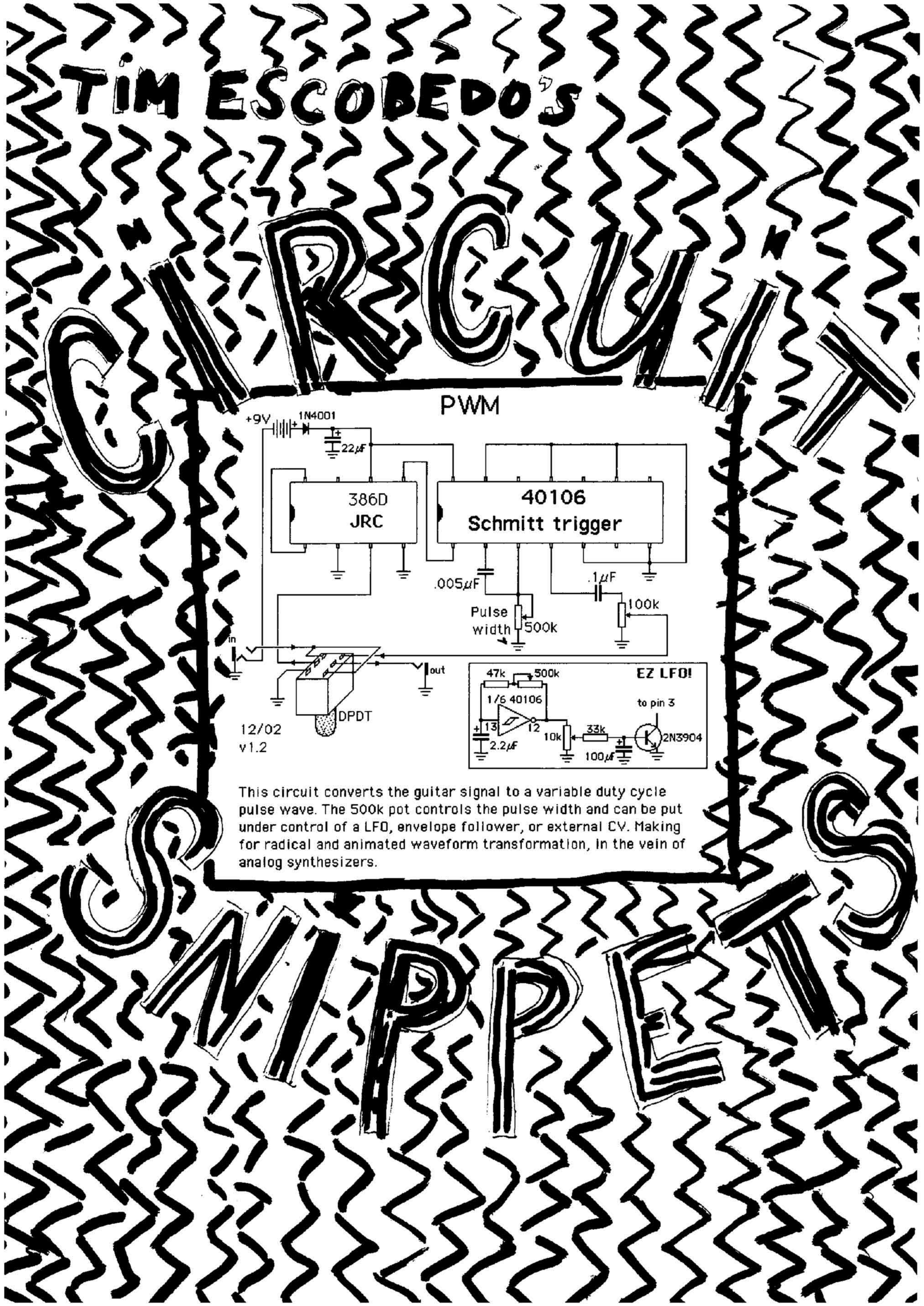
## Q&D VCF

v 1.1
3/03

*Served with and without oscillations!*

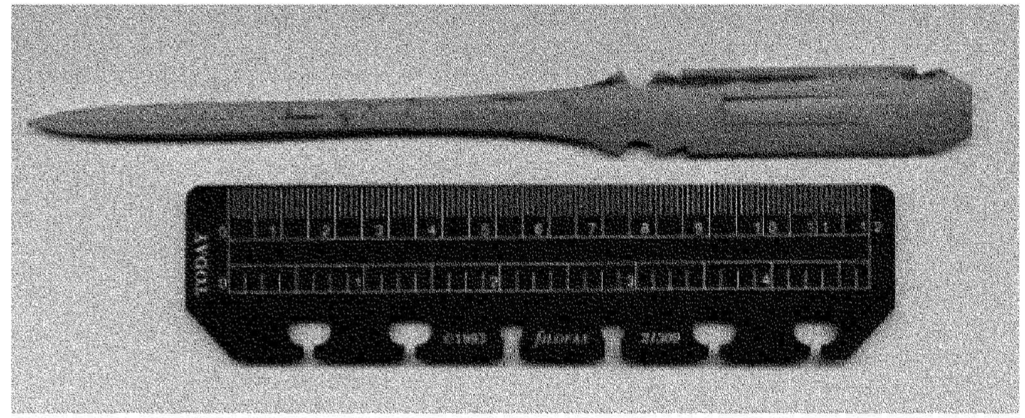
These two designs are quasi synth VCFs, useful to get a decent fake lowpass response with a minimum of parts. Trim the input levels so that the output is unity gain with the Resonance set low and the cutoff frequency set all the way up. Two versions here, one will oscillate with the Resonance maxxed out, one won't. Get your guitar synth going with one of these filters!








The free reed is represented in its most basic form by the *enggung* (or *ngo*) of Bali.



This is a piece of bamboo or palm bark fashioned into the shape of a handle with free reed cut into one end. This end is placed over the player's mouth and with the appropriate mouth shape, various notes can be produced.

This instrument is used to imitate the call of frogs in certain pieces of ritual music and its link to the guimbarde is made obvious by the fact that they are traditionally made by the same craftsmen who make the Balinese guimbarde called the *genggong*.

Another fact suggestive of the link between the free reed and the idioglottal guimbarde is that the character *huang*, meaning tongue, is used in China to describe both the reeds of such instruments as the sheng, as well as certain types of guimbarde. The construction method of the metallic idioglottal guimbardes is essentially the same as that of the metallic idioglottal free reed. A piece of brass or bronze (although certain Asian guimbardes are also made of steel) is hammered to the correct thickness, this hammering process also serving to work harden the metal, giving it a "springy" quality. The outline of the reed is scratched into the metal using a sharp tool, then this outline is worked over and over again until it is just visible on the other side of the metal, but not quite cut through all the way. This other side of the brass is then sanded lightly until the reed is freed, with a cut of extremely close tolerance around it.

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# EASTERN FREE REED INSTRUMENTS

After such basic free reed instruments as the *enggung*, the next evolutionary stage was to couple the free reed with a resonator of some sort, resulting in many different instruments across the Far East. I have catalogued the basic forms and given some specific examples of each.

## Free reed noisemakers

Into the general category of "noisemakers" (which I hope does not sound too negative a description) I place musical toys and signalling devices, mostly incapable of melodic playing.

A.C. Moule describes the ku kuai and the similar *sheng tzu*, given to pilgrims at certain Chinese religious festivals. These both consist of a two chambered piece of bamboo with a couple of idioglottal free reeds cut into the sides.

Commonly found in many parts of South East Asia are free reed horns, such as the Burmese *kwai*, the Cambodian *sneng* and the Vietnamese *tödiap*. These are made from cow horn, water buffalo horn, or elephant tusk; open at either one or both ends, with a free reed placed over an opening midway along the concave side. The pitch of the note produced can be varied by covering and uncovering the open end(s). These instruments are chiefly used for alarm signals, funeral rites and other ritual purposes.

## Free reed pipes

Widespread throughout Southeast Asia, but conspicuously absent from most of the standard musical instrument reference books, are the various free reed pipes. These consist of a length of bamboo or cane, with varying numbers of fingerholes and a free reed set into the wall of the pipe. These days the reed is usually of metal, typically a brass or bronze alloy, although examples with palm bark or bamboo reeds can still be found. This suggests that it may be possible that these instruments date as far back as the Stone Age.

Most commonly they are end-blown, such as the Thai pi joom, the Cambodian *pey pok* and the Vietnamese pi lao luong. In these the reed is located towards the closed end of the pipe and the end of the pipe is placed in the player's mouth, with the instrument held downwards at an angle. Often they are played using circular breathing.

Sometimes two such pipes are fastened together to form a double instrument, as with the Vietnamese pi doi and the Burmese *pibat*. Usually only one pipe has fingerholes, the other being used to provide a drone. The drone pipe is also sometimes thinner than the melody pipe.

Some free reed pipes, such as the well-known Chinese bawu and the somewhat lesser known Vietnamese ala, are transverse or side-blown instruments. In these, the reed is set part way down the pipe, with the instrument being played in a position similar to that of the typical Western flute.

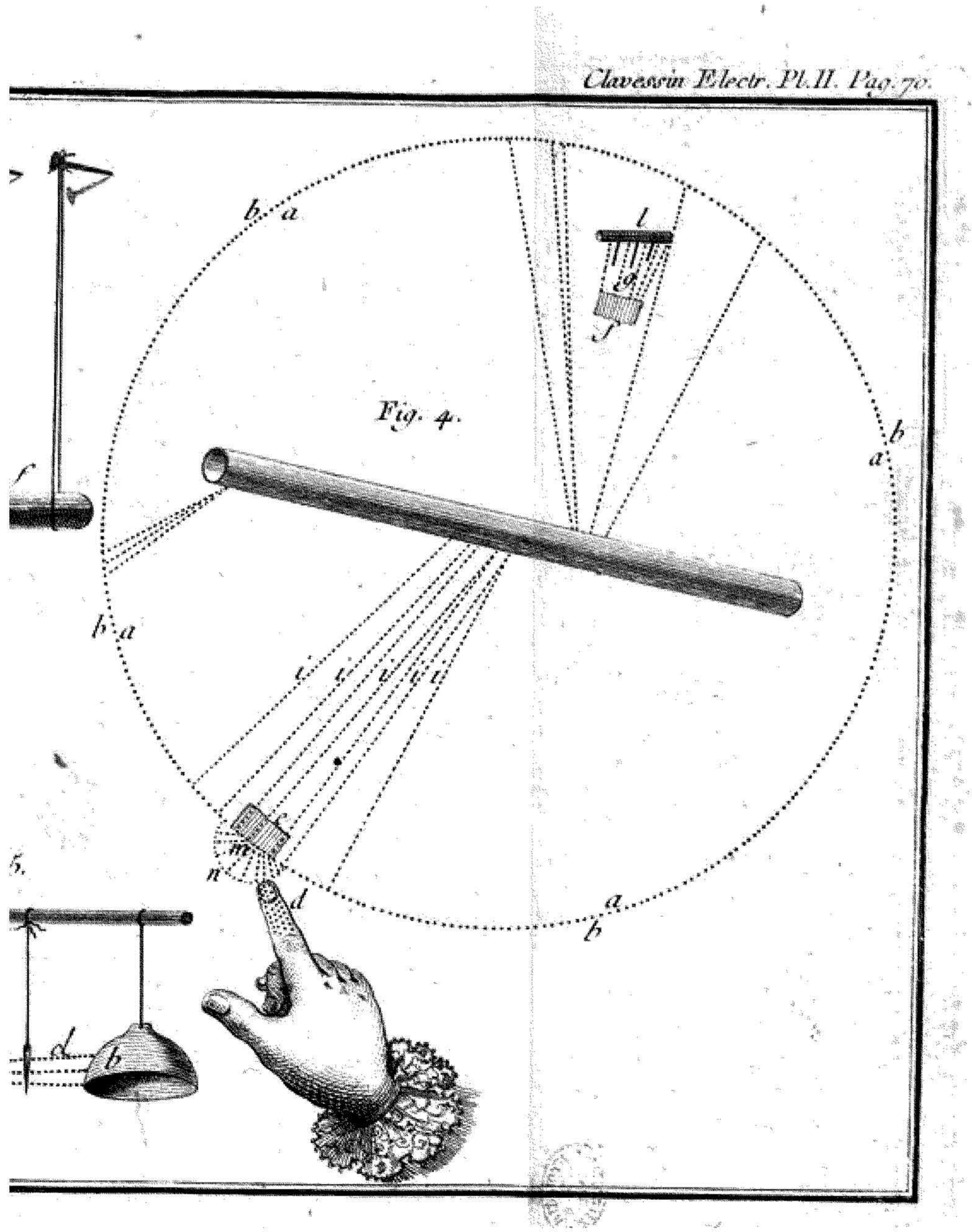
## Free reed pipes with gourd windchest

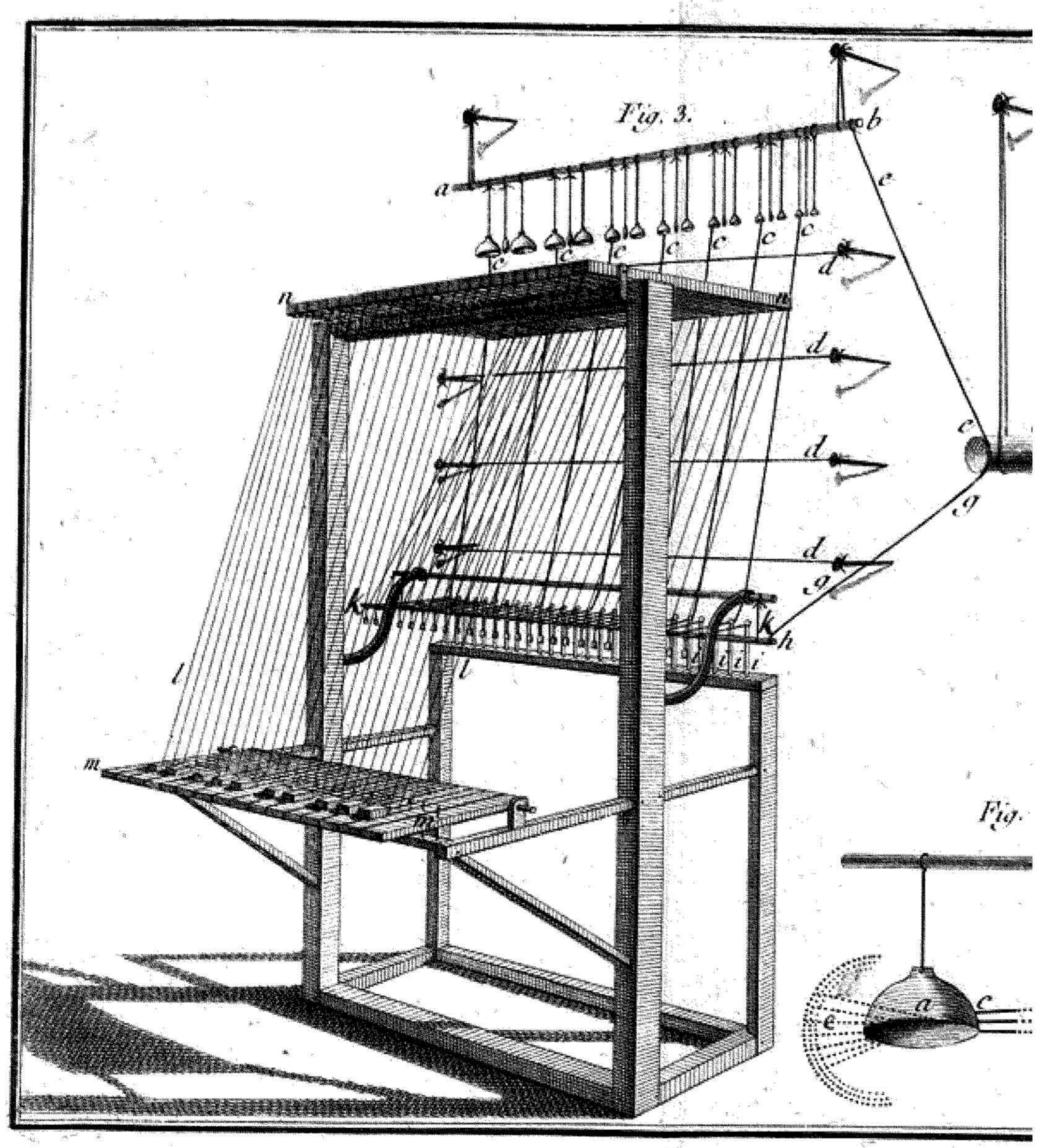
Often free reed pipes are given a gourd windchest, with the neck of the gourd being used as a mouthpiece. Single pipe instruments are still found amongst some of the hill tribes of Northern Thailand and bordering areas, but more commonly they have two or more pipes, such as the Chinese hulusi. Traditionally, these instruments have one melody pipe with fingerholes, the other pipe(s) being drone pipe without fingerholes. Recently "improved" models have appeared that have two melody pipes.

Mostly these instruments are end-blown, but there is at least one example of a transverse gourd reedpipe, the Vietnamese ding tac ta.

## Free reed pipes with resonator

The *mangtong* (莽筒) is used as a bass instrument in the lusheng ensembles of various Chinese provinces. It consists of a fairly typical free reed pipe inserted into a large bamboo tube with a diameter of about 20cm and a length of between 60cm and 200cm, acting as a resonator to increase the sound of the reed pipe. A large lusheng ensemble might include up to two dozen mangtong players.






## Mouth organs

The free reed pipes described above have a few disadvantages when compared with beating reed instruments and flutes. As free reeds cannot be overblown in the same way as flutes or the more common woodwind reeds, they tend to have a very limited range, rarely much more than an octave and often less. Also the timbre of the notes produced tends to change the further they depart from the natural pitch of the reed.

One solution to these limitations is to connect several reedpipes to the same wind source, each pipe being optimised for a particular pitch, making a small hand-held mouth-blown free reed organ. Each pipe has one reed (of palm bark, bamboo or more commonly of a brass or bronze alloy), its pitch being determined by the shape of the reed and often further tuned with a blob of wax added to weight the tip of the reed. The pipe itself (usually of bamboo) is tuned to the appropriate pitch either by simply cutting it to length, or by cutting tuning holes or slots into the wall of the pipe. Several such pipes are then inserted into a windchest of gourd, carved wood or metal, having some sort of mouthpiece. Usually a fingerhole is made in a convenient place on each pipe, without this hole being covered, the resonance system of pipe and reed is inactive and no sound is produced. In some mouth organs certain fingerholes are sometimes stopped stopped with a piece of wax in order to provide a constant drone behind other notes selected by the player's fingers. In some instruments, such as the *sompoton* of Borneo, certain pipes lack fingerholes and the notes are selected by covering and uncovering the open ends of the pipes. On most mouth organs the reeds respond to both blowing and drawing.

Mouth organs could be further classified according to several more or less arbitrary schemes, such as the number of pipes, tuning system, reed materials, etc. I have chosen to group them together according to the way the pipes are arranged.

## Mouth organs with bundled pipes

In these instruments, a bundle of pipes is inserted into a windchest, usually of gourd. Examples include the *hulusheng* used by several minority groups in Southern China and neighbouring countries, as well as the increasingly rare *keluri* and *enkulurai* of Northwestern Borneo.

## Mouth organs in double raft form

These have two rows of pipes side by side along the instrument, in line with the mouthpiece of the instrument. Examples include the *sompoton* of Northeastern Borneo, the Thai/Laotian *khaen* and the *lusheng* played by various Chinese minority groups (the latter two having windchests of carved wood, contrasting with the gourd windchest of the former).

## Mouth organs with pipes arranged in crosswise row(s)

These have one or more rows of pipes arranged across the windchest, at a right angle to the direction of the mouthpiece. Examples include the Chinese *fangsheng*, the Bangladeshi *plung* and the Vietnamese *m'buot*.

## Mouth organs with circular arrangement of pipes

Probably the most familiar type of Asian mouth organ to most people is the Chinese sheng, its most common form having 17 pipes of varying lengths forming an incomplete circle around a windchest of either carved wood or metal. Tradition credits the invention of the sheng to various semi-mythical characters such as the Emperor Huang Di (AKA Huang Ti, etc.) or the Empress Nu Gua (AKA Nu Kua, Nu Qua, Nu Koua, Nawa, etc.) in the third millennium BCE, its shape said to have been inspired by the phoenix at rest on its nest (with the shape of the Chinese panpipes *paixiao* representing the phoenix in flight). The word *sheng* (笙) has become something of a standard term for mouth organs, however the earliest written descriptions (as far back as the fifteenth century BCE) use the name *he* (和, meaning "harmony") to describe a small mouth organ, *chao* (巢, meaning "nest", presumably referring to its resemblance to a bird's nest) to describe a medium sized one and *yu* (竽) to describe a somewhat larger one, all having varying numbers of pipes often arranged in crosswise rows. Later the seventeen pipe circular arrangement became more or less standardised, with the name *yu* denoting an instrument primarily used for melodic purposes and the name *sheng* denoting one used for mainly harmonic purposes. These older instruments often had much longer mouthpieces than those used on modern ones - it is suggested that this was so the emperor could see the faces of the female court musicians that serenaded him!

Of the seventeen pipes of the typical sheng, traditionally three or four were blocked and had no reeds, however by the mid-twentieth century these silent pipes were often given reeds to add some chromatic notes to its traditional diatonic scale. Also larger instruments with more pipes started to be produced and resonators added to give more volume. New variations on the traditional sheng have been invented, such as the keyed sheng or *jiajian sheng* (加键笙). As its name suggests, instead of the notes being selected by the player's fingers, there is a system of keys or buttons which open and close the ends of the pipes. The most recent versions of this instrument have 37 pipes, covering three fully chromatic octaves. Larger ensembles sometimes use the *da paisheng* (大排笙, "large row sheng"), a large floor-standing organ-like instrument and the somewhat smaller *baosheng* (抱笙, "held sheng"), supported by a stand or held in the player's lap.

The sheng was introduced into Korea during the Three Kingdoms period (57 BCE to 668 CE), where it became known as the *saeng* (생) or *saenghwang* (생황). Typically the saenghwang has seventeen pipes, with one of them being silent. It is not a commonly featured instrument in Korean classical music, although it is sometimes used in duet with flute or dulcimer.

By the sixth century CE, the Chinese mouth organ had also spread to Persia, where it was known as *mushtaq sini*, *bisha-i mushta* and later as *chubchiq*. The instrument is depicted in several illustrations from that period, but seems not to have entered the mainstream of Persian music.

Around the eight century CE, the Chinese presented a gift of three *sheng* and three *yu* to the Japanese court. The *yu* fell almost immediately into disuse, but the *sheng* took root and became known by the Japanese name *sho* (represented by the same character used by the Chinese, 笙). Slimmer and higher pitched than the typical sheng, the sho has seventeen pipes of which two are traditionally silent. Its most common application is in playing long sustained tone clusters to accompany gagaku performance, but in recent years some composers have started to exploit the melodic capabilities of the sho, the late John Cage being one of them.

Various specimens of sheng also made it as far as Europe, where they are said to have been one of the main inspirations for the development of the Western free reed instruments.





ſoie : j'eus par ce moyen l'effet que je deſirois. Quand en baiſſant la touche *t*, je portois le levier *f* contre la verge non iſolée *n*, le battant ſe mettoit dans un mouvement très-vif, & frappoit alternativement les deux timbres *p*, *m*, avec tant de vîteſſe, qu'il n'en réſultoit qu'un ſon. Ayant donc pluſieurs timbres diſpoſés de la même façon, on pourra faire un Claveſſin aſſez parfait.

*FIGURE* 3, *ab*, verge iſolée qui ſoutient les timbres.

*ccc*, fils d'archal attachés aux timbres iſolés.

*ddd*, cordons de ſoie qui retiennent les fils d'archal *ccc*.

*ee*, fil d'archal qui porte l'électricité du conducteur *f* à la verge *ab*.

*gg*, autre fil d'archal qui va du même conducteur à la verge de fer *h*.

*iii*, tuyaux de verre.

*kk*, petits leviers de fer qui ſe meuvent dans des charnieres maſtiquées au ſommet des tuyaux *iii*.

*ll*, fils de laiton par le moyen deſquels le clavier *mm* fait mouvoir les baſcules *nn*.

baſcule *b*, & l'on portoit le levier *f*, attaché à cette baſcule par un fil de ſoie *s*, contre une autre verge de fer non iſolée *n*; dans l'inſtant du contact, le battant frappoit le timbre, & demeuroit enſuite en repos, auſſi-tôt que le levier retomboit ſur la verge iſolée & électriſée *c* : je pouvois ainſi toucher impunément & ſans me donner de commotion. Je diſpoſai tous mes timbres de la même maniere, & j'en fis le carillon électrique dont j'ai parlé dans ma ſeconde lettre.

Il me parut que l'invention de ce carillon n'étoit que ſinguliere, & qu'elle n'avoit aucune utilité, puiſqu'il étoit plus court de frapper les timbres avec un petit marteau ; je penſai donc à le convertir en Claveſſin plus parfait, s'il ſe pouvoit, que les Claveſſins ordinaires.

### SEPTIEME EXPERIENCE.

J'attachai donc à la verge de fer *v*, avec un fil d'archal, un autre timbre *m*, à l'uniſſon du premier *p*, & je laiſſai tomber entre deux le battant ſuſpendu à la verge par un fil de

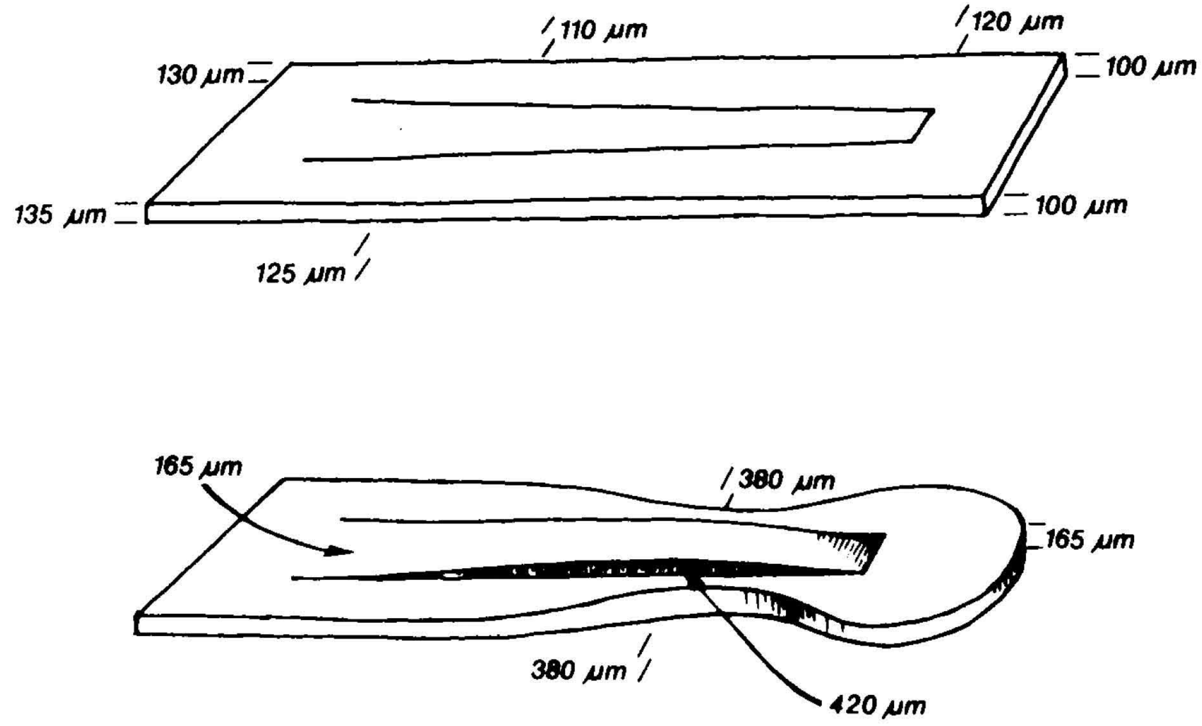



Figure 2
Diagrams of 'thin' (upper-octave) and 'round-headed' (lower-octave) free-reeds, with thicknesses of different regions.
(Drawings by Bernard Thomason, based on sketches by T. F. P.)

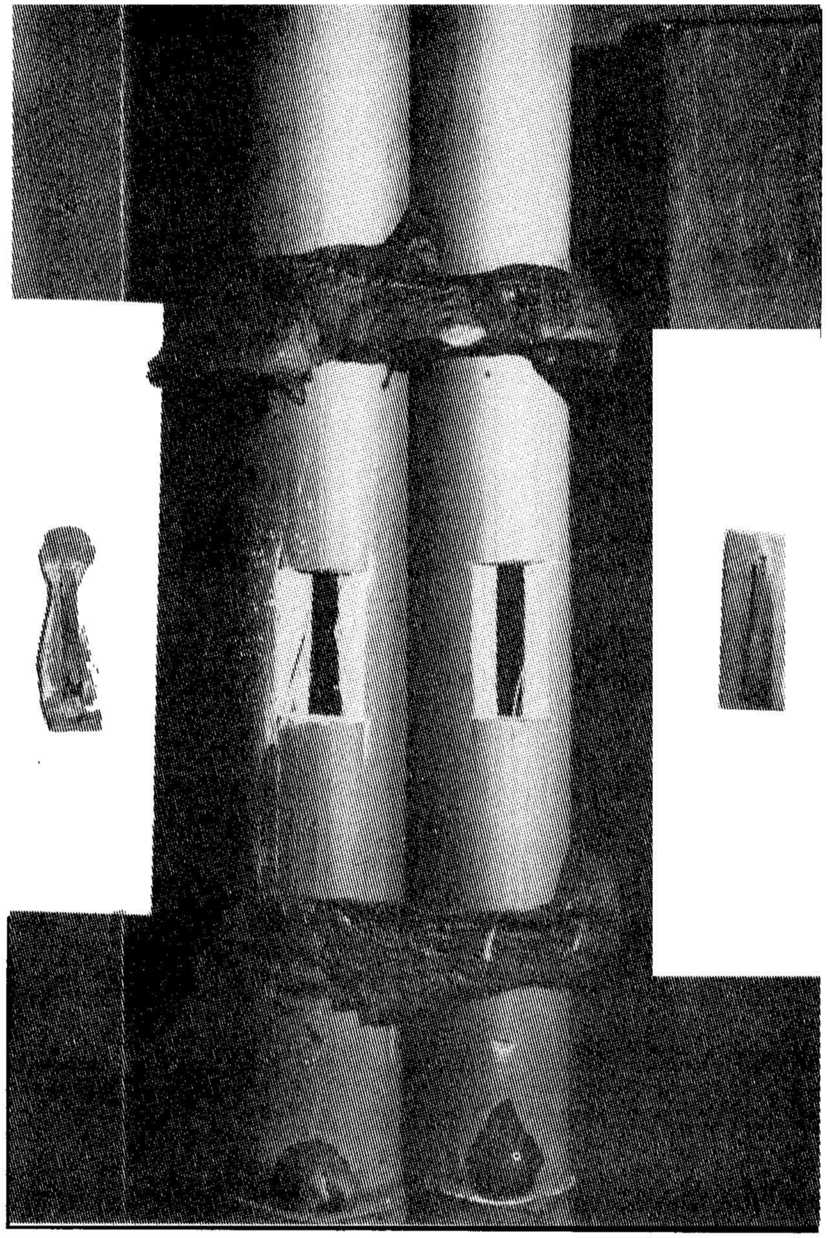


Plate I
Reed-window regions of two khāēn-pipes. The whiteness of the windows is due to the application of 'chalk' (see p. 138). The respective free-reeds – lower-octave to the left, upper-
application of 'chalk' (see p. 138). The respective free-reeds – lower-octave to the left, upper-
octave to the right – have been removed from each window. The taper on the tongues is directed toward the distal ends of the pipes. Above and below the windows is a band of black beeswax, such as normally seals the entrance and exit of the pipes from the windchest. Each reed is *ca* 12 mm in length. (Photograph by Dr R. J. Skaer, Zoological Laboratory, Cambridge.)



monté enſuite ſur un pain de réſine, je touchai inutilement aux fils de laiton : cette perſonne en étoit toute ſurpriſe ; mais je lui en fis bientôt ſentir la raiſon en lui tirant une forte étincelle.

### CINQUIEME EXPERIENCE.

J'établis un clavier, de ſorte que l'extrémité de chaque touche étoit ſous chacun des fils *iiii*; ces touches étant de bois, elles étoient moins propres qu'un corps métallique, à me donner la commotion; mais auſſi le mouvement des battants en étoit beaucoup plus foible.

### SIXIEME EXPERIENCE.

A l'extrémité *i*, *fig*. 2, du fil de laiton *d*, j'adaptai un petit levier de fer *f*, qui ſe terminoit en anneau à l'extrémité *i*, & qui jouoit librement dans un anneau ſemblable du fil *d*. Ce levier repoſoit ſur une verge de fer *c*, iſolée ſur deux petits tubes de verre, & communiquant au conducteur par le moyen d'un fil d'archal ; quand on baiſſoit la touche *t*, on élevoit l'extrémité *e* d'une cet article. On voit qu'en plongeant la phiole dans l'eau, j'avois en vue d'augmenter ſa vertu électrique, & par conſéquent celle du conducteur qui y communiquoit par un fil d'archal. Le mouvement de mes battants devint donc plus vif ; mais il le devint tellement qu'il n'étoit plus poſſible de toucher impunément aux fils *iii* : je recevois, en y touchant, une commotion trop violente pour que je priſſe plaiſir à cette nouvelle Muſique ; & je penſai à la rendre un peu moins piquante.

## *Quatrieme Experience.*

Je me ſervis, pour toucher les fils *iii*, d'un morceau de fer fixé au bout d'un tube de verre. J'évitai par ce moyen la commotion ; mais il me fut impoſſible de tirer plus de trois ſons, parce que le morceau de fer étant iſolé, s'électriſa bien-tôt par le contact des fils de laiton. Quelqu'un étant alors ſurvenu, je me déterminai à ſouffrir quelques étincelles pour lui faire voir l'eſſai du carillon électrique : je jouai un commencement d'air aſſez paſſablement ; & étant

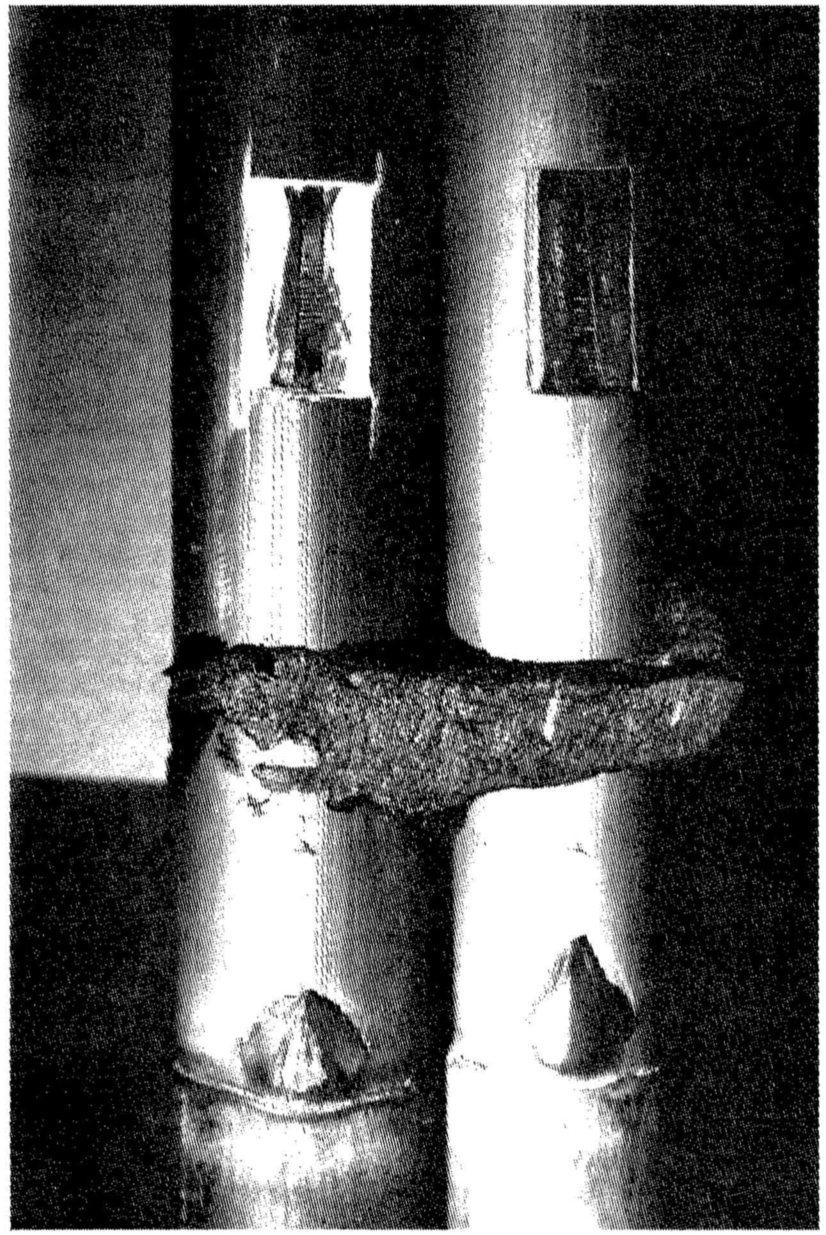
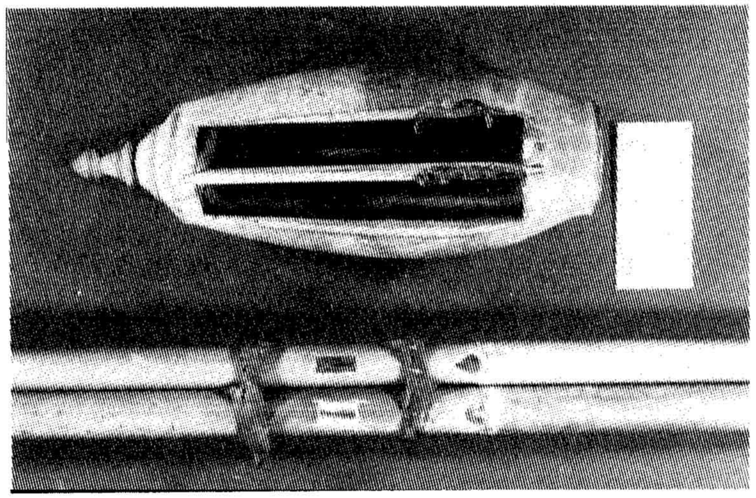


Plate 11
Upper- and lower-octave pipes (to right and to left, respectively) with free-reeds *in situ*, showing transverse striations in the bronze, generated in the course of honing. (Photograph by Dr R. J. Skaer, Zoological Laboratory, Cambridge.)



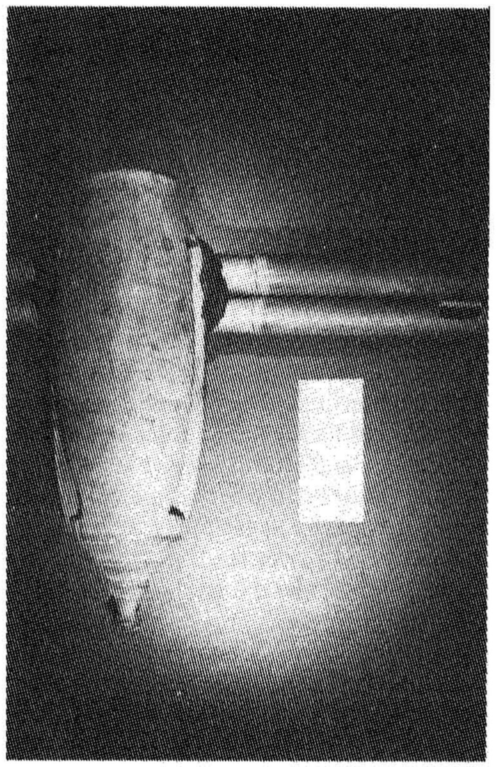


Plate 9
Windchest and pipe-insertion in khāen made in Ban Sikaeo.
(a) lateral view of windchest with a pair of upper- and lower-octave pipes secured at entrance and exit by black beeswax. The lower vent of the upper-octave pipe is seen to the left.
(b) view of windchest from above with cavity revealed and upper-baffle in position. To the left lower- and upper-octave pipes, side by side.



don de ſoie *ff*. Cela étant ainſi, & ayant établi une communication entre la verge de fer *aa* & le conducteur électriſé, je réuſſis à jouer le commencement d'un air, en touchant ſucceſſivement aux extrémités *iiii* des fils *ddd*.

Mais ſi les fils noirs avoient un avantage, en ce qu'ils empêchoient le battant de revenir ſur la ſonnette, quand je ceſſois de toucher à ſon fil de laiton; ils avoient auſſi un inconvénient, c'eſt que la vîteſſe du battant en étoit conſidérablement affoiblie, & que le choc en étoit beaucoup moins ſenſible. Je tâchai donc de remédier à cet inconvénient, en augmentant la force de l'Electricité.

## *Troisieme Experience.*

Je remplis à moitié d'eau une phiole de verre blanc, & je la plongeai à moitié dans l'eau; on ſait que cette phiole ſert à l'Expérience de Leyde, & qu'étant iſolée elle ne peut s'électriſer. Je n'avois pas encore lu les Lettres de M. Franklin, & j'ignorois abſolument qu'il eût penſé avant moi & comme moi ſur battant eſt venu la frapper. De là j'ai conclu qu'ayant pluſieurs timbres ſur les différents tons de l'octave, je pourrois réuſſir à en tirer quelques airs, en les touchant ainſi ſucceſſivement. J'y trouvois une difficulté; c'eſt qu'après avoir retiré le doigt, le battant frappoit encore la ſonnette deux ou trois fois, ce qui ne devoit produire qu'une grande confuſion. Il falloit donc faire enſorte que le battant ſe mît en mouvement dans l'inſtant que je toucherois à la ſonnette, & qu'il ſe tînt en repos auſſitôt que je ceſſerois d'y toucher.

## *SECONDE EXPERIENCE.*

J'ai fait deſcendre un fil noir *g*, de la verge de fer à la ſonnette. Ce fil ſervoit, comme je le prétendois, de frein au battant, qui ne venoit plus frapper la ſonnette qu'à mon ordre, & quand je la lui montrois avec le doigt. Je diſpoſai donc pluſieurs timbres de différents tons, chacun avec ſon fil noir, & ſon battant *eee*; j'attachai auſſi à chacun de ces timbres un fil de laiton *ddd*, que je fixai par l'autre extrémité à un cor-

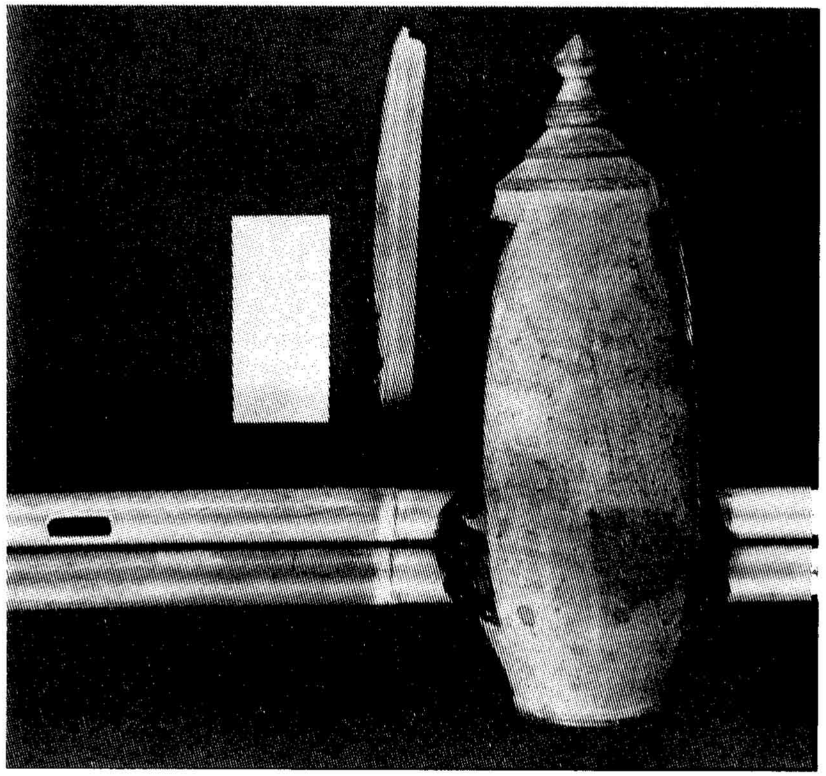


Plate 9c
Same lateral view as in (a), but with upper baffle removed to show small tenon at either end of the baffle. (Photograph by Dr R. J. Skaer, Zoological Laboratory, Cambridge: the longer side of the rectangle of white paper is 50 mm long.)

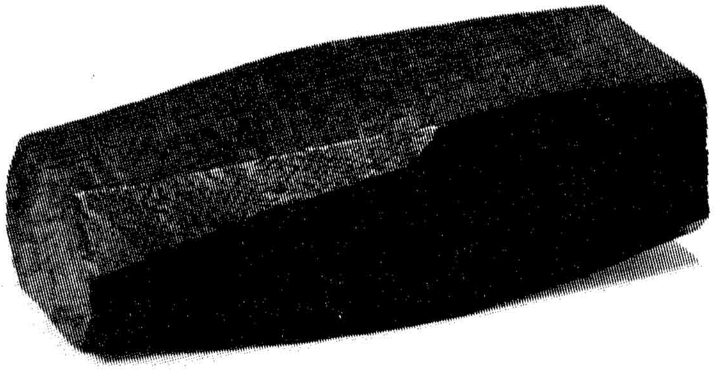


Plate 10
Roughly shaped block of hardwood from which windchest is carved. (Photograph by the Museum of Archaeology and Ethnology, Cambridge)

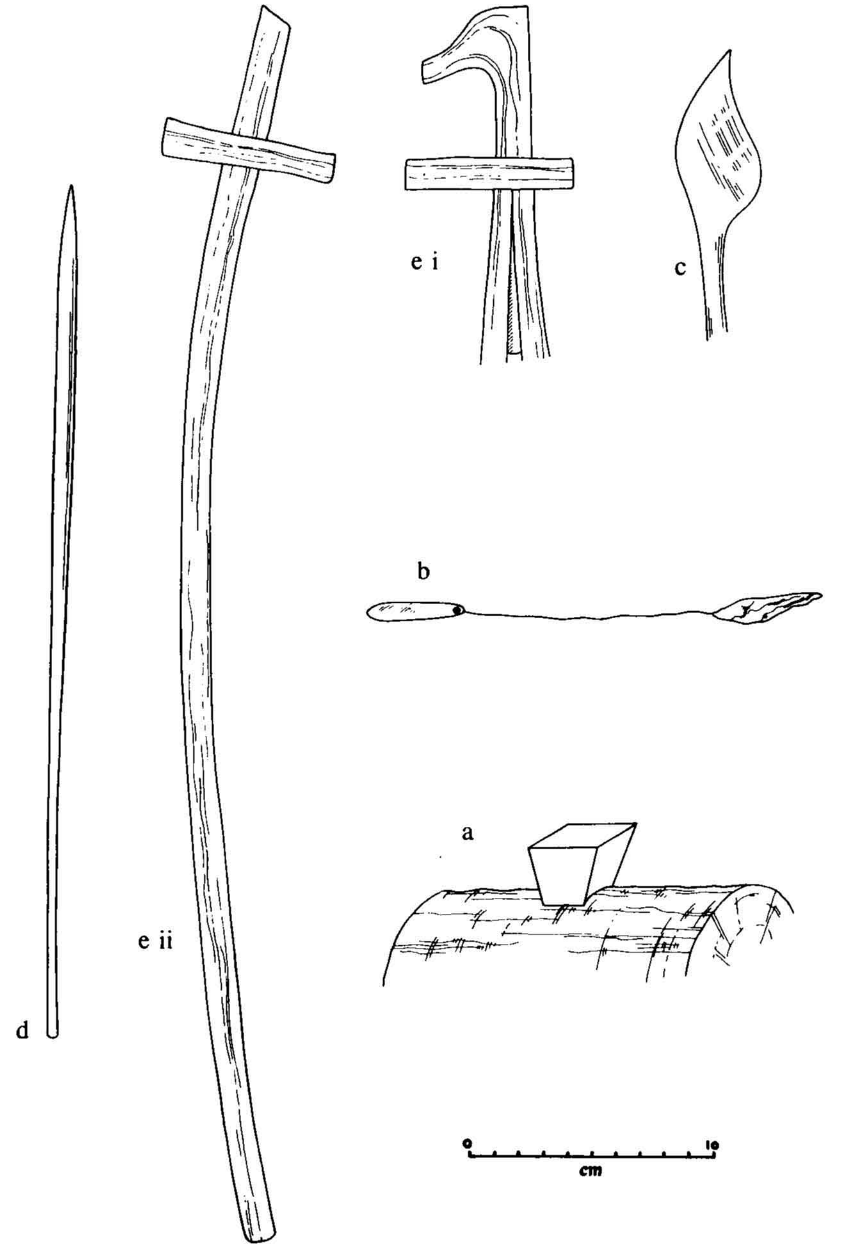
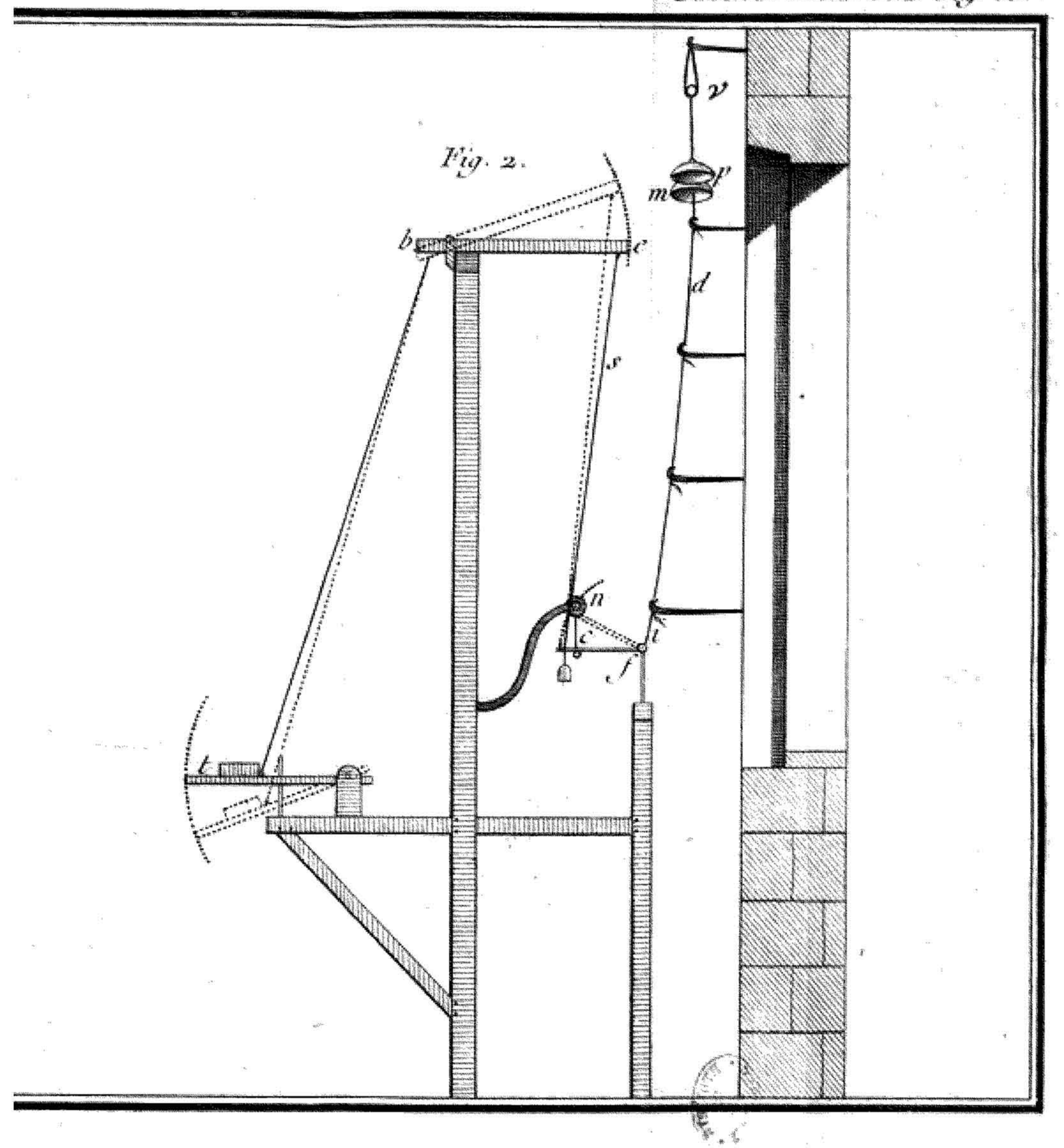
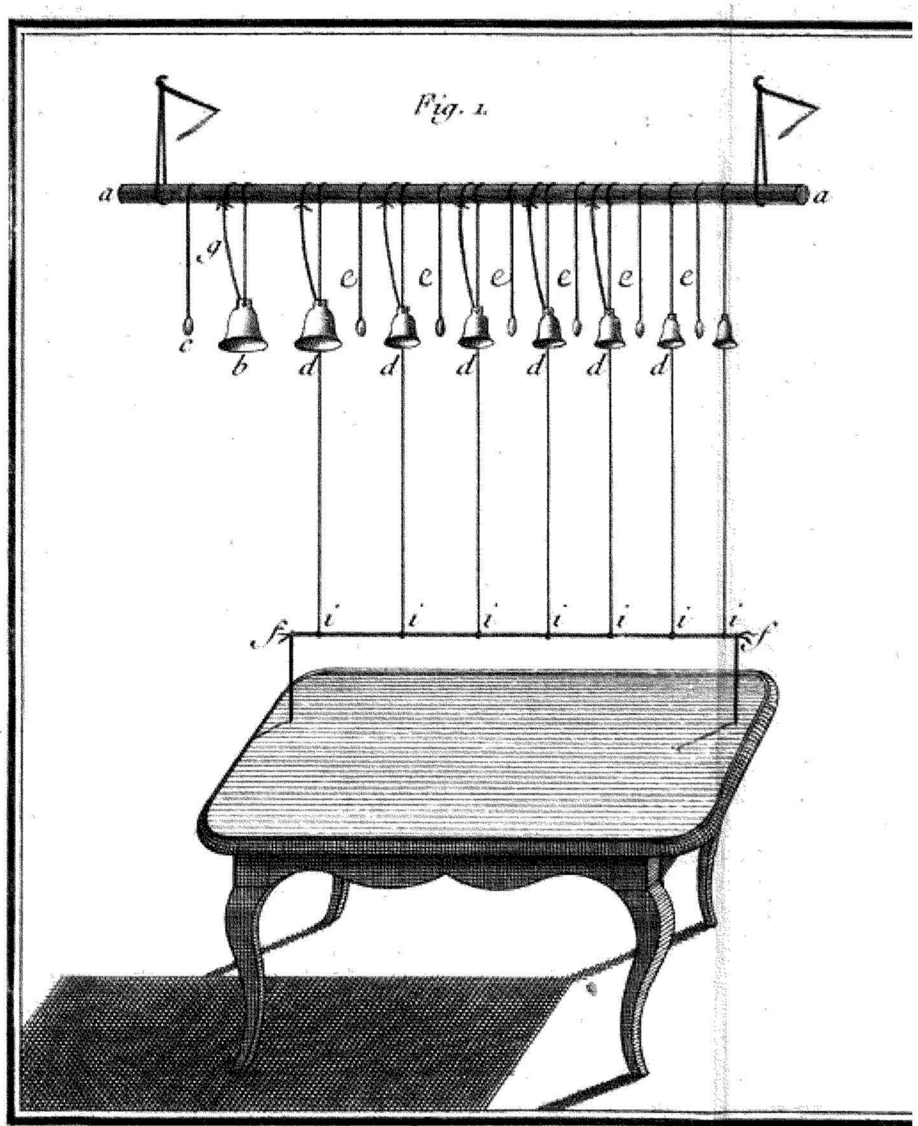



Figure 1
(a) anvil on which bronze-strip for free-reeds is cold-forged; (b) bronze knife used to detach anterior end of free-reed tongue from the surrounding frame; (c) characteristic leaf-like blade of the standard regional knife: mīt tǭk; (d) iron spike used in removing nodal septa from bamboo-canes, first heating to redness; (e) i, ii, two views of the wooden 'monkey-paw' used in the straightening of bamboo-canes.
(Drawings by Jeremy Gray, based on field-sketches by L. E. R. P.)

*Clavessin Electr. Pl. I. Pag. 30.*





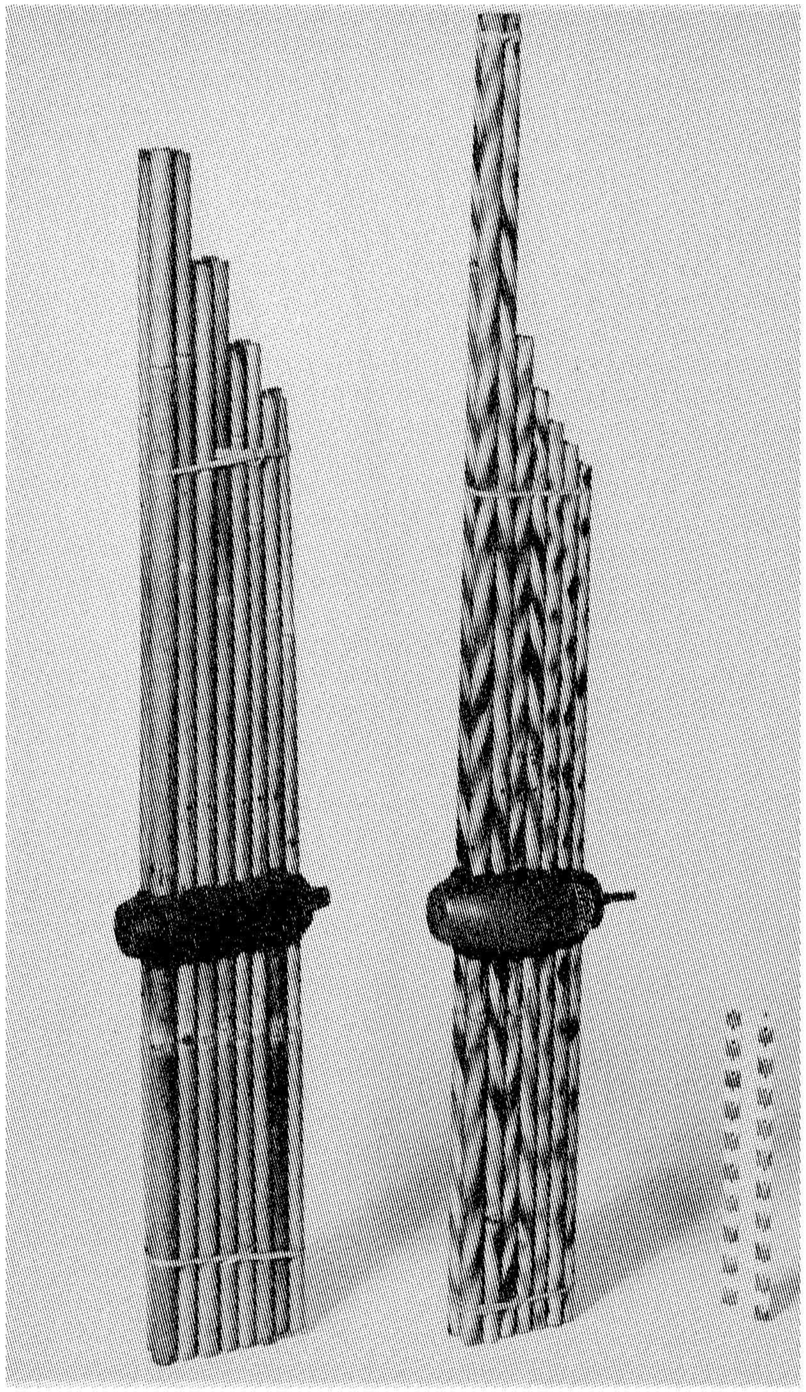
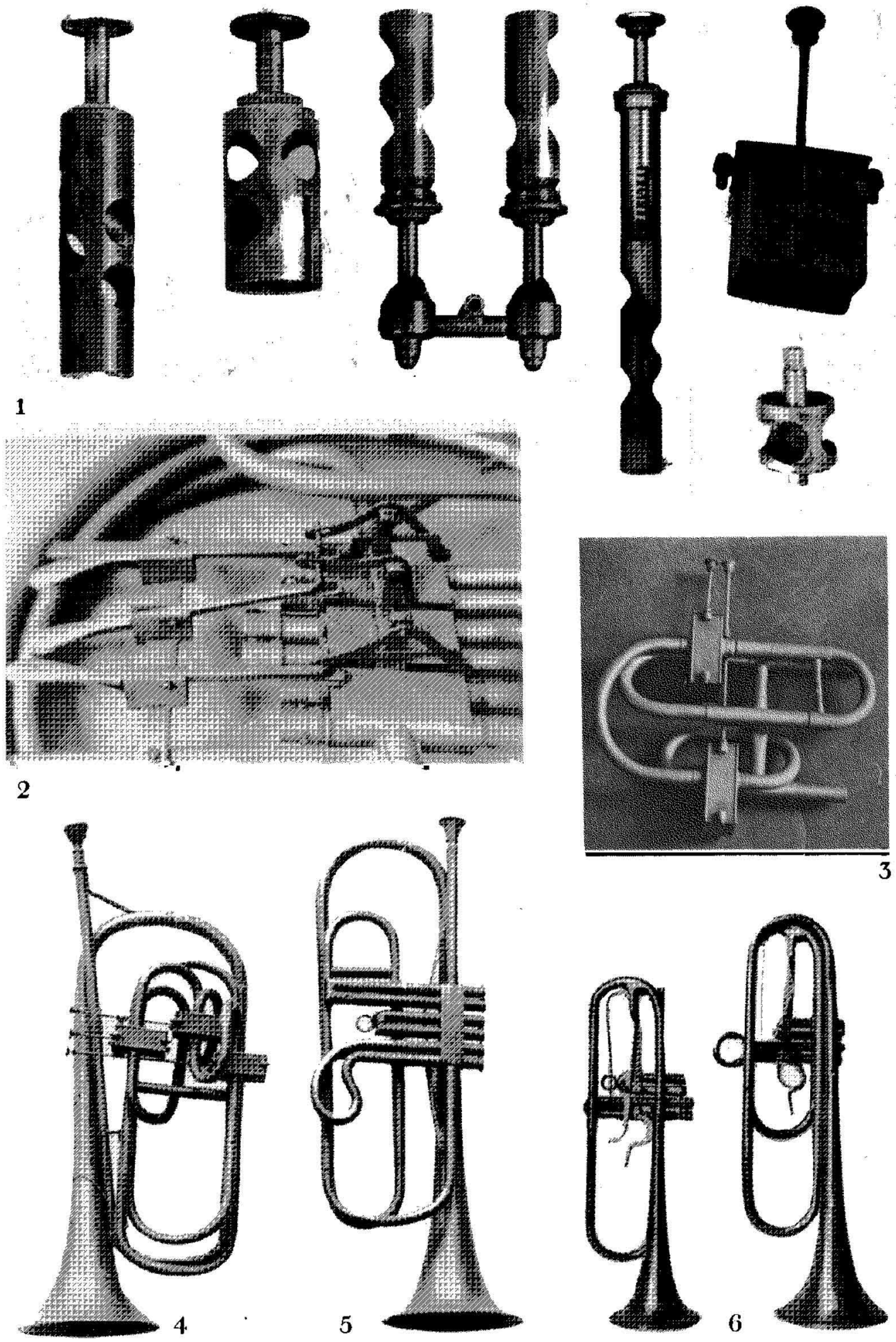



Plate 8
Medium-sized khāēn from North-East Thailand (left) and from Laos (right). The scale is in centimetres. (Photograph by the Museum of Archaeology & Ethnology, Cambridge.)




XIII 1. *Valves* (mostly cornet): Périnet, early type; Berlin; double-piston; Stoelzel; 'square'; (below) rotary; 2. Horn, Schott (do. 1314); 3. Schuster-type horn valves (Brussels Conservatoire 1310); 4. Bass trumpet, W. Schuster (Berlin, Instit. für Musikforschung 3104); 5. Bass trumpet *c.* 1825 (formerly Berlin 3105); 6. Trumpets in B flat (1837) and E flat, M. Saurle (Munich, Bayerisches Nationalmuseum).



# LE CLAVESSIN ÉLECTRIQUE.

J'ENTRERAI tout de ſuite dans le détail des expériences qui m'ont conduit à l'invention du Claveſſin électrique ; & je ne tâcherai de les expliquer qu'après avoir bien reconnu quels ſont les corps électriques, ce que c'eſt que cette matiere de l'Electricité , & quel eſt ſon mouvement.

## *PREMIERE EXPERIENCE.*

J'ai iſolé une verge de fer *a a*, *fig.* 1 ; j'y ai ſuſpendu une ſonnette *b*, par un cordon de ſoie , & un battant *c*, par un fil de métal. La verge étant électriſée , j'ai approché le doigt de la ſonnette, & auſſi-tôt le

C