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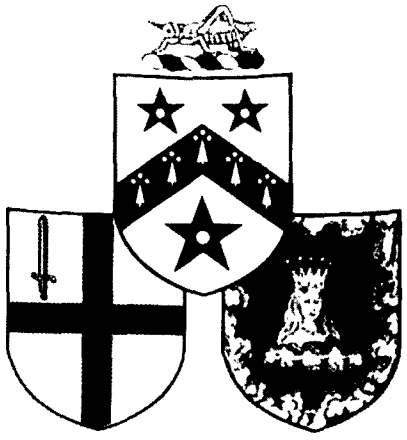

CHIPPENDALE'S LOST GEOMETRY

A Lecture by

PROFESSOR IAN STEWART MA PhD FIMA CMath
Gresham Professor of Geometry

21 May 1997

GRESHAM COLLEGE

Policy & Objectives

An independently funded educational institution, Gresham College exists

- to continue the free public lectures which have been given for 400 years, and to reinterpret the 'new learning' of Sir Thomas Gresham's day in contemporary terms;

- to engage in study, teaching and research, particularly in those disciplines represented by the Gresham Professors;

- to foster academic consideration of contemporary problems;

- to challenge those who live or work in the City of London to engage in intellectual debate on those subjects in which the City has a proper concern; and to provide a window on the City for learned societies, both national and international.

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Gresham Geometry Lecture
21 May 1997

Chippendale's Lost Geometry

> The conclusion cannot be far away — that the highest aim of work in Public Museums is not — however ingeniously — to multiply facts in the memories of visitors, but to kindle in their hearts the wonder and loving sympathy — THE NEW KNOWLEDGE — called for by every page in the far-reaching annals of Nature.
>
> *The Rev. Henry Higgins, in his 1890 presidential address to the Museums Association.*

The City of London has long been associated with the manufacture of fine furniture. The cabinetmaker George Hepplewhite opened a shop on Redcross Street in the mid-1700s. Thomas Chippendale, though born in Otley, Yorkshire, moved to St. Martin's Lane in 1753, where his showrooms, workshops, and home were established; he stayed there until his death in 1779. His son Thomas II continued this operation, and opened a second shop in the Haymarket in 1814, which moved to Jermyn Street in 1821.

In recent years Alan Moore, a consultant who lives in Maidstone, has been developing the theory that makers of fine funiture, such as Chippendale and Hepplewhite, must have made use of geometric techniques which have since been 'lost'. Not in the sense that they have vanished from the face of the Earth, but in the sense that they are no longer connected with Chippendale and Hepplewhite. Some, indeed, may have vanished completely.

Some Background

For more than a decade Mr Moore has carried out a private research project on the methods and technology used by the great 18th century cabinetmakers — Hallet, Chippendale, Cobb & Vile, Linnel *et al.* This work has led to some remarkable (and controversial) findings. Since the late 19th century it has been the accepted view that the fine pieces of furniture made throughout the period 1670-1820 were the product of superlative artistic judgement combined with infallible skill in the use of conventional hand tools. A commonsense appraisal suggest that this theory is unlikely for a number of entirely practical reasons. The known cabinetmakers employed small numbers of relatively unskilled artisans, probably including women and children. Their rate of production of furniture was high; their prices were sufficiently modest for their products to be widely bought. Except during the longer periods of daylight, the lighting in their workshops was poor, making intricate close-up work difficult, but much work was done during the evenings.

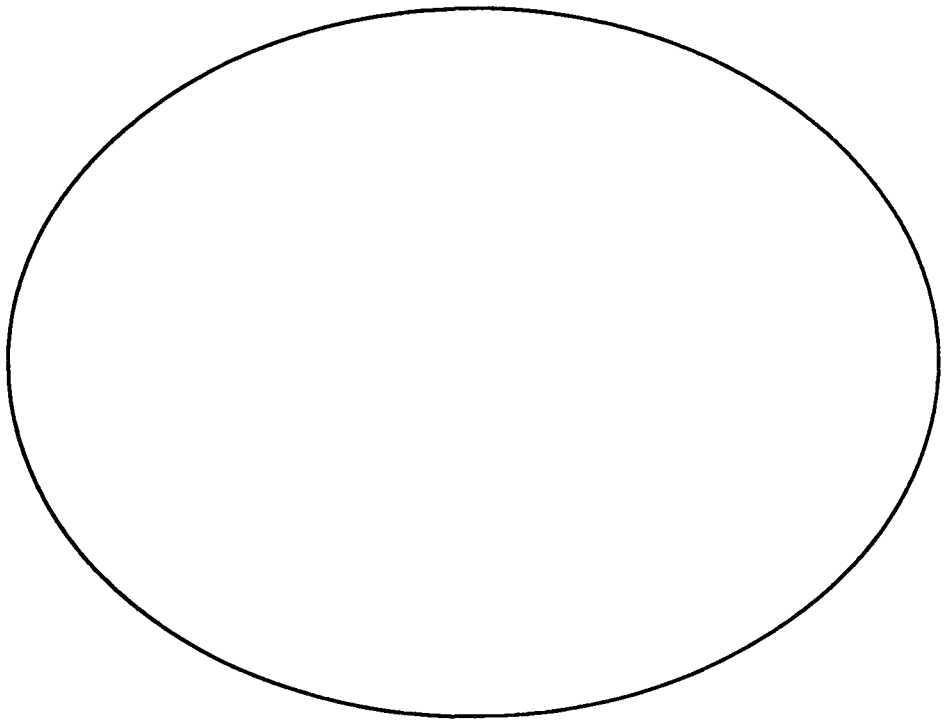
It therefore seems likely that the cabinetmakers employed various simple and robust techniques, such as special jigs and methods of working. There do not seem to be records of these methods, but this is no surprise since they would have been kept secret for competitive and marketing reasons. It is possible that some of the equipment remains, its

purpose unrecognised. Mr. Moore, an experienced woodworker and an expert on furniture, has therefore attempted to work out the kind of approach that *might* have been used. He has, for example, discovered a strikingly simple method of turning a cabriole leg on a modified lathe, in matching sets of four, by introducing packing pieces and then discarding them again. The geometry of the result is compellingly similar to that of classical cabriole legs, suggesting that similar methods were indeeed used.

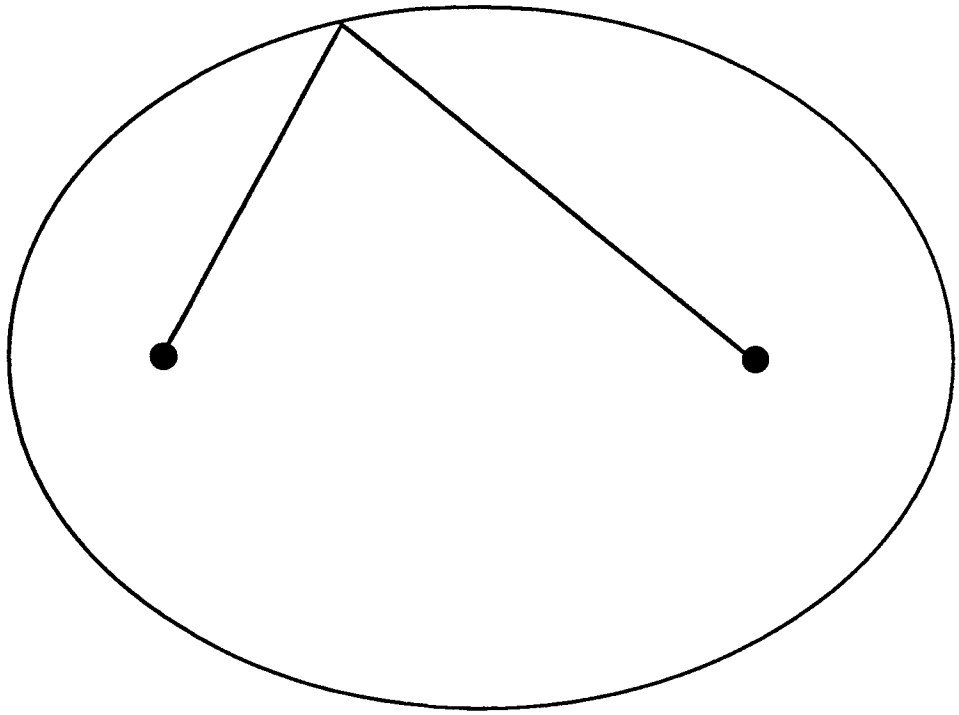
At any rate, such techniques — whatever they were — would have enabled poorly educated artisans with no artistic ability to produce work of a consistently high quality at speed in poor lighting. The artistic input would have come from the cabinetmaker himself in the design of jigs, etc. to create the overall form of the furniture.

'Not an Ellipse'

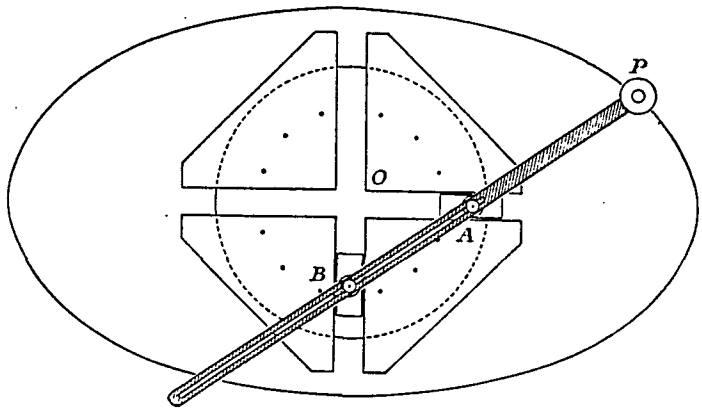
As a simple example of the methods that might have been used, consider the manufacture of a table with an elliptical top:



A precise mathematical construction of this curve is difficult. One fairly practical method is to employ the ellipse's 'focal property': a line from one focus to the perimeter and back to the other focus has constant length:



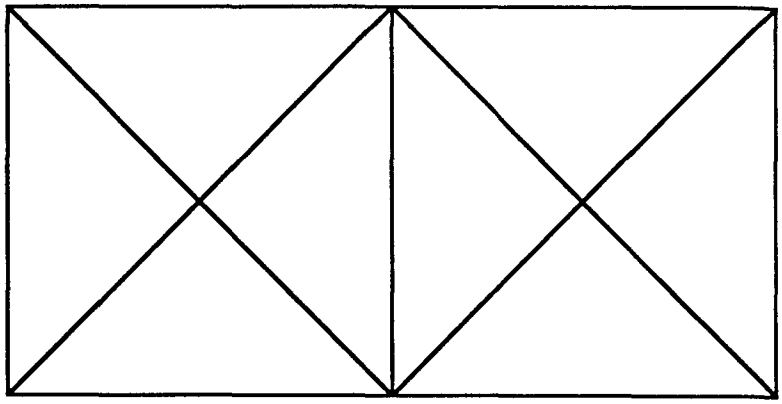
Other mechanical aids are also available, such as the *Trammel of Archimedes*:



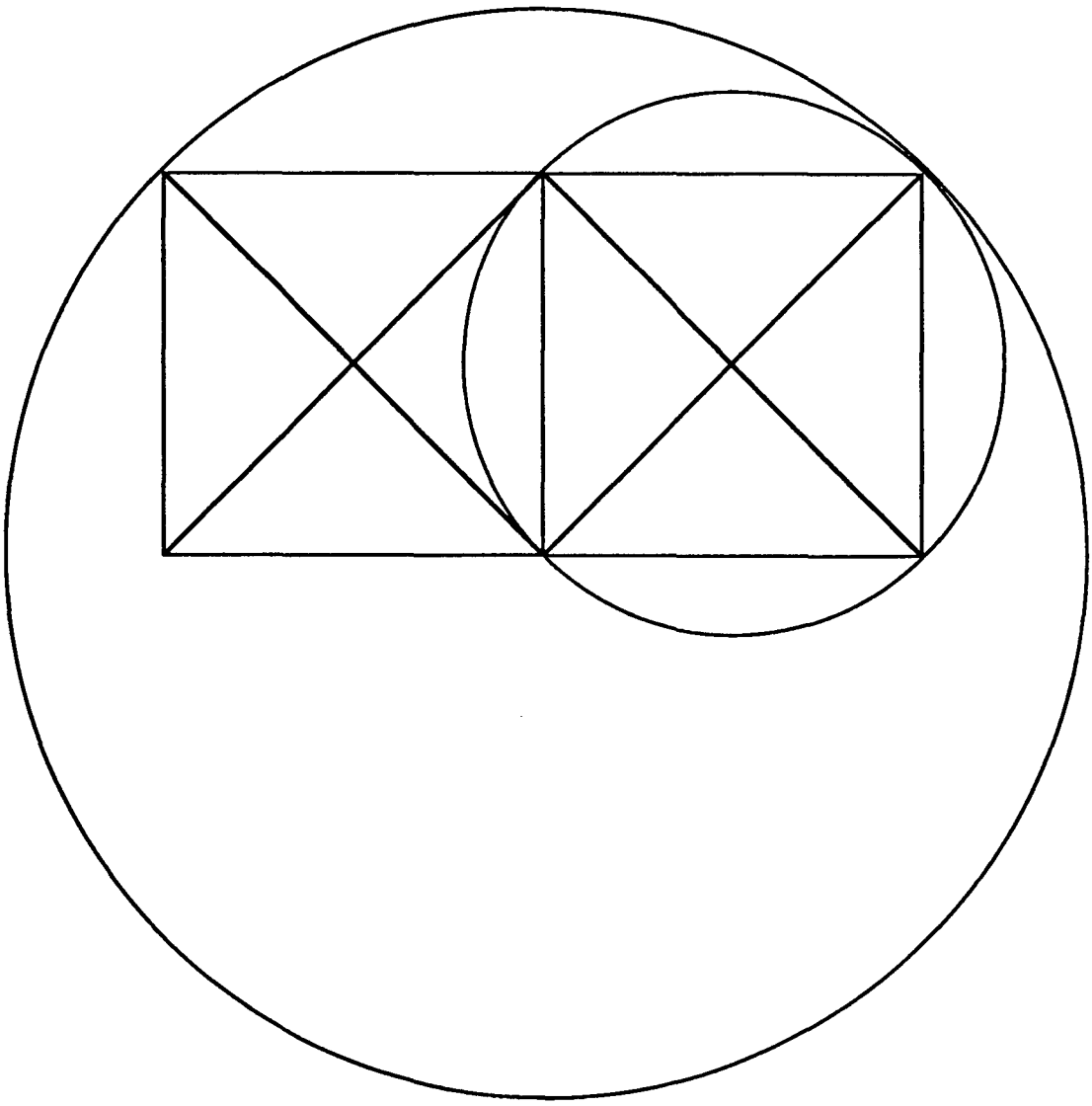
However, once the shape has been drawn (in poor light by a poorly educated artisan) it must be cut (also in poor light by a poorly educated artisan). Errors may well be introduced.

A better method would allow the cut to be made *directly* — in effect, as the curve is drawn. Now the only curves that it is simple to cut directly are straight lines and arcs of circles. Can we construct an ellipse from those?

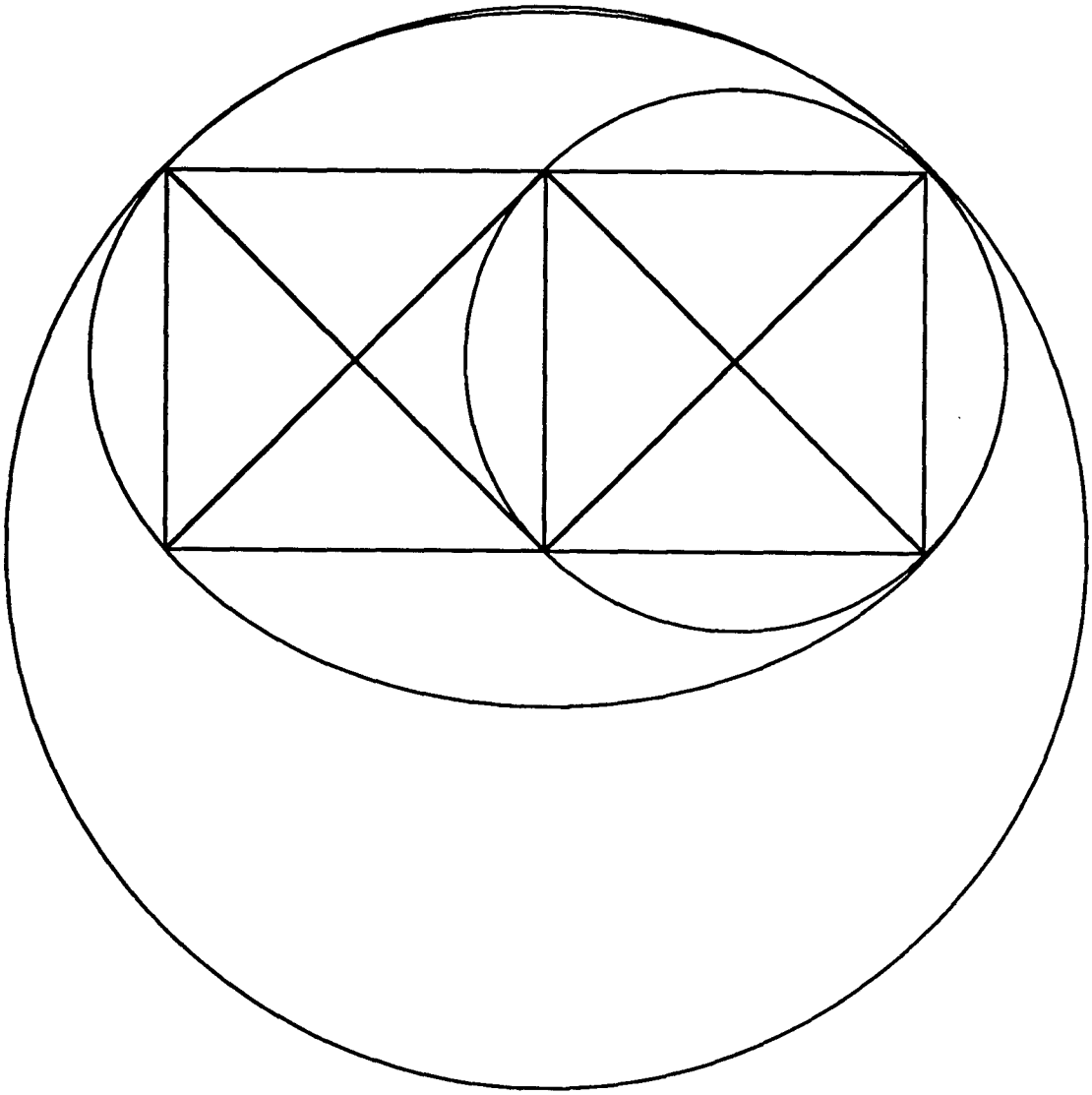
Four arcs of a circle can come very close to an ellipse. Start with the following diagram:



Now swing four circular arcs, like this (for clarity only two are shown):

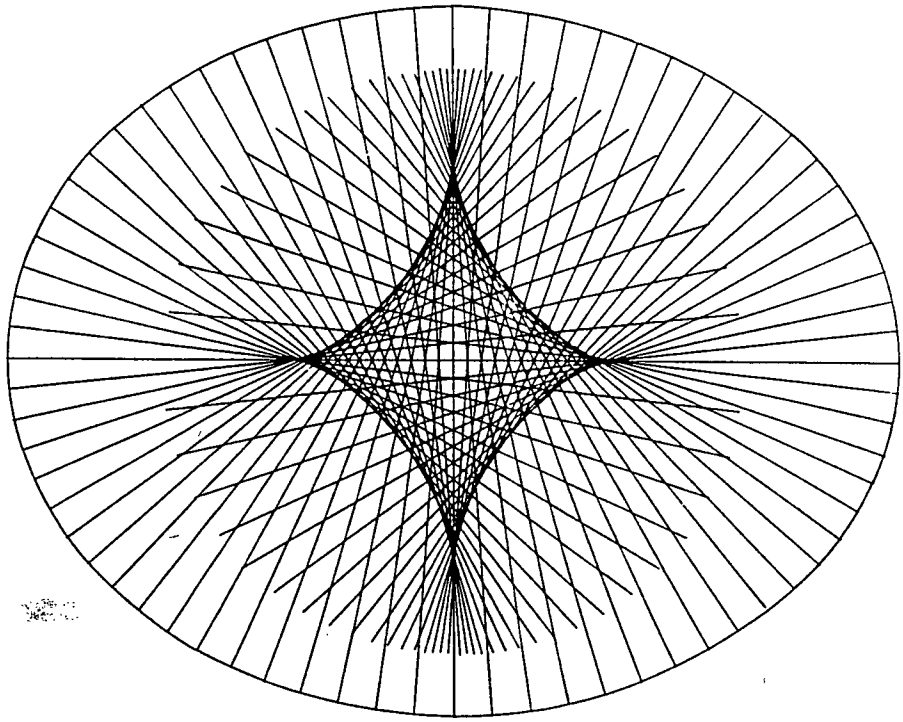


Alan showed this construction to many mathematicians, to be told only that it was 'not an ellipse'. True, it is not — ellipses are not amde from circual arcs. But *it is astonishgingly close*, as can be seen if we superimpose a true ellipse:

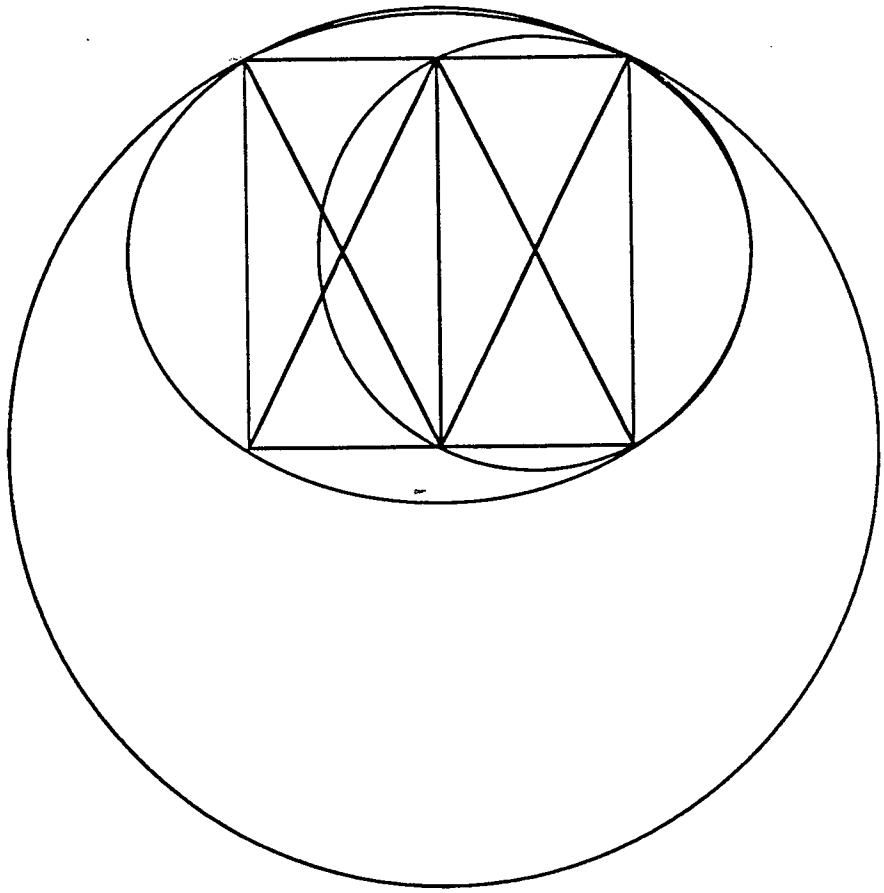


In short, what suffices for practical purposes is *a good approximation to an ellipse.*

One reason why this method works is that the ellipse has two points of minimum curvature, and two of maximum curvature. These occur at the cusps of the following diagram, the *evolute* of the ellipse (envelope of its normals, equal to the locus of centres of curvature).



The method readily extends to give ellipses of different eccentricity:

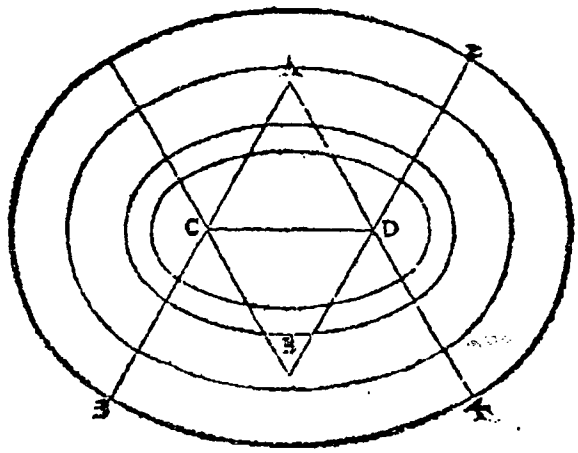


and even to other curves shapes altogether.

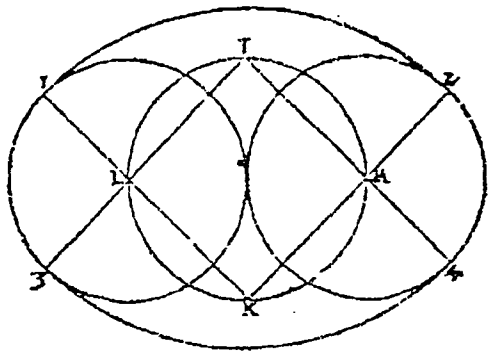
The next two pages of diagrams show that this technique was once well known: it is from *The Five Books of Architecture* by Sebastiano Serlio (1475-1554). Serlio's aim was 'to clarify the works of Vitruvius'. Vitruvius flourished around 40 BC!

Of Geometrie

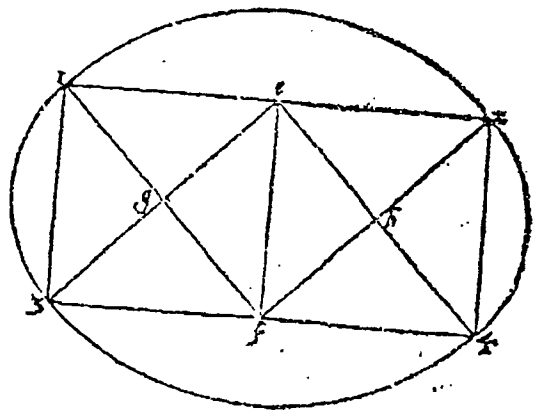
A Man may make Oualle formes in diuers fashions, but I will onely set downe foure. To make this first figure, you must set two perfect Triangles one aboue the other, like a Lozenge, and at the ioyning of them together, you must draw the lines through fo 1.2 3.4 and the corners A B. C D. shall be the foure Centers, then set one foote of the Compasse vpon B. and the other vpon 1. and draw a line from thence to the figure 2. After that, from the poynt A. and 3. to 4. you must also draw a line: which being done, set the one ende of the Compasse in the poynt C. and then draw a piece of a Circle from 1. to 3. and againe, the Compasse being in the Center D. draw a piece of a Circle from 2. to 4. and then the forme is made. You must also vnderstand, that the nearer that the figures come to their Centers, so much the longer they are: and to the contrary, the further that they are from their Centers, the rounder they are: yet they are no perfect Circles, because they haue more then one Center.



FOr the making of the seconde Oualle, you must first make these Circles, as you see here drawing, where fiue straight lines stand: the foure Centers shalbe I.K.L.M. Then placing one point of the Compasse in K. you must draw a line with the other point from the figure of 1. to 2. Againe, without altering the Compasse, you shal set the one foote of the Compasse in I. and so draw a piece of a Circle from the figure 3. to the figure 4. and that maketh the Compasse of the Circle. This Figure is very like the forme of an Egge.

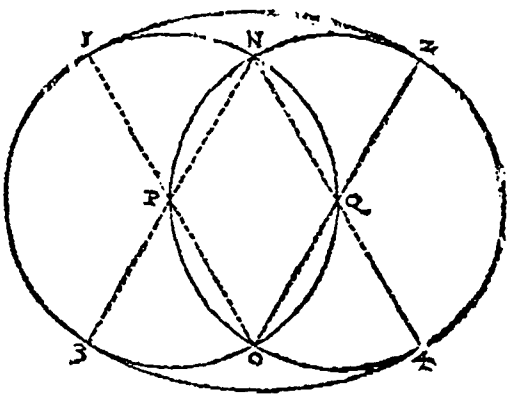


THe third forme is made by two seuerall centers, drawing Diagonall lines in them, which shall cut the two Centers G. H. and the other two the centers E. & F. Then draw a piece of a Circle by F. fo the figure 1. vnto 2. Do the like from E. to 3. and 4. which done, from the points G. and H. make the two sides from 1. to 3. and from 2. to 4. and so end by the Oualle.



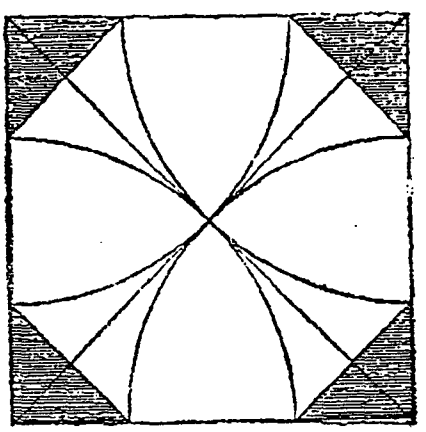
IF you will make this fourth Quale, then make two Circles that may cut through each others Center, & the other two Centers for the closing of the Circle be N.O. after that, whether you draw the right lines or not from the points O.N. you shall shut up the sides from 1 and 2. and from 3 to 4.

And although our Authour saith, there are foure formes of Quales: yet this last figure is of the same forme as the first, onely this is easier to make.

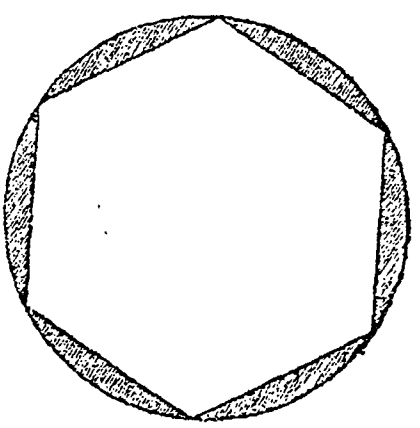


TOuching the Circles, there are many figures which are round, and yet some have 5.6.7.8.9 and 10. corners, &c. But at this time, I will speake onely of these three principally because they are most common.

THis Octogonus, or right points, is drawen out of a right foure cornerd square, drawing the Diagonus which will shewe you the Center: then set one foote of your Compas upon the corners of the Quadrate, and leading the other foote through the Center, directing your Circle towards the side of the Quadrate, there your right poynts shall stand to make it eyght cornerd: and although a man might only doe it by the Circle, making a crosse therein, and deviding each quarter in two, yet it will not be so well, and therefore this is a surer and more perfect way.



THE Hexagonus, that is, the six cornerd Circle, is easiest made in a Circle: for when the Circle is made, you may devide the Circumference in five parts equally, without stirring the Compasse, and drawing the line from one poynt to another, the five corners are made.



Tools for the Partially Sighted

The reconstructed techniques, like those of Chippendale and Hepplewhite, allow people with no artistic ability to produce work of a consistently high quality at speed in poor lighting. This implies that many of them would be suitable for disabled and partially sighted people today — who often cannot work with modern sophisticated tools such an an electric drill or a circular saw for safety reasons.

Methods that would have suited the able-bodied and fully-sighted a few centuries ago had to overcome the same kinds of difficulty that face the disabled and the partially sighted today. Moreover, woodworking is normally carried out standing and using both hands, but most of the proposed new tools can be operated from a sitting position and do not require the use of both hands.

Gresham College will shortly run a workshop — in the true sense of the word — to test the feasibility of this idea. The workshop is expected to create interest in the work of Chippendale and other London cabinetmakers, and should provide additional evidence, of a very practical nature, to support the hypothesis that their work relied in part on applying 'new knowledge' in the form of geometry. This could stimulate further research on this fascinating area of City history.

Organizations for the partially sighted, such as PHAB and RNIB, have an interest in developing the ideas further, with a view to making it possible for partially sighted people to support themselves by making such items as hand-crafted reproduction antique furniture — or any other type of furniture.

The Future

The new theories can be seen as a rediscovery of a lost geometry, perhaps eventually leading to the rewriting of a major area of art history. Careful quantitative studies of the geometry of actual antique furniture could be carried out to establish beyond doubt what methods were actually used. There are educational opportunities for these geometric ideas, which would appeal to the more practically minded child. The Kensington Science Museum has expressed interest in mounting a permanent exhibit based upon Mr. Moore's geometric theories and the resulting tools and techniques.

Commercial Applications

Route Two Profiles Ltd. is a Maidstone-based company formed in 1995 to develop Mr. Moore's ideas into a range of new woodworking and machining tools. The main product of Route Two Profiles is a special patented lathe upon which intricate shapes (such as cabriole legs) can be turned quickly and easily. At the moment several major manufacturers of tools are actively involved in discussions about this and other products.

The tools envisaged for the workshop are a separate development, intended especially for use by the disabled and the partially sighted, but after the workshop has finished the prototypes would become the property of Route Two Profiles Ltd. and might eventually form the basis of a commercial range of tools.

Fig.2

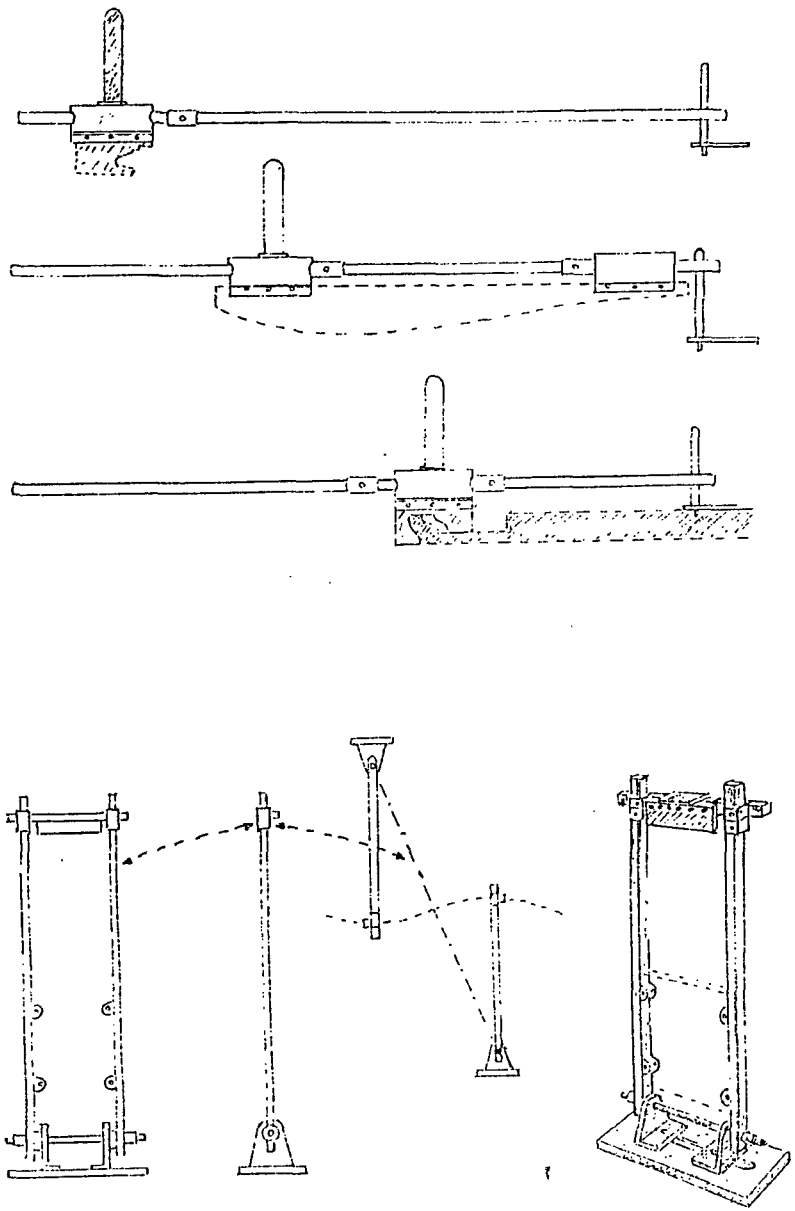
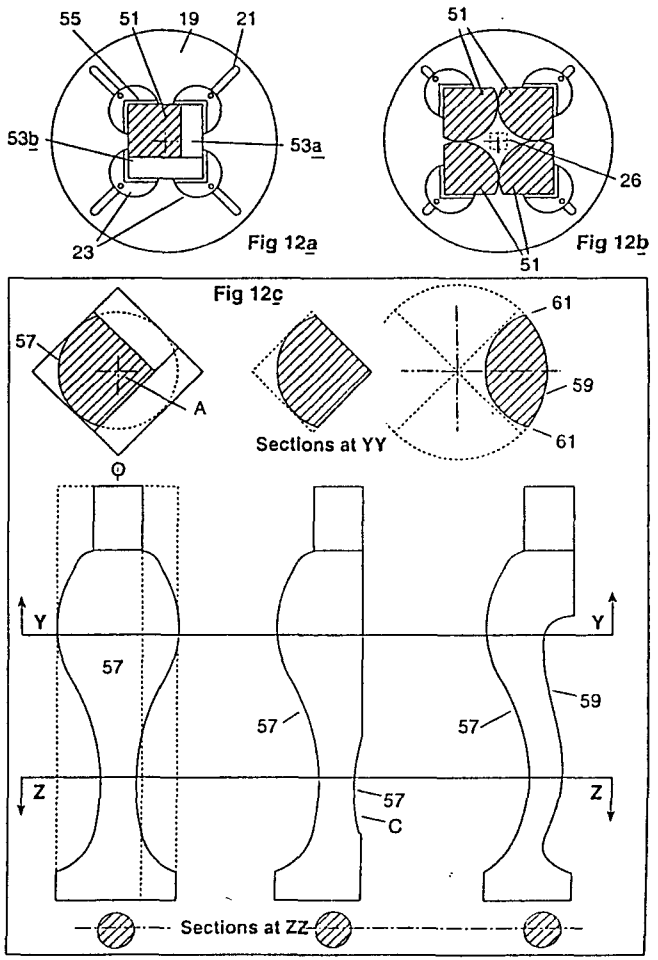


Fig.1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51
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53b
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Fig 12a
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Fig 12b
Fig 12c
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Sections at YY
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C
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Sections at ZZ

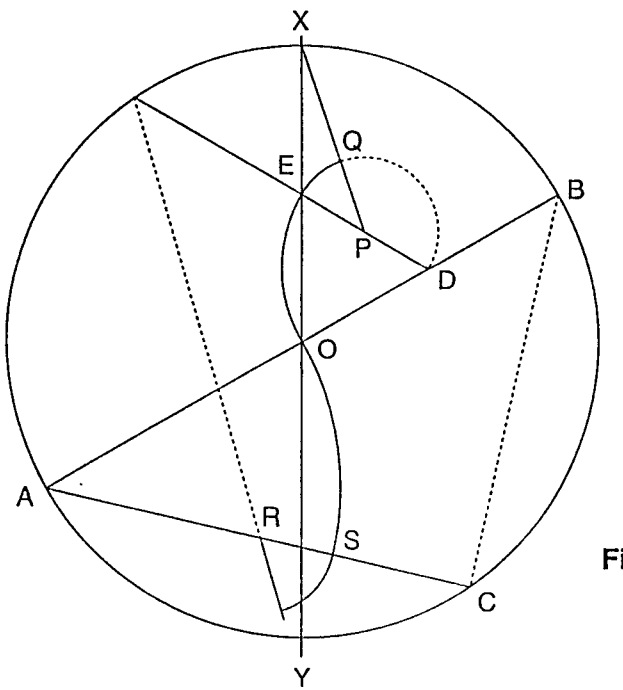


Fig 10a

Fig 10b

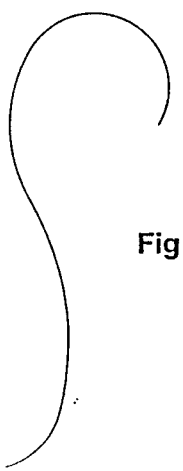


Fig 10c

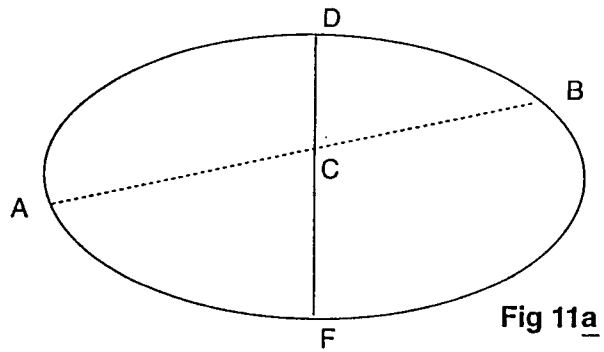


Fig 11a

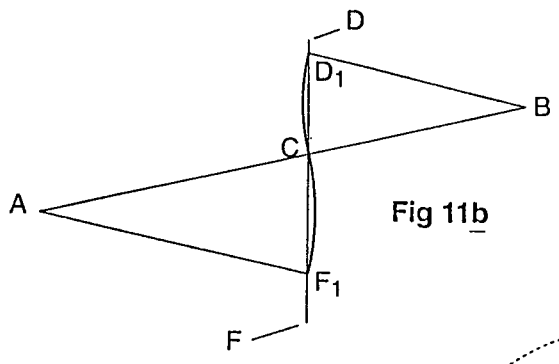


Fig 11b

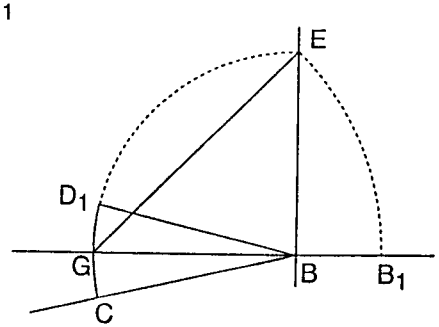


Fig 11c

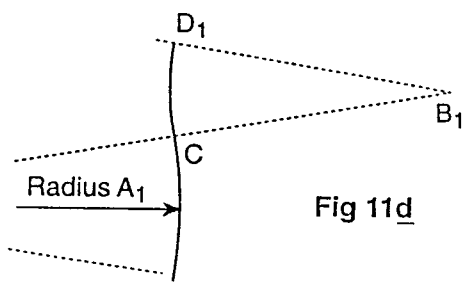


Fig 11d

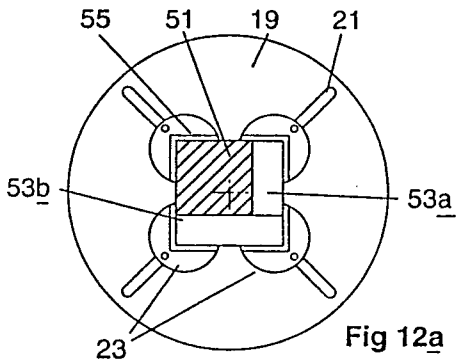


Fig 12a

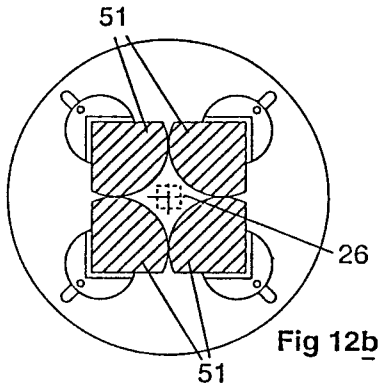
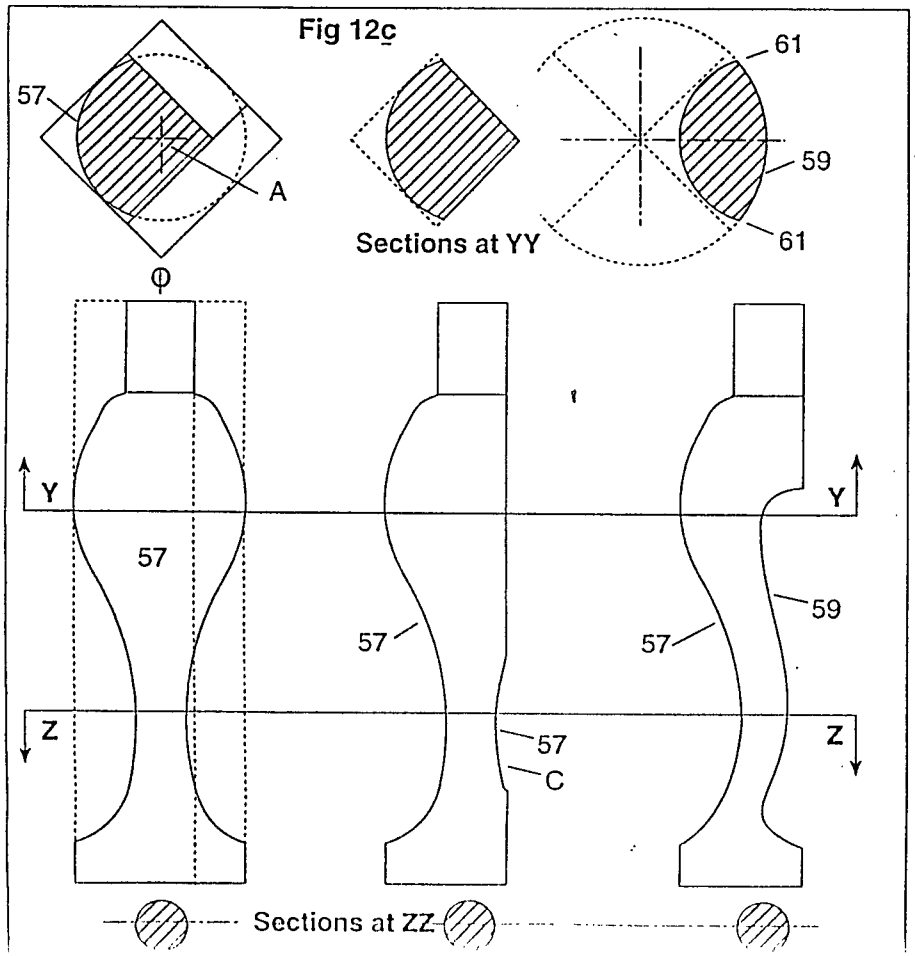


Fig 12b

Fig 12c



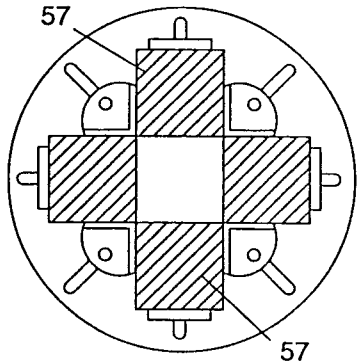


Fig 13a

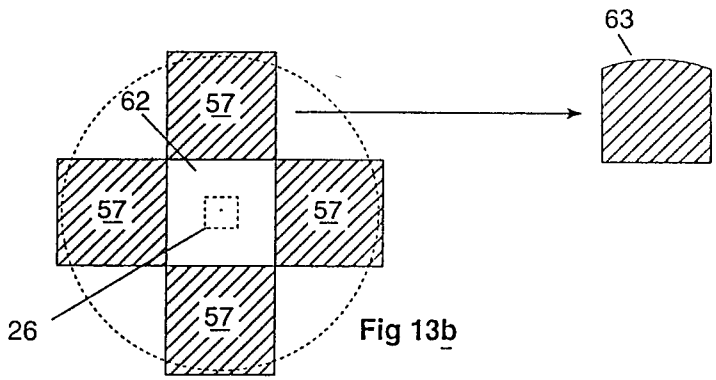


Fig 13b

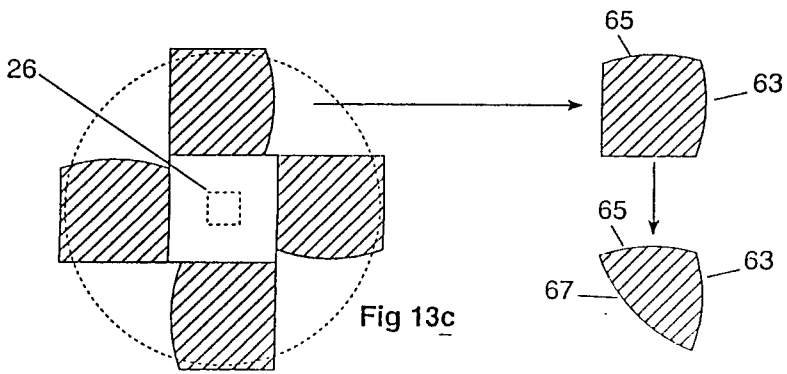


Fig 13c

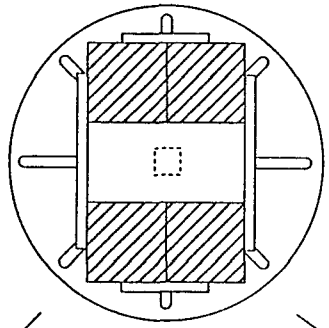


Fig 14

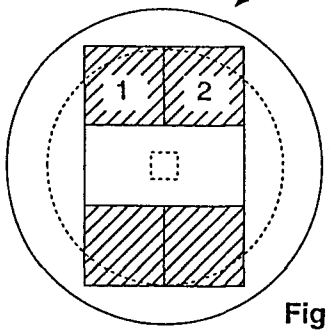


Fig 15a

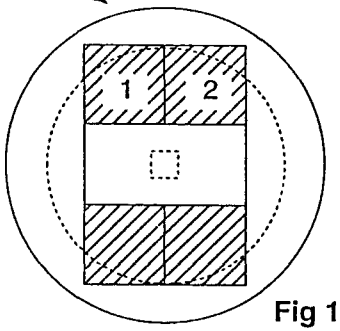


Fig 16a

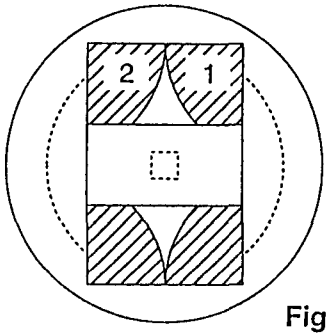


Fig 15b

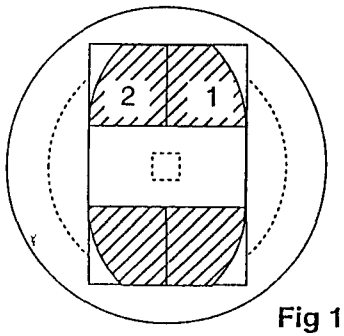


Fig 16b

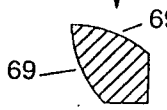


Fig 15c

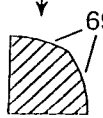


Fig 16c

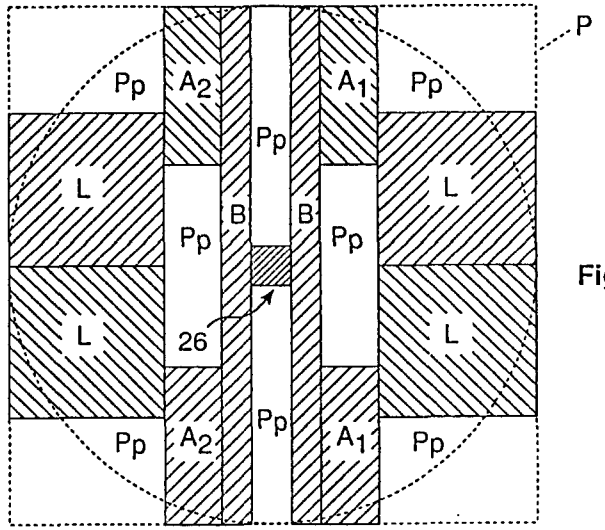


Fig 17

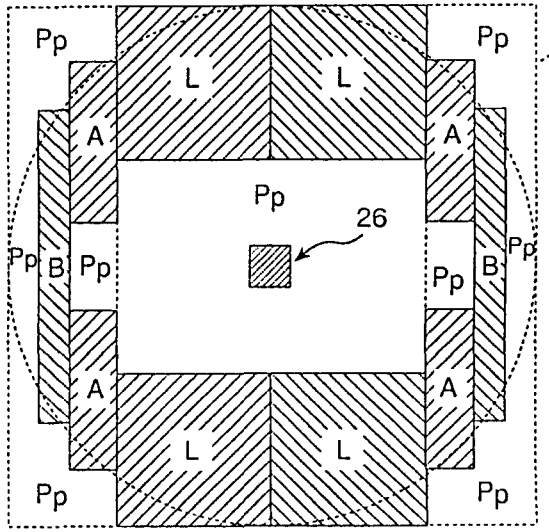


Fig 18

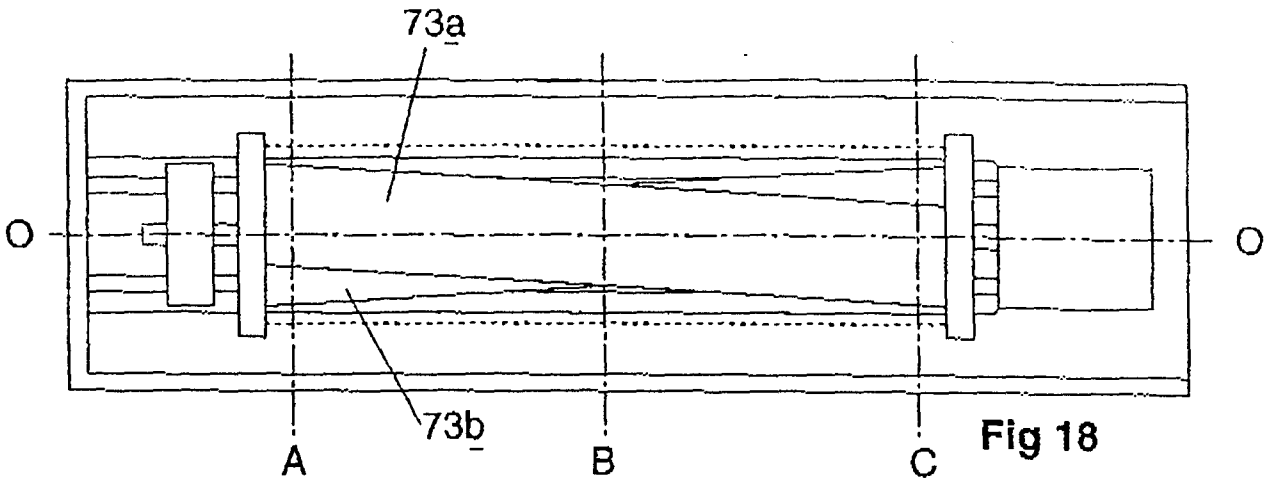


Fig 18

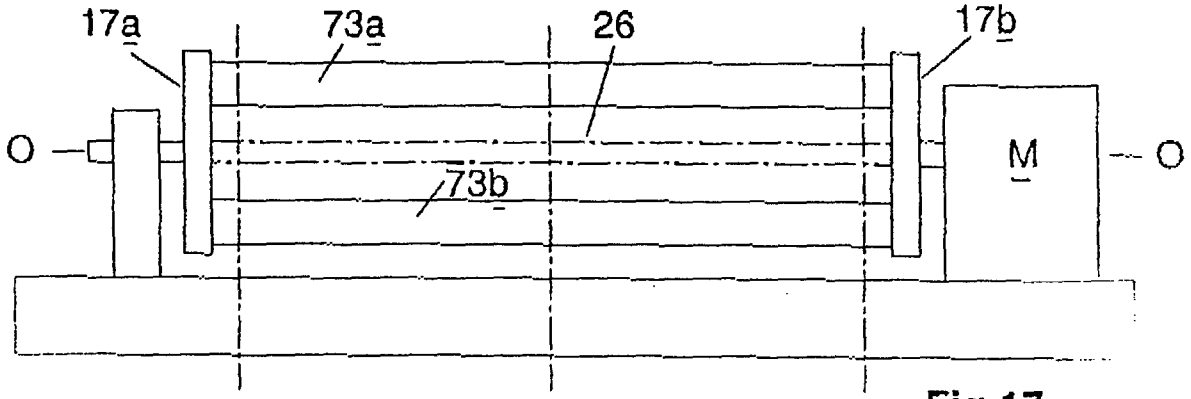
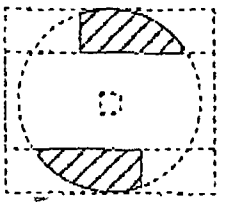
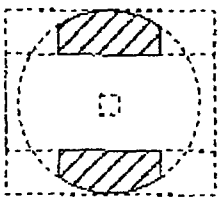


Fig 17



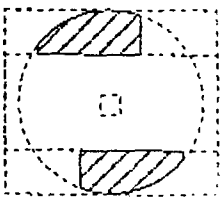
Section at A

Fig 19a



Section at B

Fig 19b



Section at C

Fig 19c

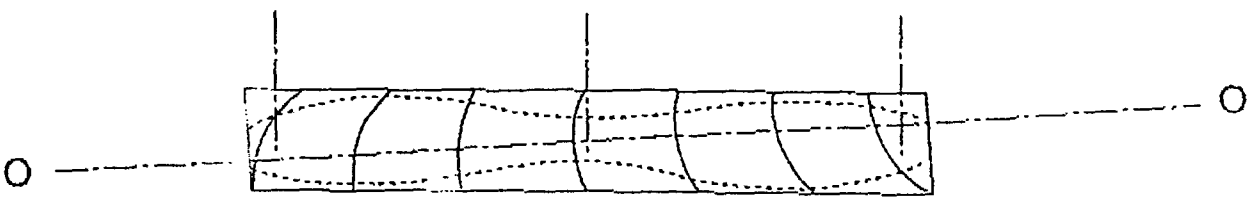


Fig 20