THE ORIGINS OF THE LANTERN

The true inventor of the magic lantern: Kircher, Walgenstein or Huygens?

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There is an ineradicable tradition to designate Athanasius Kircher as the inventor of the magic lantern. Among the authors sharing the tradition we find C.W. Ceram, the famous archaeologist; Olive Cook in her book 'Movement in two dimensions'; T.C. Hepworth in his 'Book of the Lantern', recently cited in the Journal of the Magic Lantern Society of Great Britain; J.A. Hes in his thesis 'Under the spell of the image'; Constance Eileen King in her 'Encyclopedia of Toys'; Julius Pfragner in his entertaining book 'The Motion Picture'; Joachim Richter in his lovely illustrated article 'Die Lanterna Magica'. Even the great Joseph Priestly said in his famous history of discoveries (1772) about Kircher that "we are, perhaps, at this day, most obliged to him for his ingenious contrivance of the *Magic Lantern*". No wonder that many authors point to the Dane Walgenstein, or to the Dutch scientist Christiaan Huygens (cf. Stephen Wischhusen, D.B. Thomas, S.I. van Nooten, Josef Maria Eder) some further research might be needed. This short article may serve to summarize the ongoing discussion, and hopefully to bring it to a definite conclusion.

Kircher's claim

The evidence brought forward in favour of Kircher is found in his book 'Ars Magna Lucis et umbrae' (The great science of light and dark) first published in Rome, 1646. The drawings which supposedly prove Kircher's inventorship are presented below (fig.1, 2).

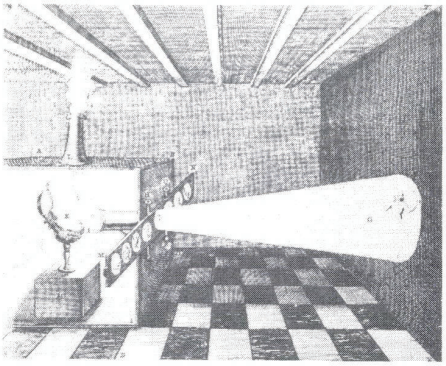


Figure 1

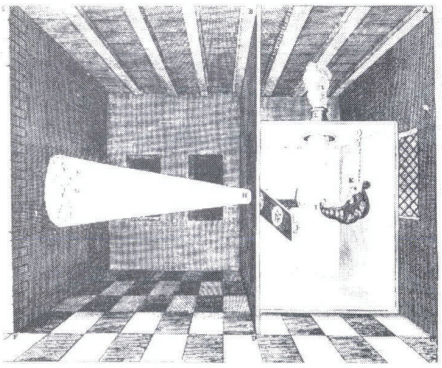


Figure 2

They both show a lantern with lightsource, translucent slide and a lens. However, the arrangement of the parts is very intriguing: the lens is situated between the lightsource and the slide, while the slide and the image are both upright! How could Kircher make such a mistake? It may be helpful to cite Kircher's own description of the arrangement:

"Fiat ex ligno receptaculum A.B.C.D. deinde in L. caminus, ut lucerna per illum fumum suum emittere possit, Lucerna vero K. in medio ponatur vel affixa filo ferreo vel supra fulcrum M. e regione forminis H., intra quod tubus palmaris committaretur, in tubi vero principio I. lenticulare vitrum melioris notae inferatur in foramine vero, seu in fine tubi H vitrum planum ?probe elaboratum ponatur, in quo coloribus aqueis & diaphanis quidquid volueris pingatur."

In English: "Make a wooden box A.B.C.D., with a chimney at L, such that the lamp can emit its smoke through it; the light K itself should be placed in the middle of the box, either hanging at a chain or placed on a pedestal, in a straight line with the aperture H in which a good tube is mounted. In the very beginning I of the tube a lens of good quality is mounted, in the aperture or rather the end H of the tube a well-finished flat glass is placed, on which is painted whatever you want, with translucent watercolours."

This translation, which differs markedly from the one given by Eder, has the intriguing property that it describes Kircher's figures rather well, whereas it is also fully compatible with an arrangement as it ought to be. The problem is that Kircher did not precisely tell where the tube should be mounted: inside or outside the box. Much depends on the interpretation of the words "intra quod". If they refer to "receptaculum" the description fits the engravings accurately; if they refer to "foraminis H", then the text might describe the correct arrangement. "Foramen" and "receptaculum" are unfortunately both neuter nouns.

From the foregoing it follows that Kircher's engravings do not necessarily reflect his concept of the magic lantern. One passage supporting this idea runs as follows:

"Hoc pacto intra cubiculum V.T.S.X. in muro candido lumen lucernae vitrum lenticulare transfiens imaginem in H vitro plano depictam (quae inverso situ in vitro ponitur) rectam & in muro grandiorem exhibebit, omnibus coloribus ad vivum expressam."

"In this manner will the light of the lamp, passing through the lens, display the image painted on the glass plate in H (which is to be inserted upside down) on the white wall of the room V.T.S.X., upright and magnified, coloured, as drawn from life."

The interesting part of course is the short sentence within brackets, which indicates that indeed Kircher knew how to put slides in a projector. This evidence points to the fact that the engraver must have made some bad mistakes that remained uncorrected. It is easy to find more errors in the engravings: the letters are not used consequently in the two figures, some letters are even used twice to indicate different parts; the concave reflector is missing in one drawing and placed too high in the second; in fig. 2 the slide is placed between the tube and the wall in such a way that the tube could not have been inserted in the aperture, while the support of the tube, just visible, could never have been functional.

Assuming that the engraver was in error, how could it happen that Kircher did not correct the engravings before they were printed? The explanation could be quite simple. Neither the two engravings, nor the verbal description of the magic lantern appeared in the first edition of 'Ars Magna' but are taken from the second edition which was printed in Amsterdam, 1671. The engravings were specially made for the second edition, and the question is: where? It is most likely that a Dutch engraver prepared the new illustrations. Kircher probably made some sketches which the Dutch publisher did not like; the magic lantern was at that time already a well-known contrivance which should receive ample attention in an up-to-date textbook of optics. Therefore the publisher may have decided to replace Kircher's sketches (which are rather unattractive throughout the book) by two large elaborate engravings. In this way it could happen that two elaborate figures were added which did not follow the numbering of the other illustrations: the magic lantern engravings remained without a number between plate XXX and plate XXXI. Another possibility is of course that somewhere between Rome and Amsterdam Kircher's sketches got lost; then the engraver was thrown upon the written description which, as we have seen, was quite ambiguous.

However it may be, it is most likely that the two engravings were made in Holland and published before Kircher could see them. So Kircher was trapped by his own thrift: Dutch publishers paid for manuscripts, whereas publishers of many other nationalities wanted to be paid by the others. A similar mishap occurred to Harvey, the discoverer of the circulation of blood who, in the first edition of "De Motu Cordis", added a list of 126 errors made by the German publisher (cf. Lindeboom, 1978).

One weakness of the above proposed explanation is that Kircher seems to have never protested against the erros made by the publisher. In the "Physiologia Kircheriana", which is a summary of Kircher's empirical work, published by his student J.S. Kestler in 1680 the same figures are featured with the same text. Joannes Zahn, in his book "Oculi Artificialis" (1685) criticized Kircher's arrangement. He rightly explained that the projection lens should be placed behind the slide: "Quocirca non bene capio, quod Kircherus..." (Therefore I do not quite understand what Kircher teaches...). Apparently it did not occur to Zahn that the engraving could have been published without Kircher's consent. Neither did Priestly know of a withdrawal of the figures; otherwise he would not have written: "those who chosae to see Kircher's own drawings of this ingenious instrument, will find some very fine ones in his *Ars Magna lucis et umbrae* p. 768, 769." This is even more astonishing as he himself presented a quite elaborate illustration of the true working of the magic lantern (pl. VII, figs. 47, 48).

As the upright slide is clearly at odds with the written description, we will assume that figs. 1 and 2 were made without Kircher's consent. In that case one wonders how the engraver got the idea to place the slide upright despite the explicit instructions. Reinhardt proposed that the engravings are just mistakes, which do not allow further interpretations. However, the upright slides suggest that the engraver, having misunderstood the proper placement of the tube with the lens, tried to make some sense out of the contraption. He might even have experimentally verified the principle of projection with a lens between lightsource and slide. If this was the case, figs. 1 and 2 might represent the engraver's solution to this problem.

After some experimentation the author recognized that indeed images can be projected with the arrangement of figs. 1 and 2. If the lens has a very short focal distance (say less than 4cm) a reduced image of the lightsource will be formed behind the lens. If the reduction is sufficient the image could be used as a point-lightsource, projecting a slide without interference of any further lens. The longer the distance between lightsource and lens, the more perfect the point-lightsource is. The farther the distance between point-lightsource and transparency, the less perfect the lightsource needs to be. And finally, the larger the transparency, the less critical the dimensions of the lightsource. Magnification will be proportional to the ratio of the distances from point-lightsource to screen and transparency.

Let us just assume that the engraver of Kircher's figures, whoever he was, made his engravings accurately after an existing experimental arrangement. In order to set the scale we also assume that the room height is 2.50m in both figures. We then obtain the following dimensions of the point-lightsource projection system.

Dimension	Fig. 1	Fig. 2
Lightsource to lens	19cm	24cm
Diameter of lens	20cm	20cm
Lens to transparency	65cm	55cm
Diameter of transparency	20cm	20cm
Transparency to wall	250cm	187cm
Diameter of image	95cm	75cm
Magnification	4.75x	3.75x

The two arrangements show some properties typical for point-lightsource projection. The distance from

lightsource to lens could be over five times the focal length. The reduction of the lightsource could be fourfold. The distance from lens to slide and the diameter of the slide are both remarkably large. Magnification is quite poor, however, especially if compared to normal values for magic lanterns of that time. Zahn obtained a thirteenfold magnification in a room which does not seem to be much larger than Kircher's projection room (see fig. 3). In the

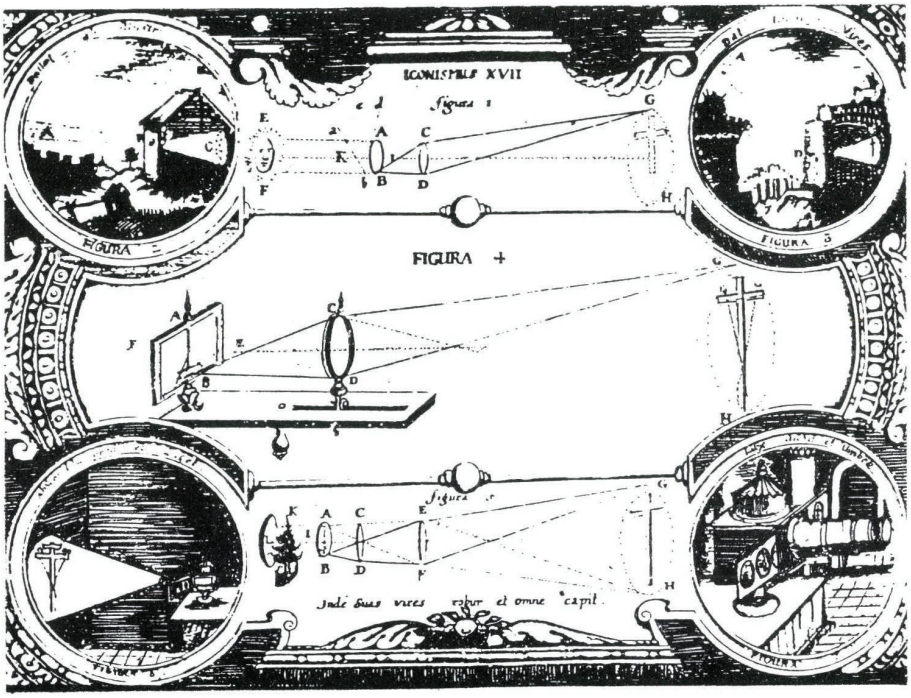


Figure 3

later 19th century lanterns a twelvefold magnification at a distance of two metres was quite standard (15cm focal length). Of course the poor performance of the sketched lantern is quite in line with the principle of point-lightsource projection; the magnification is also well in line with the ratio of distances from point-light to transparency and to screen. Finally, the most decisive evidence for this interpretation is that in a point-lightsource projector, indeed slides need to be placed upright, not inverted. The gain through placing the lens between lightsource and transparency is at least a fourfold sharpness of the image, at the loss of 25% of radiance.

The evidence presented thusfar leads to the conclusion that Athasius Kircher may have known the familiar projection lantern in 1671, even though the illustrations represent possibly a point-lightsource projector. This is not sufficient to prove his inventorship, as magic lanterns were described before 1671 quite frequently. Kircher's claim was based on the first edition of ***Ars Magna*** in 1646, but here we find nothing on projection lanterns. The two figures to which Kircher refers in his later work are presented below (figs 4, 5). They represent a camera obscura with the object illuminated by three candles, and a lantern emitting a collimated beam of light, probably used for mirror writing. Nothing points to an arrangement with light, slide, and projection lens in that order.

Thomas Walgenstein

Even if Kircher did not invent the magic lantern before 1646, there is still the possibility that he invented it later. Were the ideas presented in 1671 original, or did he learn about this elsewhere? Curiously enough, the ***Ars Magna*** contains a perfect cue leading to the answer. Kircher mentions a scientist:

"Thomas Walgenstenius Danus, haud infimae notae Mathematicus, qui recolens meas in describendis iis inventiones lucernam fol. 767 a nobis descriptam, in meliorem formam reduxit, quam & postea magno suo lucro diversis in Italia principibus vendidit, ut proinde jam Romae res poene vulgaris sit."

"The Dane Thomas Walgenstein, a well-known mathematician who, referring to my inventions in his own writings, improved the lantern described by us on page 767, and who later sold it with much profit to various Italian nobles, so that the object is already normal in Rome."

This Danish scientist is mentioned in various sources, among which is a letter of P. Petit from Paris to Christiaan Huygens. Writing on the magic lantern Petit adds: "Il me semble que celle du danois que jayveu" etc. The date on this letter is the 28th of November 1664; Walgenstein must have constructed his lantern before that date, and indeed it is recorded that he gave performances with his lantern in cities like Paris, Lyon, Copenhagen, Rome. Could then Walgenstein be the original inventor? There is no evidence to prove this, and there is certainly no reference to Walgenstein's lantern before 1660. However, the Dane studied mathematics and physics at the university of Leyden in the years 1657-58. Here he could have met Christiaan Huygens who was already a famous scientist at that time. Huygens knew of the Dane in 1664, otherwise Petit would have written "Walgenstein" instead of "the Dane". Huygens could also have met with Walgenstein when he was a member of a Dutch legation to Denmark in 1649. Huygens mentioned a projection lantern in 1659, along with some designs for moving slides: "pour des representations par le moyen de verres convexes a la lampe". Therefore, it is quite possible that Walgenstein became familiar with Huygens' lantern during his stay in Holland; he would have recognized the commercial value of the instrument and put it to profit for himself, keeping its operation secret.

Huygens' lantern

Whatever Walgenstein's role has been, it is a fact that the earliest reference to a projection lantern is Huygens' manuscript of 1659 (Complete Works, vol. XXII). The problem is, however, that he mentioned only "slides, convex lenses and a lamp"; nothing about the arrangement. Since Kircher's engravings contain the same items, we need more information about the way they were put together. This information is contained in letters to Huygens's brother Lodewijk (1662) and the before-mentioned correspondence with Petit (1664).

On 5 April 1662 Christiaan complains to his brother about the lantern his father ordered: "Vous ne scauriez croire avec quelle peine je m'occupe a des telles bagatelles qui me sont desia toutes vieilles, outre que j'ay honte que l'on sache par de la qu'elles vienent de moy. L'on y est assez complaisant pour faire semblant de les admirer, mais apres on s'en mocquera et non pas sans raison." ("You would not believe how much effort I spend at such trifles in which I lost interest already, and further I feel ashamed that this way it will be known that they come from me. People are kind enough to feign admiration, but later one will ridicule it and not without reason.").

On April 9 Christiaan writes again that, when the lantern arrives, Lodewijk should sabotage it "en ostant un des 2 verres qui sont proche l'un de l'autre, de sorte qu'il en demeurera encore 2 de reste, car il y en a 3 en tout" ("by removing one of the two lenses that are close to each other, such that only two lenses remain, as there are three in total"). From this passage it is clear that the lantern contained a condensor lens and two objective lenses comparable to the well-known Huygens' ocular.

On May 3, 1662 he adds "il est impossible de faire ces representations quoy qu'on se mette dans un chambre obscure; ce qui vient de l'impression que la lumiere a faite dans les yeux, qui ne s'en efface pas qu'apres un assez longtemps" ("it is impossible to give these performances without going into a darkened room; this is due to the impression daylight has made on the eyes, which will only be wiped out after a rather long time"). Thus, the lantern, possessing a faint lightsource did not project a very bright image.

On August 17 the lantern was still not ready. Huygens pretended to have forgotten the construction of the first lantern "de laquelle ayant oste les verres il y a longtemps, je ne scaurais retrouver a cet heure quels ils ont este." ("of which, having removed the lenses long ago, I cannot now remember what kind they were"). It is hard to estimate how long ago he used his first lantern; it must have been before 1661, when Constantijn Huygens, Christiaan's father, left ofr Paris. Some date in or before 1659 would well qualify.

Of course Huygens only pretended to have forgotten the construction; he just did not want his father to ridicule the family at the French court. A similar reluctance appears in the correspondence with P. Petit in 1664. On November 28 Petit informs after the dimensions of Huygens' lantern, describing his own plans. This letter is of special interest because it contains the oldest sketch of a magic lantern that is known (see fig. 6). Petit determined some of the dimensions with the help of Walgenstein's apparatus:

"Il me semble que celle du danois que jay veu aboit le verre de figures A tous joignant le trou de la lanterne & 2 ou 3 pouces comme en B un convexe de 7 ou 8 pouces de foyer & au bout du tuyau C un autre denuiron 12 pouces qui seslognoit ou sapprochoit de B suivant quon voulut representer....."

Figure 4

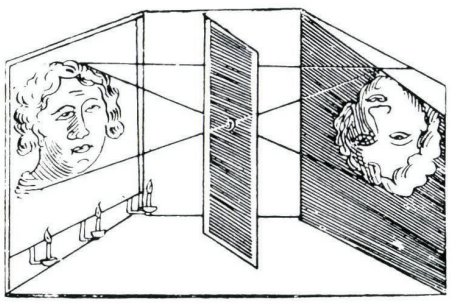
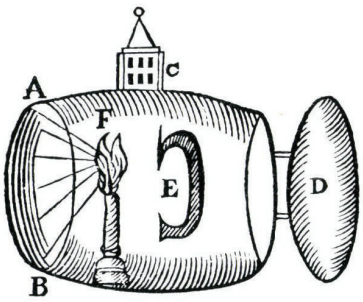


Figure 5



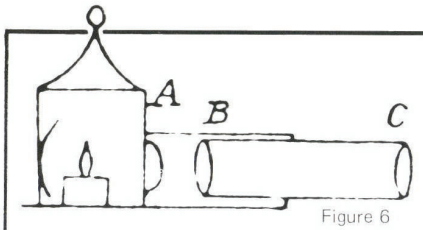


Figure 6

"It occurs to me that the one of the Dane which I have seen had a lens (in the figure at A) filling the aperture of the lantern; at two or three inches*, as in B. a convex lens with a focal distance of seven or eight inches; at the end of the tube C another lens of about 12 inches focal length which is moved from or towards B, as one wants to project the figures near or far away... I already had a lamp made, handy and more powerful than any other lamp I have seen, with a concave mirror behind it and a convex lens in front of it, in order to increase the light. Regarding the lantern, I want to make it six inches on four sides, and nine inches high. With regards to the lenses, I feel that they are quite large with a diameter of one and a half inch and focal lengths of six and 12 inches; ...one would like to project the images 40 or 50 feet away, instead of the length of a room..."

Here we see a quite small lantern, much smaller than the ones displayed in figs. 1 and 2. The focal length of the objective lens is too small to span the distance mentioned. Huygens would certainly have noticed this, but again he appeared to be incooperative. Of his reply on December 11 only a few notes remained; he repeated that the lenses were removed from his own lantern long ago, and that he did not remember the dimensions. He added that the lantern was not well made, and did not have a concave mirror. One lens had a focal distance of six inches. He also gave a sketch demonstrating the working of the project objective.

Reconstructing Huygens' first lantern on the basis of these scarce data we arrive at a rather small lantern, not dissimilar to the ones shown in fig. 3 and fig. 7, both from Zahn's book published in 1685.

It did not have a concave reflector, but condensation of the light was obtained by a condensor lens. Projection of the image was achieved by means of two lenses. The image was, as might be expected, quite faint and it required some dark adaptation; consequently the lantern was probably only fit for entertainment in the family circle. It is not as important to know whether the actual date of construction was before 1659, as no other lanterns were reported before that date.

There remains the slight possibility that Thomas Walgenstein constructed the first lantern during or before his stay in Leyden in the years 1657-58. In that case Huygens might have copied it in 1659. There is a good reason to disqualify this hypothesis. This is that Huygens always acknowledged every scientific source he used; he never sought financial benefits by appropriation of discoveries. He also had no reason to conceal Walgenstein's eventual contribution, as he did not value the apparatus. On the contrary, he tried to conceal that the invention was his.

Our conclusion then is that neither Kircher nor Walgenstein invented the magic lantern; Christiaan Huygens was the true inventor, although he did not at all foresee its tremendous outgrowth to the slide and film projectors on which an industry worth billions would be founded.

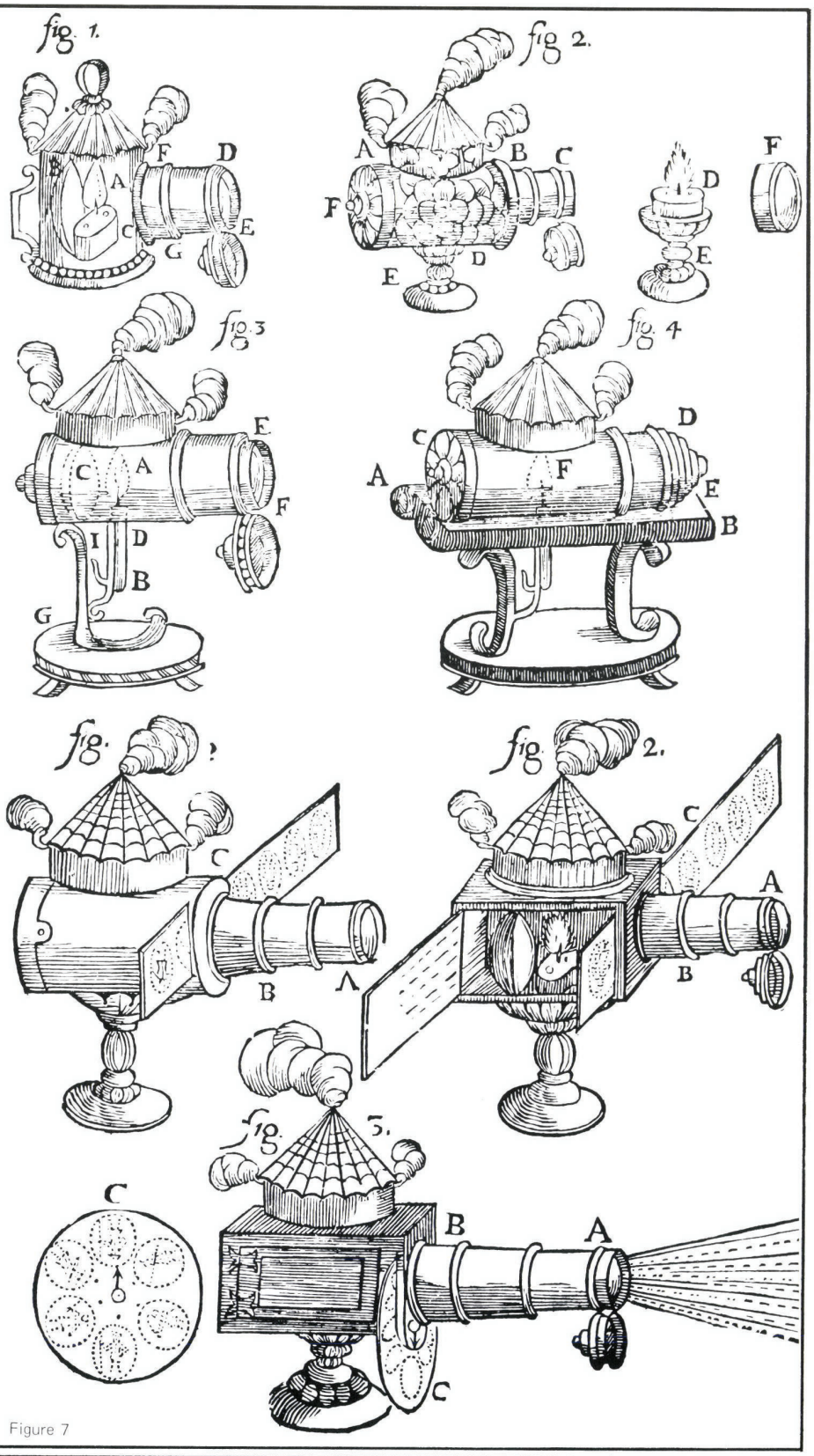


Figure 7

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