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Possible answer to Giza pyramid air-shaft construction puzzle

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Abstract: Among the pyramids, Giza pyramid is still a mystery. There are several unanswered questions about the Pyramid of Giza, like "When was it built?", How was it built?", "Why was it built?" and so on. This paper aims at solving one of the puzzling questions," how were air shafts of Giza pyramid built?" Effort is being made to explain the possible methods of construction of air shafts of both King's chamber and Queen's chamber. Method of construction explained in this paper is based on the available evidences, which are also listed along with the methods.

Keywords: Archaeology. Giza pyramid, Archaeological Theory, Air-shafts, King's chamber, Queen's chamber.

I. INTRODUCTION

Research and innovation is little easy these days, as we can get enormous data directly through the internet. In many cases, a new experimental result will be the output of the research. But in case of Egyptian Pyramids, we are trying to find the secret of something which was used several thousand years ago and there must be some purpose for building the pyramid. We are having the advantage of definitely getting the result. This is because, it was working sometime in the past and if we create the similar situation it should work again. One such best opportunity is the research on Pyramids. It is still having many unsolved questions.

A. The important unanswered questions.

- These questions are mainly to the pyramid of Giza only.
- When was it built?
- Who built it?
- How was it built?
- How many workers were there?
- How long was the time to complete?
- Why in that location?
- Why was it built? This is the most important but unanswered question**.**
- **How were air shafts of Giza pyramid built?** This is the second most important question for which this paper will give the possible answer.

B. Details of air shafts.

Air shafts are the most difficult part of the construction of the pyramid.

The difference between King's chamber and queen's chamber

The main difference between the air shafts of King's chamber and queen's chamber is that the air shafts of Kings Chamber comes out of the pyramid wall to the atmosphere but in the Queen chamber, it abruptly ends at a particular height.

The Queen's chamber is exactly vertically below the apex of the pyramid. So, the two shafts from the Queen's chamber are equally inclined (shown by angle θ as shown, ending at same height inside the pyramid, but are abruptly closed. Therefore the purpose of air shafts is unknown.

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Note: The picture shown here is not to exact scale. It is just to explain the internal structures of the Giza pyramid.

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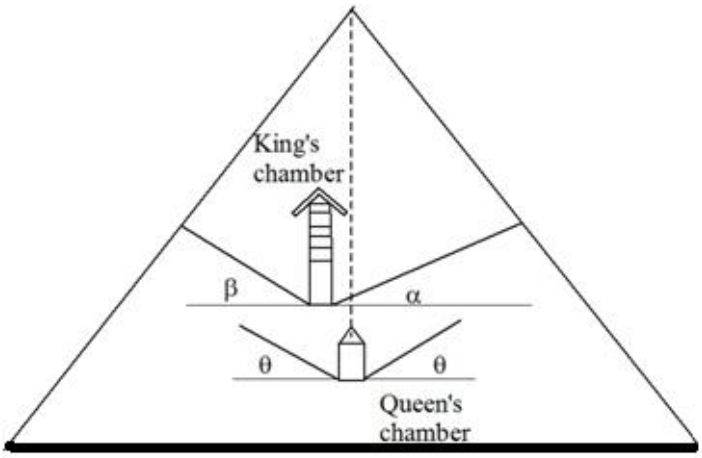

Figure 1.Air shafts in the pyramid of Giza.

King's chamber is slightly offset and so, the air-shafts are not equally inclined on both sides because if the inclinations are same and distances on both sides are different, the openings of the air-shafts will not be at the same height. Hence the angle on one side ,shown by angle α is more than the other, shown by angle β to exactly compensate to make the opening at same height. Most interestingly, the openings are at exact 108 cubits (bricks) from the top.

This exact whole number at both sides is making it extremely difficult to achieve by other previously-published methods but the method explained in this book will make it very easy.

C. Difficult to build even with present technology.

Even with today's calculation it is extremely difficult to make such long and deviated shapes while placing the very big limestone blocks without almost altering the cross-sectional dimension of the air shafts along its length.

D. Air-shafts were possibly constructed simultaneously along with the construction of the pyramid.

The possibility of construction details available within Giza pyramid indicates that it was not done after constructing the pyramid but while constructing the pyramid. One can realize that it was almost impossible to achieve this with such perfection even with very today's complex calculation.

E. Possible methods used.

There were probably two methods. One is a chemical method and the other is casting method. Both the methods are discussed below.

i) Chemical method.

In this method, a material must be filled in to the air shaft and finally after completion of pyramid construction, the material inside the shaft will have to be taken away by chemical reaction. It is something like filling calcium carbonate and finally reacted away by dilute hydrochloric acid or any other acid. But the biggest problem is that soapstone by which the pyramid was built itself will react with any such acid first. So, chemical method is almost ruled out.

ii) Casting method.

In this method, a material will have to be in molten condition and poured to the air shafts. After cooling, the material would solidify. After completion of the construction, the solidified material will have to be either burnt away or washed away by water. In King's chamber, the burning method was probably used and in Queen's chamber, it was probably washed away as discussed below.

II.KING'S CHAMBER

Pyramid air shafts were built by a method which is called in modern terms as "investment casting". While the pyramid was being constructed, shellac like material was used to create air shaft. Once the pyramid was totally complete, the material was burnt away.

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We have evidence that some black soot is still there at inner surface of the air-shafts.So, something was burnt in Kings chamber, both from outside as well as inside because the air-shafts are ending as openings up to the pyramid wall. But in Queens chamber, the air-shafts abruptly end in the middle of the pyramid. Therefore it was melted away or taken out by chemical corrosion. That is why lots of salt deposition was noticed in Queens chamber, before cleaning it.

F. **Steps involved are given in sequence:**

- Initially, a supporting pipe is clamped as shown in the figure 2. Then the filler material(probably, shellac in this case) is poured and allowed to solidify
- The clamps are removed.
- Supporting pipe is carefully removed.
- The extended portion of the solidified material will be as shown in figure3.

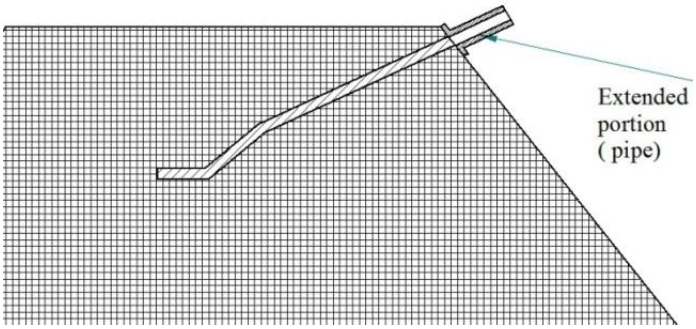

Figure 2. Supporting pipe for filling material.

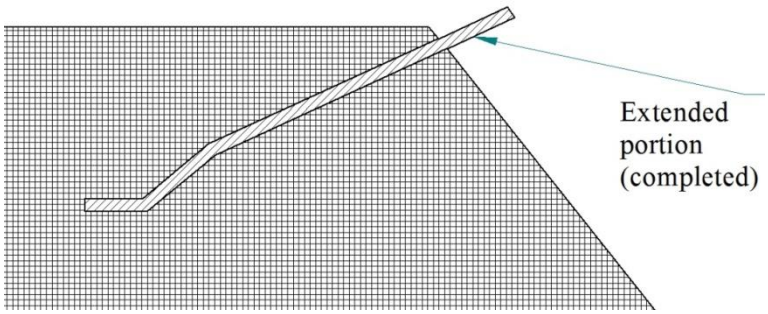

Figure 3.A portion of the pyramid is shown with air shaft.

- Then the portion above the extended pipe is carefully constructed, as shown in figure4.

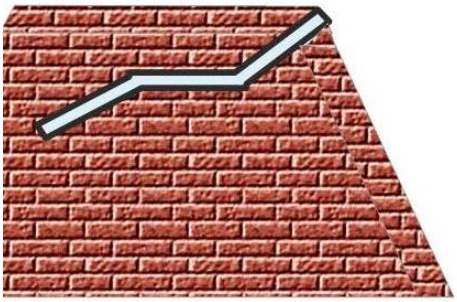

Figure 4.Brick construction above the air shaft.

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G. **Material selection as filler.**

Material selected for filling inside cannot be soft like a cotton wick because it can't withstand the load of the limestone bricks. Therefore it must have been a very hard material. But initially it must be soft and flexible because the constructors should have to bend it according to the plan and orientation of it.

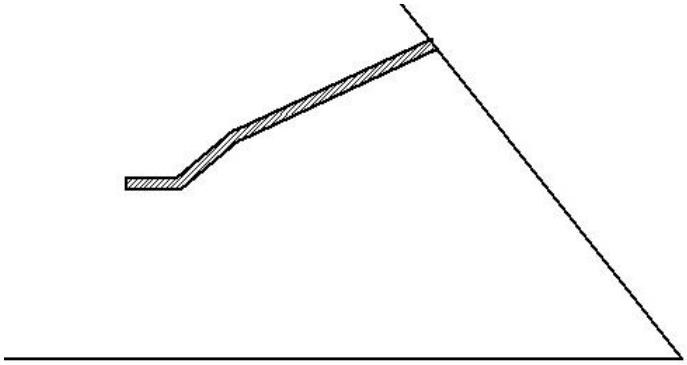

Figure 5. Material filled in to the shaft.

We can imagine something like plaster of Paris, but it should be a combustible material for burning it away or it should react with the chemical so that it reacts and dissolves away in to water. But the limestone is that which will react with almost any acid and therefore such strong chemical use cannot be done. So, it must have been a material like shellac, which will be initially molten and soft at little higher temperatures but once solidified becomes very hard. Hence it was casting like material which means initially soft and can be bent in any direction but becomes hard on solidification.

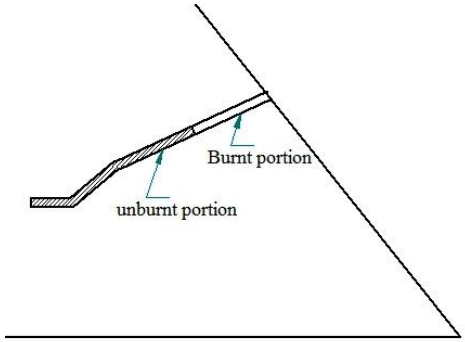

Figure 6.A portion of the filler material burnt.

Any material which is very hard after setting containing an oxidizing agent and a combustible substance could have been used and one cannot pinpoint which was the exact material used at that time because there are several possibilities. One of the possibility according that one can assume is shellac.

It will be extremely hard but with little heating we can shape it in any way we want. Also it is highly combustible material and if mixed with a little oxidizing agent , it continuously burns of course giving some soot. If we add too much of oxidizing agent then the combustion will be so fast that it will explode like a cracker. So, better to add little lesser amount of oxidizing agent, producing little soot. Therefore it was very likely that a calculated amount of oxidizing agent was to add and evenly mixed. The sooty appearances that were noticed initially inside the air shaft before cleaning it give us the evidence that there was some material inside which was burnt to give that particular passage.

C. Remarks:

i) Bending at different places in the air shafts instead of being perfectly straight line indicates that there are (still unknown) very important constructions within the pyramid through which air shaft should not penetrate.

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ii) Melting point of lime stone is 1339^0 C, which is much above that of shellac (77 to 82^0 C) and hence no damage will be caused while shellac burns.

III. QUEEN'S CHAMBER-AIR SHAFT SYSTEM

A. Closed shafts.

The air shafts in Queen's chamber is closed at one end. But while construction, it was open, as shown in the figure. So, since it was open, they could have used shellac itself. But since the cross section was very small (20cm square), they probably filled it with some powder with some binding agent, which could be dissolved away with water. This was to support the structure till it is complete.

B. Possible materials

In case of Queen's chamber, the story is slightly different. There was no carbon particle, no trace of burning found in the closed air shafts. The material must be hard and strong, but must dissolve in water. There are two possibilities

C. Rock sugar candy

It can be melted with little heat and moulded into any shape. After solidification, it will have sufficient hardness and strength to withstand the load of the bricks of the pyramid. Rock sugar candy was dissolved away, using water sprayer some such thing. We can even today see lot of moisture in Queen's chamber and so it makes a good proof to substantiate that it was rock sugar candy which was dissolved away by water. **But there is no evidence of sugar**. So, it must be some other material

D. Common salt:

It can be powdered and using little bonding agent like sugar, compacted in to any shape, making a hard mass. It can be dissolved away with water jet. It is quite strong to withstand the construction pressure. Also, even today one can see lot of moisture in Queen's chamber and deposits of lots of common salt on the walls of the air shaft and on the walls of the Queen's chamber. This makes a good proof and justification for our assumption of the material.

E. Method of filling and construction.

A thin hollow pipe must be inserted to maintain the cavity for filling the salt powder. The pie only cannot withstand the construction load. So, common salt powder was probably filled and compacted with some binding agent like sugar syrup. This would have given bulk strength required during construction.

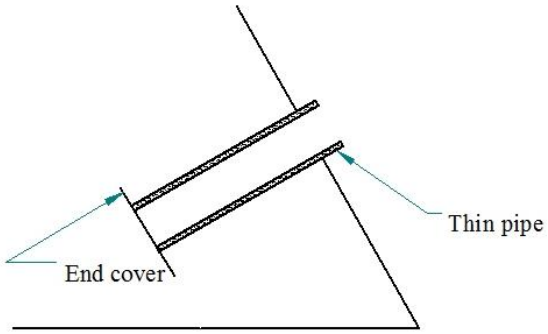

Figure 7. Inserting a thin tube for filling salt powder.

The common salt powder will have to be filled only after carefully lifting the pipe. Then the binding agent would make it almost like a hard mass.

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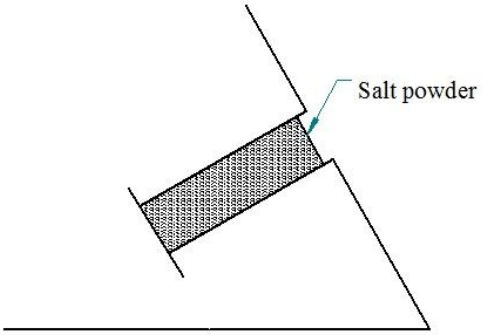

Figure 8. Pipe removed after filling salt powder.

After completion of construction, the salt and biding agent mass was probably washed away by water, as common salt and sugar readily dissolves in water. The large amount of common salt deposition in the walls of the Queen's chamber and the air shaft and also lots of moisture will make a strong proof for the above assumption

IV. CONCLUSION

i) This paper shows a possible casting method for King's chamber air shafts.

ii) This paper will almost prove a material like shellac was used in King's chamber air shafts

iii) This paper will explain a powder filling method for Queen's chamber air shafts.

iv) This paper will almost proves that common salt was used in Queen's chamber air shafts.

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BIOGRAPHY

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