

Antiquity

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Edited by

O. G. S. Crawford, F.S.A., and Roland Austin, F.S.A.

JUNE 1935

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EDITORIAL NOTICES

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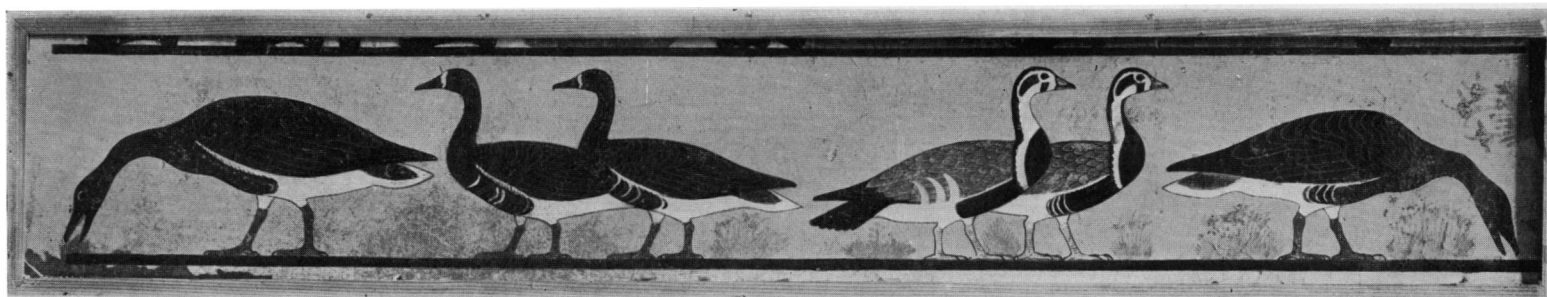
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PLASTER PAINTING OF GEESE FROM A MEYDUM MASTABA

Cairo Museum

(See *ANTIQUITY*, March 1935, p. 12)

Pyramids and their Purpose*

II. THE PYRAMID OF KHUFU (THE GREAT PYRAMID)

by NOEL F. WHEELER

Late Field Director, Harvard-Boston Expedition

AS measurements play a certain part in this article it is as well, before dealing with the pyramid of Khufu, to consider the ancient Egyptian measures.

Different values of the cubit or ell (referred to as E), are found in different sites, and in different structures of the same site and period ; but it seems quite certain that the Pyramid Age ell had a value between 20.58 and 20.63 in. In later times the variation is much wider. Opinions differ on the division of the ell, since there was also a ' short ell ' of 6 palms or hands (referred to as H), whereas the normal ell was divided into 7 hands. Most authorities take the ell of 20.58-20.63 in., divided into 7 hands of 2.94-2.95 in. each ; and for the short ell, 6 hands of the same value, giving the value of the short ell as 17.64-17.68 in. But Junker (*Giza I*) gives a normal ell of 20.64 in., divided into 6 hands of 3.44 in. each ; this last is not quoted elsewhere. Petrie (*Ancient Egypt*, 1930) gives good reasons for believing that the normal ell was used in the pyramid of Khufu and most other places, but that the pyramid of Khafré (2nd pyramid) and the South Pyramid at Dahshur utilized the short ell of 17.656-17.76 in. In the table of measurements of the pyramid of Khufu (see pp. 183-5), the average value of the ell is 20.614 in., and the division into 7 hands produces nearly double the number of cases of whole numbers of ells compared with the 6-hand division ; so that it may safely be assumed that the former is the one used by the builders.

The hand was divided into 4 fingers or digits, each of .75 in. There were also in use, according to Borchardt, a large span of 10.35 in. and a small span of 8.59 in.

* The first article of this series was printed in the March number, pp. 5-21.

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A table of the values of the ell, found or deduced by various authorities at various sites, is given on page 183.

There is a cubit measure, of the New Kingdom, which measures 20.59 in., in the Cairo Museum (no. 452).

Measurements of the Great Pyramid—its passages, galleries and chambers—will be found in detail on pages 183–5.

THE PYRAMID OF KHUFU (FIGS. 1–4)

This pyramid stands on a rock-plateau forming the eastern edge of the Libyan desert, about 5 miles from the village of Giza, from which it gets its modern locality-name. The rock-plateau is approximately 100 feet above the cultivated plain and 197 feet above sea-level.

It is built on a square base, of which the sides differ in length by only about an inch; the average side is 755 ft. 9 in. (440 E), the height above the base platform is 481 ft. 10 in. (280 E), or rather *was* this height originally. No further measurements will be given here in other than ancient Egyptian ells, hands and fingers.

The core masonry is built in level courses throughout of limestone blocks, and the whole was cased in fine white limestone from the ancient quarries near what is now Turrah, on the east side of the Nile, 12 miles from the Pyramids. After a few years' exposure this limestone mellows to a cream colour.

The original entrance is in the north face some 30 E above the base, and is at the upper end of a long passage descending at an angle of about 26 degrees through the core of the pyramid and into the rock for a total length of 220 E. At its foot, after a short horizontal stretch, is a rough unfinished rock-hewn chamber. From the roof of the Descending Passage, at about 50 E from the entrance, rises the Ascending Passage, also at an angle of about 26 degrees. This Ascending Passage opens out at a little less than half its floor-length into the Grand Gallery, their floors being continuous in the same line, to the centre-line of the pyramid; from this point there is a short horizontal passage passing through the Portcullis Chamber into the King's Chamber. From the junction of the Ascending Passage with the Grand Gallery a horizontal passage leads to the Queen's Chamber, which is on the pyramid centre-line. From this same junction a wandering well-shaft descends, vertically in places, to an opening in the west side of the Descending Passage near its foot.

PYRAMIDS AND THEIR PURPOSE

DESCENDING PASSAGE (FIGS. 1-2)

This resembles the usual entrance-passage and leads to what in other pyramids is the one and only burial-chamber cut in the rock. It differs from others only in that the burial-chamber is unfinished, that the ascending passage leads off it, and that the well-shaft opens into it. In the small horizontal passage at its foot, just short of the chamber-entrance, is an unfinished enlargement which gives the impression of being an embryo portcullis recess ; and in the chamber is an unfinished pit, and a blind extension of the horizontal passage for a distance of over 30 E. The angle at which the Descending Passage slopes is quite usual, that of the Third Pyramid and of one of the small Queens' Pyramids being within $\frac{1}{2}$ a degree of it. The passages of the Giza, Dahshur and Meydum pyramids are all between 21 and 34 degrees.

ASCENDING PASSAGE (FIGS. 1-2)

This passage, which has the same cross-section as the Descending Passage (2 E, 2 H high ; 2 E, 1 F wide), has its entrance in the roof of the latter passage. This opening was concealed originally by the insertion of a single block of limestone which formed an indistinguishable part of the passage roof. It remained in place until the plundering of Caliph Al Mamoun in A.D. 820, when it fell, and the sound of its falling led his excavators to tunnel into the Descending Passage. Immediately above the position of this fallen stone are now three granite plug-blocks, with a thin film of plaster between their faces and the passage which they otherwise exactly fit, and similar plaster between the blocks.

Above this point the passage has no special features except the three Girdle Stones, which are part of the masonry forming the four faces of the passage, but are of granite, while the normal passage masonry is of limestone. The roof of the passage ends with the beginning of the Grand Gallery, the floor continues into the gallery and ends at a point perpendicularly opposite to the termination of the roof.

GRAND GALLERY (FIGS. 3-4)

This is the largest individual space in the pyramid, some 91 E long, its floor being a direct continuation of that of the Ascending Passage, but the height extended to 16 E. The side and end walls taper inwards as they rise, at about 20 on 1. This slope, or 'batter', is that used in a number of enclosure walls of temples, etc., and is attained in the gallery by overlapping the courses, 7 overlaps in the upper end wall and

PYRAMID OF KHUFU.
Chambers & Passage System
(Granite is shaded, remainder is Limestone)

164

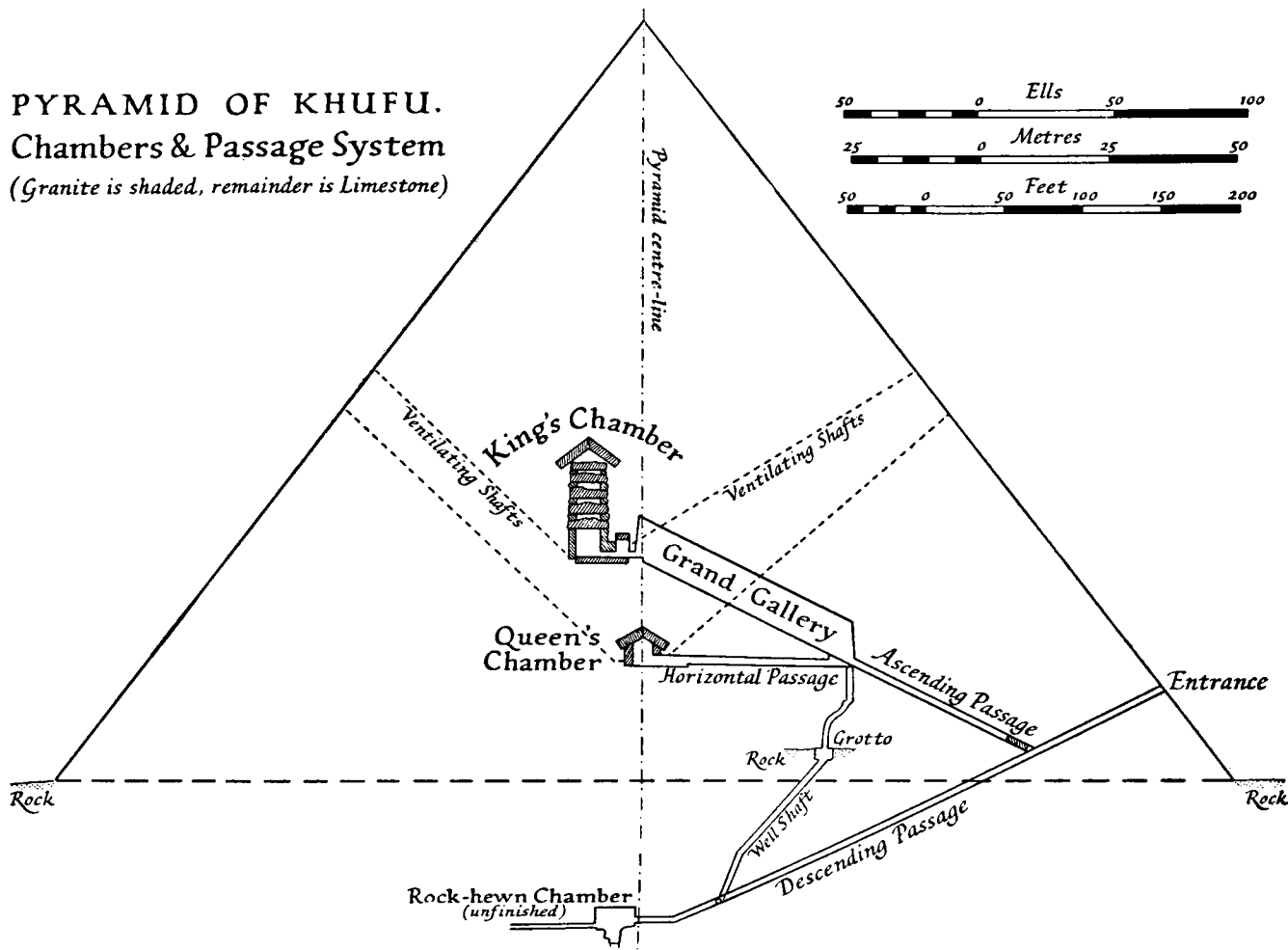
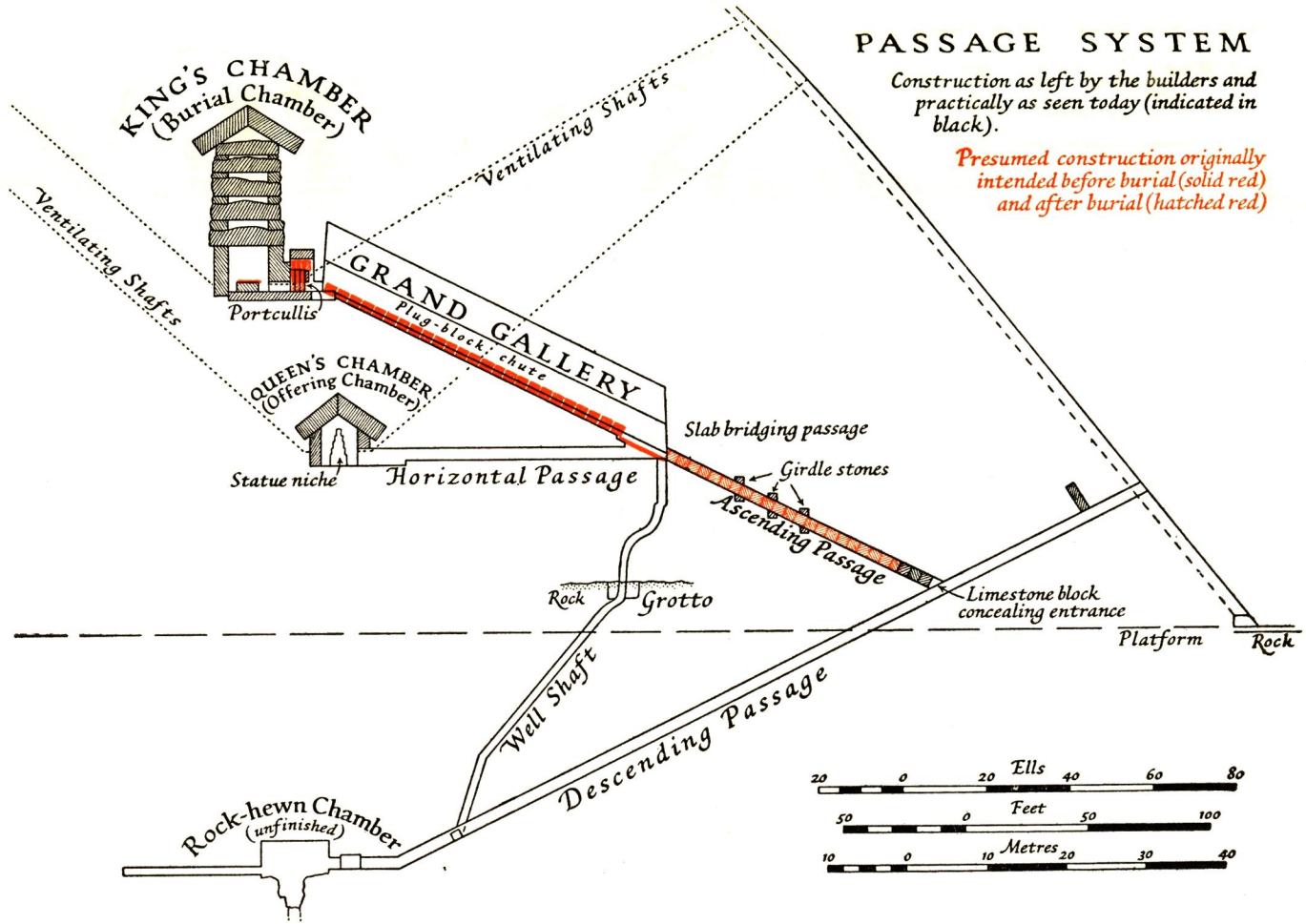


FIG. 2



PASSAGE SYSTEM

Construction as left by the builders and practically as seen today (indicated in black).

Presumed construction originally intended before burial (solid red) and after burial (hatched red)

FIG. 2

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6 in the lower. The roof stones are similarly overlapped, the slope of the gallery itself being nearly 1 on 2 and the slope of each roof block 1 on 2.2. The same method of overlapping is found in the statue-niche in the Queen's Chamber, and was no doubt intended, like the six super-imposed ceilings of the King's Chamber, to give rigidity under great load.

The floor of the gallery is made into a chute for the plug-blocks by the addition of a shallow ramp up each side, leaving a channel in the centre of the same width as the Ascending Passage. In the upper surface of these ramps, at equal distances apart, are 28 sockets. In each side wall, at a vertical height of 8 E and 5 H above the floor (about 16 feet) is a shallow longitudinal groove running the full length of the gallery. At the lower end of the gallery the floor stops short at the drop where the Horizontal Passage leads off to the Queen's Chamber, and at this point there is a recess in the floor for a large slab to rest, bridging the distance to the top end of the Ascending Passage and making one continuous floor therewith. The sockets in the side walls for 5 supporting beams to this 'bridge'-slab are visible. At the upper end, the floor of the continuing passage intrudes horizontally into the gallery for about 3 E, forming what is known as the Step: this, as all the masonry of the Grand Gallery, is of limestone.

The only other notable feature is the entrance of the well-shaft. With the structure complete this shaft was not visible, but is uncovered by the removal of the lowest stone in the construction of the western ramp. The shaft descends a little over 1 E vertically, then travels horizontally outwards from the gallery, and finally drops vertically down. With the missing ramp-stone and the bridge-slab in position there would be no indication of the entrance to the well, but by lifting the bridge-slab a small opening would show in the side wall of the Horizontal Passage. From the state of the floor at the beginning of the Horizontal Passage, and from the step down of 1 E from it to the inner end of the passage-floor, it is clear that the Horizontal Passage floor is unfinished, and would have had the greater depth throughout its whole length when completed. In this state the floor would have been on the same level exactly as the floor of the short horizontal section of the well-entrance and there would have been an opening nearly 2 E high and 2 E wide in the side of the Horizontal Passage beneath the bridge-slab; so that a person in the Grand Gallery had no need to remove the ramp-stone to gain access to the well, but merely to lift the bridge-slab.

PYRAMIDS AND THEIR PURPOSE

ANTE-CHAMBER

This consists of a horizontal passage from the upper end of the Grand Gallery at the level of the top of the Step, to the King's Chamber, which passes through the space for housing the portcullis. The passage itself is slightly smaller than the others in the passage system, and is of limestone construction from the gallery to the commencement of the portcullis recess, but of granite thereafter.

The portcullis recess is of granite on all sides except that of the entrance from the gallery, which is limestone. It is just over 7 E high and 6 long, and contains the slide grooves for three portcullis slabs to descend vertically on to the floor; the face of the south wall is also grooved for the passage of the innermost portcullis slab. The slides are empty, and have clearly never been used. Immediately outside the outer portcullis grooves is the 'granite leaf', which consists of two superimposed granite slabs in a groove, the bottom of the lower slab being exactly level with the roof of the entrance passage. That this was not a portcullis slab is clear from the fact that it has no grooves to slide downward from its present position; from its different thickness from the actual portcullis slides; and from its two-piece construction which would have been a joy to plunderers.

When the portcullis slabs were dropped there would have been a space left vacant above them equal in height to their descent (the height of the continuing passage); it would have provided a means for robbers to gain access to the tops of all three slabs, where their destruction would have been greatly facilitated. It is possible that the 'granite leaf', either by being pushed *up* (there is a boss on the upper section which would have made this easier), or by having a third section added at the top, would have served the purpose of concealing the vacant space over the portcullis and effectively sealing the entrance on all sides with granite.

KING'S CHAMBER

This burial chamber, entirely of granite, has five superimposed roofs, each consisting of a number of massive granite beams bridging the side walls of the chamber and free from the end walls. Above the upper layer of beams is an angular vault roof of large slabs. This construction, adopted no doubt with the idea of rigidity under heavy load, creates five low spaces between the various roofs, which were named by Howard Vyse in 1837 when he had tunnelled up from the

LOWER END OF GRAND GALLERY

To illustrate launching of plug blocks

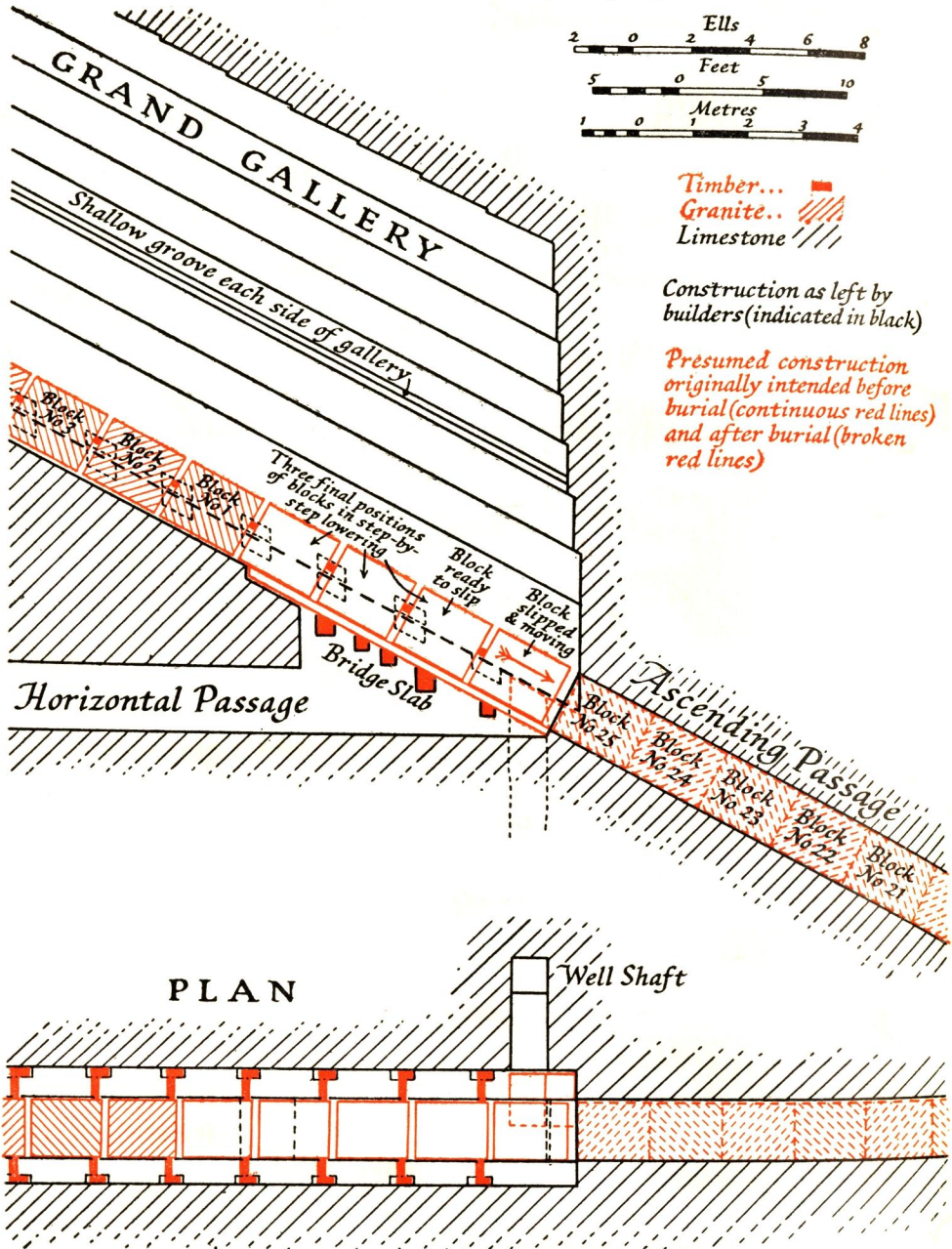


FIG. 3

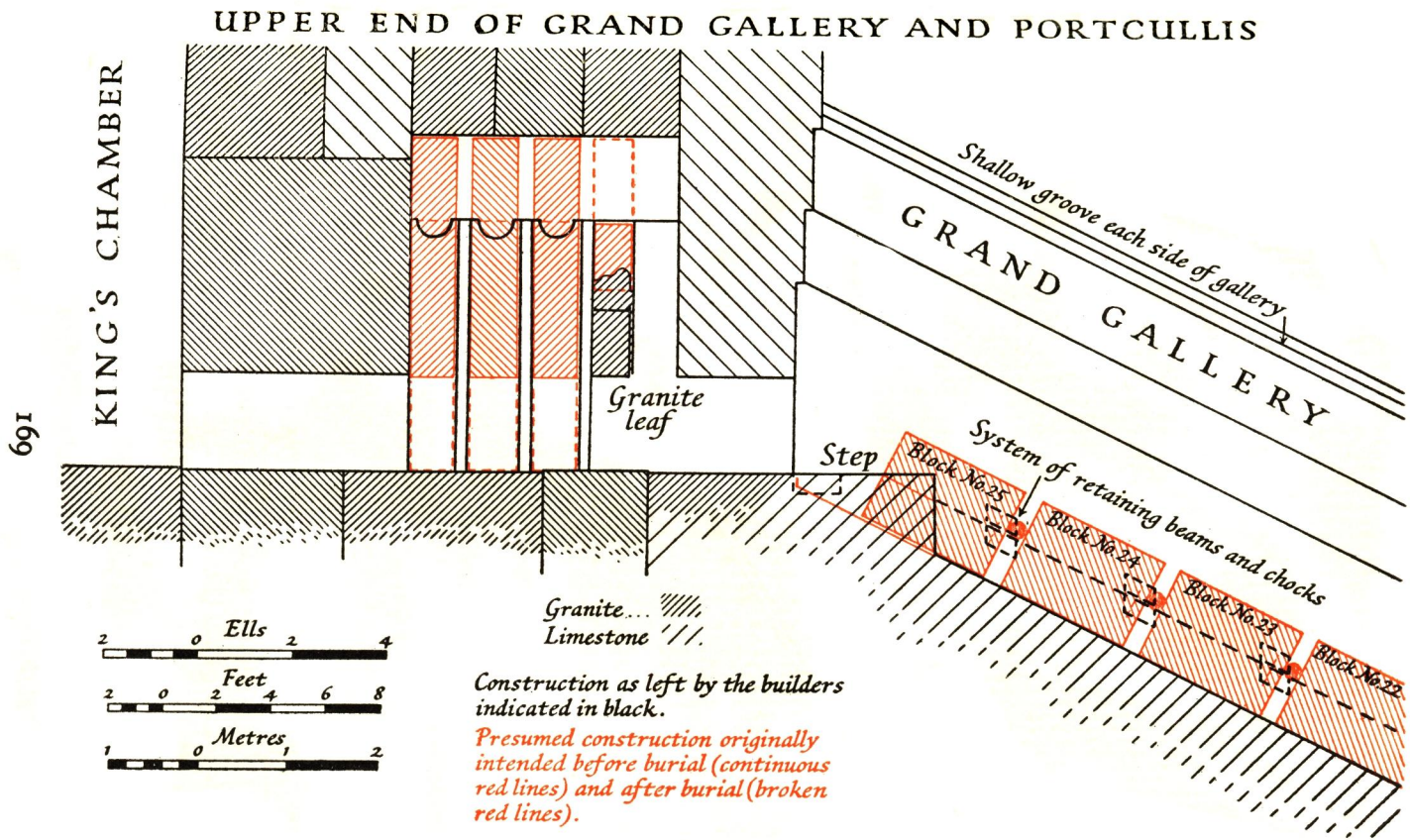


FIG. 4

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lowest to the upper chambers. The lowest chamber, 'Davison's Chamber', was found by Davison in 1765 when he discovered the break-through to it from the upper corner of the Grand Gallery: there is no evidence to tell us when this break-through was made. These Chambers of Construction are among the few places where the unworked backs of masonry are visible, always an interesting find since the red paint marks put on the blocks in the quarries are likely to be still on the stone, as they are in this case. It is common to find in these inscriptions the king's name, the date, and the name of the gang who cut the stone, since the Egyptian quarrying was organized on a very efficient system of checking throughout each block's journeyings, to the time of its resting in its final place in the structure. Here, in the Chambers of Construction, we have the name of Khufu and the names of a number of gangs.

There is an unfinished sarcophagus in the King's Chamber—broken, lidless, uninscribed—and it was so found by Caliph Al Mamoun in A.D. 820 when he made the first break through the masonry of the pyramid since its original closing. The fact of being without inscription is not in itself strange, since this fashion was in use at the time. The alabaster sarcophagus of the king's mother had no mark on its surfaces, though those of his sons and daughters followed both fashions—inscription and lack of it. The present writer is not aware of the bottom of the pyramid sarcophagus having been examined; but in the case of the king's mother there was a sign twice repeated in sunk relief, in some way significant to the men who made the sarcophagus, cut in the underside—a chisel (identical with an actual chisel in copper found in her tomb).

The remaining feature of the King's Chamber is the existence of two ventilating shafts, one low in each side-wall, which ascend through the pyramid masonry at a steep angle and emerge through the face of the pyramid about 190 E up the face from the platform level.

HORIZONTAL PASSAGE

This passage runs from the junction of the Ascending Passage with the Grand Gallery to the Queen's Chamber. Its floor is only finished at the inner end, where it is level with the floor of the chamber and its height is just over 3 E, the outer end being 1 E above the remainder and the height here about 2 E. As this latter height is that of the Ascending Passage, it may be that the greater height, which has not

PYRAMIDS AND THEIR PURPOSE

been completed throughout its length, was originally intended to admit the 'ka'-statue of the King by way of the then unroofed Grand Gallery. The niche for this statue is in the west wall of the Queen's Chamber.

QUEEN'S CHAMBER

This chamber, 11 E long, nearly 12 E high, and exactly 10 E wide, is of granite and has a vaulted roof similar to that over the uppermost of the Chambers of Construction. It is in the east-west centre plane of the pyramid, while the King's Chamber and the rock-hewn chamber have this plane passing north of them and roughly through their entrance passages. In the west wall of the Queen's Chamber is a tall niche, 3 E wide at its base and tapering by overlapping courses to less than 1 E at the top, and in height exactly equal to the height of the chamber side-walls to the spring of the vault—nearly 9 E. This niche is empty and has been broken away at the back by plunderers hoping to find a way to somewhere else. The Queen's Chamber has a pair of unfinished ventilator shafts, like those in the King's Chamber, but they were only completed to within less than 1 H of the chamber walls. Waynman Dixon found them by sounding in 1872 and broke through the remaining thickness of the walls to open them up. The Queen's Chamber has no protection against robbers in the form of a portcullis, but it was probably presumed that the bridge-slab in the Grand Gallery floor was sufficient concealment.

WELL-SHAFT

As described under 'Grand Gallery' this shaft descends from the lower end of the western wall of that gallery. Its course is erratic but interesting. After descending vertically for about 10 E it continues down more uncertainly and roughly to the rock-surface, which it reaches in what is now called the Grotto—a natural cave in the rock. From here it wavers a little before settling to a straight line descent at an angle of about 50 degrees below the horizontal, which course it follows to within about 20 E of the point at which it emerges into the west side-wall of the Descending Passage, and about 15 E from the lowest point of that passage. It descends to the level of the passage-floor and then enters it horizontally by a short tunnel. Suggestions as to the purpose of this well-shaft will be considered later.

There are two details which are not described above or illustrated in the plans. The first is the broken passage made by the Caliph

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Al Mamoun, who broke into the pyramid-surface in the north face, near the centre, but too low to strike the original entrance—which must then have been invisible as originally sealed up. He broke first into the Ascending Passage alongside the plug blocks, went down further and broke into the Descending Passage, and then returned and proceeded up the Ascending Passage into the inner passages and chambers. The second is the break through from the Grand Gallery to the Chambers of Construction, which goes straight through from the highest point of the side wall of the gallery into 'Davison's Chamber': ancient or modern, and with what purpose is not known.

PYRAMID CONSTRUCTION METHODS

There have been almost as many different suggestions as to how the Pyramid of Khufu was constructed as there have been writers on the subject, but very few are worth considering. Petrie (*Ancient Egypt*, pt. 2, 1930) suggests a ramp occupying the full width of one pyramid face, and steepened as the work progressed upwards as far as about three-fourths of the pyramid height; thereafter by a zigzag ramp up one face to the top. This ramp would need to have extended a distance of at least 1000 feet outward from one face of the pyramid. On the east is Khufu's royal cemetery (see PLAN p. 188), with the tombs of his mother, his four queens, his sons and daughters; also his pyramid-temple, the work on which must have been in progress during the construction of the pyramid. On the north the edge of the rock-plateau is only about 500 feet from the pyramid. On the south is more of the Khufu cemetery, and the ground drops rapidly at a distance of about 400 feet. On the west is the great western cemetery of the fourth and later dynasties. There is no sign whatever of such a ramp as that postulated, which must have had a mass equal to or greater than that of the pyramid itself; but small construction ramps to some of the fourth dynasty mastaba tombs are still in place in the eastern cemetery or can be traced from their broken sections.

The question of the approach is easily solved since the causeway of the pyramid descended at an easy slope from the pyramid-temple on its east face to the valley-temple which lay somewhere under the modern village of Kafr-es-Saman, at the foot of the rock-plateau cliff. This causeway was made of large blocks of masonry, and its whole course is traceable either by the bed cut in the rock or by the actual masonry which remains where the causeway came up the cliff. At the

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time of the inundation the stone could be landed from barges at the valley-temple end.

When we come to consider the means of getting the huge blocks up to the height of their courses on the pyramid we have to think of the methods to which the Egyptians were accustomed, and the easiest way in this particular case. The ramp was the favourite method of getting great weights up to a height: the easiest way of applying a ramp to the pyramid was to use the pyramid-construction itself and leave a 'spiral' ramp in the core structure at an easy inclination such as used elsewhere, encircling the pyramid continuously until reaching near enough to the top. Such a ramp with a slope of 1 on 5, up which the blocks would have easily been moved with levers and rollers, would have risen to within 40 feet of the top in two revolutions round the pyramid: a ramp circling round the pyramid once would have needed to have a slope of only 1 on 3. The suitability of this method is obvious, and one can assume that the Egyptians were ingenious enough to have thought of it, and one can almost presume that this was the method used. The completion of the full height would have been the point at which they would have worked their way back down the spiral ramp, filling in to the finished face as they descended.

Concerning the passage-system, we have a number of unfinished pyramids to refer to, and one of the most definite is that of the first queen of Khufu, the northernmost of the three small pyramids east of his own. This queen's pyramid was originally begun about 100 feet further east than it now stands, and because of its possible encroachment on the area of the secret tomb of Khufu's mother, Hetep-heres, the site was shifted. At the time of this shift the masons had cut into the rock for the beginning of the descending passage to the tomb chamber, and had also cut the sloping bed for the massive stones which were to frame the entrance; so that we know this to have been the usual procedure in commencing a pyramid, and can safely assume that Khufu's own pyramid was begun in the same way. The rock-cutting work was done first and then the superstructure was built over it.

Of the method followed in the casing we have also some very clear examples in the mastaba tombs of Khufu's royal cemetery (eastern). There, from the unfinished sections, tool marks, etc., it has been possible to reconstruct the process pretty completely. When the core masonry was finished, the first course of casing was built up complete, each block being faced level beneath and on the side which was to butt against one already in position; the bedding being levelled to fit each

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stone individually. The bedding and the side faces were smeared with a very thin coat of fine plaster, less than a millimetre thick, which served as a lubricant on which the stone could be pushed up for fitting and withdrawn for further adjustment. The final fit of the side faces was helped by the use of a long copper saw, about 5 millimetres thick, which was worked down between the two stones to give a fitting face on each, after which the stone was pushed up against the neighbour and a very fine joint resulted.

The blocks arrived from the quarries *unworked* and with the name, date and gang-name of quarriers painted on one face of certain stones in red ; possibly all stones were marked, since the only face on which such marks can now be found are the unworked backs.

The levelled bed of rock had been previously marked out with incised lines giving the base outline of the mastaba or pyramid, and when the first course of casing was in place the same thing was done on its levelled upper surface, the lines being set back a definite amount for the rise above the lower lines. This was the method always employed by the Egyptians to define, measure or state in writing a given slope, a rise of 1 E on a base of 5 H, etc. Often in scribing these lines two would be marked, one to the correct measure and another about 1 H outside it for the stone-dressers to measure back from in finishing off the surface ; the correct line was of course covered by the outward excrescences of the undressed face of the stone of the course above, until the final facing brought the work exactly to the line.

The subsequent courses of casing were put on in the same way, each being completed before the next was begun, and the structure reached its full height with all the faces undressed. Each face was then dressed from the top downwards as a whole. There were exceptions to this in many instances of inferior workmanship, usually found in the tombs of poorer people or in generally poorer times, but the best work in the Giza eastern cemetery always followed it. It is by far the easiest method of carrying out such work, and would have been entirely suitable for the pyramid of Khufu. Petrie gives as a reason for believing the face to have been finished before erection that the planes of some of the casing blocks differ from that of the contiguous block very slightly ; but there are several other causes which might account for this.

MEASURES TO DEFEAT PLUNDERERS

From the earliest times Egyptian tombs showed great ingenuity in the attempts to make it impossible, or very risky, for plunderers to

PYRAMIDS AND THEIR PURPOSE

gain access. Usually they were unsuccessful, because the plunderers were even more ingenious, and the true 'secret' tomb with nothing to show above ground was the only method pretty certain to escape.

The system of sliding plug-blocks down an inclined passage to fill it was widespread over a long period, and there are many examples among the fourth dynasty tombs at Giza; a noteworthy example is the rock tomb of Wah-ka at Qau, where a very cunning but unsuccessful plug-system was used. The usual procedure of the plunderers was to tunnel alongside the plug-blocks when these were of harder stone than the surrounding masonry: the Caliph Al Mamoun gained entrance to the pyramid in this way.

Another favourite stand-by of the tomb builder was bluff. The tomb entrance appeared to be in one place, whereas the actual approach was elsewhere. The concealed opening into the Ascending Passage of the pyramid is a case in point—the plunderers being expected to go down the normal Descending Passage, find what they thought was the burial-chamber, find it rifled and assume that the burial priests had been before them—as they often were—and leave the rest of the pyramid alone.

The portcullis was another well-used adjunct, and examples of it are found in many places. A large number of the Giza mastaba tombs have a single portcullis at the bottom of a deep shaft in the rock. It was usual also to conceal as well as possible the outer entrance to the tomb. The entrance into the Great Pyramid consisted of a single block of stone which was indistinguishable from the others of the casing-face; and it was not discovered until after the plundering of 820.

From all this one can see that there was nothing new or unusual in the measures adopted in the Pyramid of Khufu to defeat the robber. It is only in the means of carrying out these measures in detail that the pyramid goes further than most other tombs, the care and thought given to the detail being remarkable.

ORIGINAL PLAN OF THE PYRAMID OF KHUFU, AND PURPOSES OF ITS PARTS

There is some reason for believing that the original design of Khufu was for a pyramid of about 300 E-side (about the same size as that of his father), to contain only the normal passage descending to a burial-chamber in the rock, though this plan must have been discarded for a better one before the superstructure was begun. One indication of this is the height up the pyramid-face at which the entrance is placed.

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Some examples of the proportion of this height to the total slant-height are :—

Pyramid of Khufu, as it is	.. .. .	.116
Pyramid of Khafré, upper	.. .. .	.0824
Pyramid of Menkauré	.. .. .	.0632
Pyramid of Khufu, had its face been at the end of the plug	.. .. .	.05
Pyramid of Khufu, 10 E outside plug	.. .. .	.06

This last case would have meant a pyramid of 330 E-base and 210 E-height, multiples of 11 and 7 by 30. The pyramid as it is has the base and height multiples of 11 and 7 by 40, and the Meydum pyramid 11 and 7 by 25.

Another indication is the unfinished state of the 'burial-chamber' in the rock. This, one of the first works undertaken in the pyramid construction, would scarcely have been left as it is unless discarded. It would even have been a better means of deceiving robbers had it been a convincing burial-chamber and not an obviously unfinished one.

However this may be, it is certain that the present pyramid was built from the platform upwards as one complete design, without alteration, so that the change in plan, if any, must have been made before the platform and base lines were laid out. It seems likely that Khufu, who would have begun plans for his pyramid as soon as he came to the throne, would have taken his ideas from the pyramids of his predecessors and of his father in particular. One can imagine the architect who designed the present pyramid coming to Khufu with his plans and having them enthusiastically approved at once.

When we come to the internal passage-system we find a much more drastic and significant change in the plan, which implies a complete alteration in the purpose to be served by the Pyramid. Before going over the many clear signs of this, however, it would be as well to attempt a reconstruction of the procedure of the burial arrangements as originally intended. The coffin would be carried down the Descending Passage and up the then empty Ascending Passage—a portable ladder of some kind being used to mount from the one passage to the other. On entering the Grand Gallery the slab-bridge would be covering the horizontal passage to the Queen's Chamber, and the procession would probably proceed up the gallery on the plug-blocks which would then have been loaded into their places in the chute. There is accommodation for 25 of these blocks between the cross-beam sockets in the ramps, and 25 blocks of the same size as the three now in the Ascending Passage would have exactly filled that passage to an inch.

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NO. 1 block at the time of the burial would have been about half an E above the upper end of the bridge-slab, and NO. 25 about halfway into the space now occupied by the Step at the top of the gallery.

The coffin would then have been taken in under the three portcullis slabs and placed in the sarcophagus. Omitting here any possible ceremonies connected with this, the lid would have been closed and the procession have returned to the pyramid entrance. The Queen's Chamber, which would have had the 'ka'-statue of the King in its niche, would have been the offering-room into which all the offerings, furniture, etc., would have been placed; whether before or after the coffin's journey up does not affect matters here. On emerging from the King's Chamber the priests would have seen the portcullis slabs dropped into place one by one, the 'granite leaf' pushed up or built up to seal the space now vacant over the portcullis, and would have emerged from the pyramid, leaving the plug procedure to be carried out by the gangs brought up into the Grand Gallery for the purpose.

Probably the concealing limestone block at the opening of the Ascending from the Descending Passage would be built into place and fixed immovably before the plug-blocks were released, but it is also possible that a temporary measure for checking the plug-blocks at their stopping position was used, and the limestone block put up afterwards. In any case the plug-blocks would have been lowered, NO. 1 first, step by step, from ramp-socket to ramp-socket, until each lay in the lowest position in the chute. Then each block would have been released when it reached this position, to slide down the Ascending Passage and bring up against the rear of the preceding block. A thin liquid plaster was used between each pair of blocks, and this was probably put on immediately before slipping each block.

Now we come to an interesting point. What about the gangs who were doing the plug-block work, when the first block went home? Were they expected to remain to die of starvation or suffocation? It is possible but by no means probable at this period. It is here suggested that the well-shaft was expressly constructed for their escape, either with or without the knowledge of the highest officials. If without, one can well imagine the representative of the workmen concerned getting hold of the right subordinate official at an early stage of the Pyramid construction and 'squaring' matters. It is possible that, before the pyramid superstructure was begun, they established themselves at the Grotto in the rock surface and tunnelled down to a point near the base of the abandoned Descending Passage, where no one

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would be likely to see too much of their operations. Then, as the courses of the pyramid rose, they were able with the connivance or help of the right man to have the upper part of their shaft left as a small gap in each course put in. The slight 'wandering' of the well-shaft may be due to their efforts to make a negotiable passage rather than a sheer vertical shaft which would have been a hindrance and danger to their projected escape: the vertical 20 feet or so at the extreme top would have been due to the local foreman having at that point realized where the lower end of the Grand Gallery was coming in the building.

With the well as an escape, the gangs had only to lift the bridge-slab, get down the well-shaft, seal the lower end with a block prepared, and emerge from the pyramid entrance when most expedient to themselves and those 'in the know'. Some time subsequent to this the sealing-stone would have been placed in the entrance and the pyramid be a finished task.

Assuming the above to have been Khufu's original intentions, we find a number of strange things in the actual pyramid. The details will be gone over and these discrepancies noted:—

ENTRANCE. The sealing stone must have been put in place, since Al Mamoun could not locate the true entrance.

CONCEALING BLOCK at foot of Ascending Passage. This was heard to fall by Al Mamoun and he found it later in the Descending Passage.

BRIDGE-SLAB. No trace of the actual slab is known, but it may well be that the workmen, when they lifted it for their escape, toppled it down the Ascending Passage and Al Mamoun removed it with his general tunnelling work. That three granite blocks have made their trip down implies that the bridge-slab did exist then.

GRAND GALLERY. There is a 'rail'-like groove along each side wall at a height of about 10 feet above the tops of the housed plug-blocks, which would well have carried a flooring of rafters for the tackle needed in handling the blocks and placing them. The sockets in the side ramps continue down past the bridge-slab recess to the end of the gallery, implying a step-by-step descent of each block to this point. There is a break through from the upper end of the gallery to the lowest of the Chambers of Construction over the King's Chamber. It was found by Davison in 1765, but whether it is Al Mamoun's work, or later or earlier cannot be said. If earlier it would have been original, and there seems no point in that. The Step at the upper end of the

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gallery is the interesting point here, since it encroaches on the area which would have been required for plug-block 25 in the uppermost socket position. It must therefore be unfinished and not completed as originally intended.

PORTCULLIS. This is clearly unfinished. There are no portcullis slabs, and the ' granite leaf ' is incomplete as it is now.

KING'S CHAMBER. The sarcophagus is obviously unfinished. The worked faces are very poor, and the lid was never present, since the first to break into the pyramid found it missing then. He also found no trace whatever of burial, offerings, pottery, etc., and one can presume the chamber to have been empty but for the sarcophagus itself.

HORIZONTAL PASSAGE AND QUEEN'S CHAMBER. The floor of the former is apparently unfinished, being originally intended to be 1 ell deeper. The niche in the chamber is and has always been empty of statue. No mass of offerings or furniture was ever in the chamber, or there would certainly have been mention of Al Mamoun's having found it. The two ventilation-shafts from the sides of the chamber to the outer casing of the pyramid were only completed to within 5 inches of the inner face of the walls, and did not connect with the room until Wayman Dixon broke them through in 1872.

WELL-SHAFT. The lowest ramp-stone on the west side of the Grand Gallery has been removed and there is no record of when this was done. It could have been done during the escape of the working gangs, since the uncompleted Horizontal Passage floor made the opening under the bridge-slab rather small otherwise ; it may have been done by Al Mamoun's men. No trace has been found of the actual stone. A sketch in Davidson's *The Great Pyramid* is referred to as evidence of the ramp-stone having been forced out from *below*, but this sketch and an examination of the surrounding stonework *in situ* show quite clearly that the stone was prized out from above, *i.e.*, from within the Grand Gallery. There is a better sketch in Edgar's *The Great Pyramid*, but in both sketches, as in the original, the breakage of edges and corners shows that a crow-bar or something of the kind was used on the right and left sides of the stone and above it at the back, to prize it out of place into the gallery. The greatest efforts were made at the side contiguous to the Ascending Passage opening, no doubt because the workers knew of the inclined seating of the stone which would release it best in that direction. There is not so much as a mark *underneath* to show any attempt to raise the stone from below, and in the confined space of the little narrow passage there to the opening of the well-shaft

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proper nothing but a modern 'jack' could have forced the stone upwards, and would not have caused the breaks on the adjacent stones on the gallery side. To anyone who has had experience of prizing blocks from masonry or working heavy stones through confined spaces it is obvious at a glance that the men who removed this ramp-stone were in the Grand Gallery.

In Mr Davidson's book it is claimed that the well-shaft was tunnelled vertically upwards from the foot to the Grand Gallery in later dynasties for a tour of inspection of tombs. Since the main Pyramid entrance was intact there would be no reason at all for such an inspection according to Egyptian lights, as their later inspections were to ascertain whether robbers had gained access or made attempts to do so. A vertical shaft such as the well, driven upwards, would have been an entirely un-Egyptian method. Had they possessed the detailed plan of the building, as the accurate arrival of the shaft at both ends implies, they would have certainly tunnelled up alongside the plug-blocks—especially as it would be known that only three blocks existed, or, if Al Mamoun's account means what is said of it, that only limestone blocks had to be dealt with after the first three; the intersection of the well-shaft with the Grotto on the rock-surface would then have been mere coincidence.

Taking all the above signs of lack of finish—3 plug-blocks only out of 25, Horizontal Passage floor unfinished, Queen's Chamber niche empty, Step uncut for receipt of plug-block 25, no portcullis slabs fitted, no lid to the sarcophagus, no reported trace of body, bones, offerings, pottery, etc., and uncompleted ventilating-shafts to Queen's Chamber—one is justified in presuming that a change took place in the purpose during construction. One can say, in fact, that this change must have taken place when the Grand Gallery roof was yet unplaced, when the King's Chamber also was open, and the roof-slab of the portcullis recess not yet in position. This would have been when the main mass of the Pyramid had reached about the 34th course, to allow the Grand Gallery floor to be completed high enough to accommodate three plug-blocks at least. The central part of the pyramid, including the King's Chamber, portcullis recess and remainder of Grand Gallery, would have risen at the same time above the 34th course probably to about the 50th to the 55th. It may well be no more than a coincidence, but there is one of those changes of course-depth, which occur many times in the height of the pyramid, at the 35th course; and it is the most noticeable change in the whole series. There is an interesting article

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on these course-depth changes, and an explanation, in Petrie's *Ancient Egypt*.

Until fairly recently there was no outside evidence of the existence of circumstances which might have caused such a change of plan ; but from the information obtained from the excavation and recording of the tomb of Khufu's mother, Hetep-heres, certain conclusions have been reached which do supply an adequate reason. A sufficiently full account of the work on this tomb will be found in the Bulletin of the Boston Museum of Fine Arts.¹

To sum up the facts which emerged :—Hetep-heres was the daughter of King Huni of the third dynasty, wife of Seneferu, and mother of Khufu. She died in the reign of Khufu and was buried by him near the pyramid of her husband at Dahshur. Plunderers got at this tomb and their depredations were discovered too late, in that they had opened the sarcophagus and removed the body with the jewellery which was on it. The fact—of the robbery but probably not of the missing body—was conveyed to Khufu, and by his orders a secret tomb was commenced at once and finished roughly at great speed, situated in the most important point in his own royal cemetery at Giza. The tomb consisted of a vertical shaft, 100 feet deep in the rock, leading to a rock-hewn burial-chamber, and was situated alongside the causeway of Khufu's pyramid, nearer to it even than the pyramid of the first queen of Khufu, and with the whole vast cemetery of his queens and children behind it. The shaft was filled solid with courses of fine limestone masonry in plaster of Paris, and the top course was of irregular pieces of the local nummulitic limestone, so that its secret was kept safely from the day of the re-burial until A.D. 1925.

One can imagine the feelings, and to a certain extent the actions, of Khufu on hearing of his mother's tomb at Dahshur being attacked. One can imagine also that the responsible officials at Dahshur were in a very uncomfortable position, but that they affirmed strongly to the King that no real damage had been done, and kept silent as to the contents of the alabaster sarcophagus which was re-buried.

The idea of a secret tomb for the burial and a normal tomb with superstructure for the public to see was not a new one—Seneferu most probably had done the same thing, as others did after him—and if we put ourselves in Khufu's place I think we should cast quizzical eyes at our own pyramid from that day. There would certainly be ample

¹ Supplement to vol. xxv (May 1927), and xxvi, p. 76.

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reason for setting to and altering the whole intention of the pyramid ; to continue the work so that outward seeming should not be changed while saving unnecessary work by omitting what was no longer essential in the construction, and devising some entirely unsuspected site for the actual burial. Possibly, and probably, the number of persons aware of the reason for the change in plan would be very few—the King himself, and his most trusted officials only. It would have been quite in keeping for him to have arranged for a public ceremony at his funeral and a dummy burial in the pyramid, while those entrusted with the task buried him as previously planned where none other saw it.

This leaves us with the obvious question—where was Khufu buried ?—the question remaining to the many who have arrived by one route or another at the conclusion that he was not buried in his pyramid.

No tomb has yet been found at Giza which could have been his. At one time the idea was circulated (it is in Edgar's *Great Pyramid*) that the tomb near to the Sphinx, called 'Campbell's Tomb', had been that of Khufu ; but this tomb is now known to be of a very much later date. Taking the procedure adopted with Hetep-heres, one can assume that Khufu would probably have chosen a position within the boundary of his royal cemetery, which limits are clearly defined, but this area has been almost entirely excavated down to the rock. The possibilities lie in the 'almost'. There is, for instance, a pre-Khufu quarry alongside and beneath his causeway, which has been filled in with large blocks of limestone and gypsum. This was done presumably to give a level floor for Khufu's causeway, which crosses it, and the filled quarry lies within a few yards of the tomb of Hetep-heres. The clearing of this would be a difficult, laborious, and expensive task ; but it cannot be said that there is nothing there but a filled quarry until the quarry has been emptied.

The area of the pyramid-temple has also remained unexcavated so far, though there appears to be little left beyond the basalt floor, across a part of which thousands of tourists trek yearly to the Sphinx, and perhaps the lowest courses or other traces of some of the walls. There seem to be no other possibilities so far as we know at present. That there was a problem connected with Khufu's place of burial was known in later Egyptian times, when the fact that the Great Pyramid was his work must have still been well known ; and the question was then put into writing as to who knew the places of burial of Im-hetep, Seneferu and Khufu, as though it were an oft-repeated query.

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NOTE I

TABLE OF VALUES OF THE ELL AS DEDUCED BY VARIOUS AUTHORITIES
AT THE SITES MENTIONED

inches			
20.45	Borchardt.	Nile gauge at Kuboschia.	Late date.
20.47	Erman and Grapow.	Berlin Dictionary.	
20.58	Borchardt.	Great Pyramid.	(4th dynasty).
20.59	Average of 67 examples found by the present writer in the 4th dynasty tomb at Giza numbered G.1225B by the Harvard-Boston Expedition.		
20.60	Borchardt.	Great Pyramid burial chamber.	(4th dynasty).
20.63	Petrie.	Great Pyramid burial chamber.	(4th dynasty).
	Davidson.	'The Great Pyramid: its Divine Message'.	
	Junker.	Various places in Giza west cemetery. (4th dynasty).	
20.61	Petrie.	Great Pyramid.	(4th dynasty).
20.662	"	Meydum Pyramid.	(4th dynasty).
20.67	Borchardt.	Ne-user-ré.	(5th dynasty).
20.72	Reisner.	Average of 3 examples in 'Mycerinus'. (4th dynasty).	
20.78	Newton,	according to Borchardt.	
20.77	Petrie.	Pyramid of Menkauré.	(4th dynasty).
20.80	Borchardt.	Nile gauge, Edfu.	Late date.
20.83	"	"	Luxor. "
20.86	"	"	Kuboschia. "
20.94	"	"	Elephantine and Esneh. Late date.
20.98	"	"	Taifa. Late date.
21.07	"	"	Taifa. "

NOTE II

MEASUREMENTS OF THE GREAT PYRAMID

The inch measurement is given in brackets; the first column of figures gives the ells, the second column the value of the ell to account for this to the nearest finger. The authorities for these measurements are:—Cole, *Survey of Egypt*, paper no. 39, 1925; Borchardt and Petrie in various publications; Morton Edgar, *The Great Pyramid*, 1924; Davidson, *The Great Pyramid*, 1927.

The average value of the cubit in all these measurements is 20.614 inches.

THE PYRAMID	Ells of			Necessary value of ell, in inches
	7-hands			
	E	H	F	
Mean of 4 base lengths (9069)	440	0	0	20.61
Height from platform to apex (5782.2)	280	0	0	20.65
DESCENDING PASSAGE				
Total floor length (4535)	220	0	0	20.62
Vertical rise (1854)	90	0	0	20.60

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							Ells of 7-hands			Necessary value of ell, in inches
							E	H	F	
GRAND GALLERY—contd.										
Face of Step from end wall of gallery (61.01)	2	6	3	20.58	
Step above platform level of pyramid	..	..	..	..	..	82	0	0	20.63
ANTE-CHAMBER										
Portcullis recess, length	..	..	..	..	..	5	5	0	20.59
" " height	..	..	..	..	..	7	1	0	20.59
Outer passage length (52.04)	..	..	..	..	..	2	3	3	20.59
Inner passage length	..	..	..	..	..	4	6	0	20.59
Height of portcullis sections and slides (103)	..	..	..	..	..	5	0	0	20.60
Height of outer passage (43.71)	..	..	..	..	..	2	0	3½	20.61
Thickness of portcullis units	..	..	..	..	..	1	0	0	20.59
KING'S CHAMBER										
Length (412.5)	..	..	..	..	..	20	0	0	20.63
Breadth (206.3)	..	..	..	..	..	10	0	0	20.63
Height (230.5)	..	..	..	..	..	11	0	0	20.67
Height of each course of masonry (47.1)	..	..	..	..	..	2	2	0	20.60
SARCOPHAGUS										
External length (89.71-90.01)	..	..	..	..	..	4	2	2	20.59
" breadth (38.65-38.72)	..	..	..	..	..	1	6	½	20.59
" depth (41.16-41.27)	..	..	..	..	..	2	0	0	20.61
Internal length (77.93)	..	..	..	..	..	3	5	2	20.59
" breadth (26.79)	..	..	..	..	..	1	2	½	20.56
" depth (34.34)	..	..	..	..	..	1	4	3	20.61
HORIZONTAL PASSAGE TO QUEEN'S CHAMBER										
Length (1521)	..	..	..	..	..	73	6	0	20.59
Height (46.4)	..	..	..	..	..	2	1	3	20.62
QUEEN'S CHAMBER										
Height of side walls	..	..	..	..	..	8	6	1	20.59
Height of ' ka ' -statue niche	..	..	..	..	..	8	6	1	20.59
Height of vaulted roof	..	..	..	..	..	11	5	2	20.59
Width of ' ka ' -statue niche at base	3	0	0	20.59	
Width of chamber (205.8)	10	0	0	20.58	
Average value of Ell										20.614

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EXPLANATION OF PLAN OF TOMBS

(see page 188)

A ROYAL CEMETERY OF KHUFU in which are the pyramids of three of his queens, the mastaba tombs of two further queens, his sons, daughters, grandchildren, and probably later descendants among the later tombs. The secret tomb of his mother is also here. The cemetery is bounded by the Pyramid of Khufu, his causeway, and the edge of the pyramid plateau on the west, north and east respectively, and has been in course of excavation since 1924 by the Harvard-Boston Expedition (about 117,000 sq. metres are surveyed).

B GREAT WESTERN CEMETERY of mastaba tombs of the 4th dynasty, which has an area of about 255,000 sq. metres. About one-third of this was excavated completely by Professor Junker's Austrian Expedition and the remaining two-thirds have been in the concession of the Harvard-Boston Expedition since before the war. The important part of this has been excavated but not published, except for the publication of the Austrian work ; the unexcavated part is not of great importance.

C CEMETERY south of Khufu's Pyramid, consisting of mastaba tombs of the 4th dynasty with later tombs among them. Excavated by the Austrian Expedition.

D CEMETERIES south of Khafre's causeway in process of excavation by Professor Selim Hassan of the Egyptian University.

E CLIFF EDGE of the limestone plateau.

F CEREMONIAL CAUSEWAYS of the three pyramids. Each one led from the upper temple against the east face of the pyramid to the lower or 'valley' temple.

Of Khufu's causeway only the level track in the rock remains except at the point where it goes over the plateau-edge, where the masonry blocks remain. Where it crosses the area of the quarry the floor is of large limestone blocks with which the quarry is filled. The lower end of the causeway is lost beneath the modern village of Kafr-es-Seman, which comes up to the foot of the cliff. The upper end has not yet been excavated and planned. The subway (v on plan) is contemporary and must be about the earliest known subway-crossing of a street. Its existence suggests that the causeway was walled and not open to the general public and that the traffic of priests and interested persons into the cemetery was by the subway. No tombs exist to the north of the causeway and this area was therefore probably not part of the royal cemetery.

AQ ANCIENT QUARRIES. The quarry cutting around the west and north sides of Khafre's pyramid was primarily to level a platform for the pyramid building. The Menkaure quarry has a number of contemporary tombs cut in the rock faces.

T TEMPLES. The valley-temple of Khafre is the so-called Temple of the Sphinx and is of granite. The temple alongside is in process of excavation by the Egyptian Government. The valley-temple of Menkaure is of mud-brick and here were found the slate pair of triad statues of the king (see ANTIQUITY, March 1935, p. 9 and pl. vi). The famous diorite statue of Khafre was found in the 'Sphinx Temple'.

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The upper temple of Khufu has not been excavated or planned. The basalt pavement is passed over by thousands of tourists every year, most of whom do not notice it.

The queens' temples are completely ruined, only the foundation cutting of the first, a few stones of the lowest course of the second, and about six feet high of Henut-sen's remaining. Henut-sen's temple was extended in later dynasties and seems to have been in continuous use down to Ptolemaic times, when it had become the temple of 'Isis of the Pyramid'.

The temple of Khafré has been excavated, and that of Menkauré has recently been published (Reisner, *Mycerinus*).

M TOMB OF HETEP-HERES I, the mother of Khufu. Queen of Seneferu and probably daughter of King Huni of the 3rd dynasty. The only 'secret' tomb so far found in the cemetery.

QA FIRST QUEEN OF KHUFU, name uncertain.

QB SECOND QUEEN OF KHUFU, name uncertain.

QC HENUT-SEN, third queen of Khufu.

QD NEFERT-KAU, fourth queen of Khufu. Her son was Nefer-maat. Her grandson, Seneferu-khaef, compounded his name with that of his great-grandfather Seneferu, and not with that of Khufu.

QE MERYT-ITES, wife of Seneferu and Khufu.

SA KA-WAB, eldest son of Khufu, never came to the throne. He married the eldest daughter of Khufu, Hetep-heres II, who survived him; their daughter was Meres-ankh III.

Sb HOR-DEDEF, son of Khufu. From his tomb an enemy had tried to erase all trace of his name—unsuccessfully.

SC KHNUM-BAEF, son of Khufu.

SD KHUFU-KHAEF I, son of Khufu.

SE Unknown.

SF Unknown.

SG MIN-KHAEF, son of Khufu.

SH SEKHEM-ANKH, son of Khufu who married Ka-aper (not royal).

SI MIN-DEDEF, son of Khufu who married Khufu-ankh (not royal).

D MERES-ANKH II, daughter of Khufu.

GA SENEFERU-KHAEF, grandson of Khufu. Son of Nefer-maat and grandson of Nefert-kau.

GB KHUFU-KHAEF II, son or grandson of Khufu-khaef I, and therefore grandson or great-grandson of Khufu.

Gc MERES-ANKH III, a granddaughter of Khufu. Her mother was Hetep-heres II and her father Ka-wab.

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H ANKH-HAEF, who married Hetep-heres II. She was not buried with him or with Ka-wab.

J KHUFU-ANKH, a 'royal acquaintance' who married Min-dedef.

K DWA-EN-HOR, a king's son.

L KA-EM-NEFERT.

N KHAFRÉ-ANKH ('Tomb of Numbers').

P PTAH-SEKHEM-ANKH.

W ANCIENT BOUNDARY WALLS OF CEMETERIES.

MC MOSLEM CEMETERY.

S THE SPHINX, portrait-head of Khafré on lion's body.

X AREA EXCAVATED by the Egyptian Government over 10 years ago and so far has not been published. It is hoped that the records and plans exist since the area has been well 'dumped' over.

F THREE ROCK-CUT FUNERARY BOATS OF KHUFU. FA is the funerary boat of Khufu's first queen.

Assuming that we have reached the conclusion that Khufu was not buried in his Pyramid, then the probabilities point to his having placed his tomb within the area of his own royal cemetery. When we note the positions on the plan of the secret tomb of his mother, the pyramids of his queens, his ceremonial causeway, and the general 'seniority' grading of the cemetery from west to east and from north to south, the probabilities again indicate the northwest quarters of this area. The pyramid-temple, and the whole space between the pyramid and the queens' pyramids, are presumably held up by the fact that the main tourist approach to the Sphinx is over them, but eventually they will surely be cleared and the remains of the temple planned. The quarry over the block-filling of which the causeway runs, would present a costly problem if it were to be cleared, but it cannot be definitely said that there is nothing but a quarry until it is laid bare. It must be remembered that the secret tomb of Khufu's mother Hetep-heres was only found by chance in ground already cleared; the scraping of a camera-tripod leg over the plaster-of-paris between the stones filling her pit-stairway revealed the whiteness of the plaster. But for this one error of judgment of the tomb-builders, in failing to disguise the plaster as they had disguised the masonry filling itself, it is unlikely that the tomb would have ever been found. The pit filling was of fine white limestone blocks laid in courses, but the surface course was of irregular pieces of local rock. Such care in concealment by Khufu of his mother's tomb would suggest that his own tomb will scarcely jump to the eye.

If the final clearance of the whole of the royal cemetery-area should reveal nothing, then we can frankly admit without shame that Khufu has been too clever for us, and wait for chance of new evidence to disclose the place of his burial.

PYRAMID PLATEAU, GIZA.

