

Correspondence.

The Awning over the Colosseum in Ancient Rome.

To the Editor of the SCIENTIFIC AMERICAN:

In a late issue of the SCIENTIFIC AMERICAN your correspondent, writing from Rome, alludes to the awning or canopy which is said to have been stretched over the interior of the Colosseum by the ancient Romans. The existence of such a canopy is a matter of general belief, and indeed is asserted by many modern authorities. The "Encyclopedia Britannica" (Tit. Amphitheater) and the "American Encyclopedia" (Tit. Colosseum) and "Chambers's Encyclopedia" (Tit. Amphitheater) refer to it without question. In your paper of December 27, 1890, you print an extract from the St. James's Gazette, under the heading "Ancient Engineering Feats," as follows:

"Is Mr. Eiffel prepared to put an awning over Trafalgar Square when the sun shines and remove it promptly, without the aid of a central support or steam engines, or even chains? The area of the Colosseum is certainly not less. This may seem a trifling matter to the thoughtless, because they have never considered it. Roman engineers covered that vast expanse with some woolen material, and they worked the ponderous sheet so easily and smoothly that it was drawn and withdrawn as the sky changed. The bulk of it must have weighed hundreds of tons, all depending by ropes from the circumference. But the ancients thought so little of this feat that they have left us only one trivial detail of the method."

The writer of the above does not mention the author by whom this "trivial detail of the method" is referred to, and I have been unable to discover the passage. The only allusions to the awnings (velaria or vela) in the amphitheater which I have been able to find with the aid of a distinguished scholar in Roman literature are the following: Two or three lines in Juvenal (iv., 122) speak of an admiring spectator of the games as follows: "He applauds the cuts and thrusts of the gladiator, and the stage machinery by which boys are raised up to the awnings" (velaria).

Pliny (Nat. Hist., xix., 23) tells how certain fabrics came to be first used in Rome for "awnings (vela) over theaters." He also says they were placed at one time over the Sacra Via and the Forum of Augustus, but he gives no description of their arrangement and makes no special reference to the Colosseum. And finally, Lampridius ("Life of Commodus," xiii., 17) makes the following statement about that genial emperor: "At one time when he was fighting in the theater the populace applauded him as a god, but he, supposing they were mocking him, ordered them to be set upon and slain by the sailors who managed the awnings (vela) in the amphitheater."

It is from such meager allusions apparently that the theory has been devised that an immense canopy, five and a half acres in area, was stretched across the amphitheater and "drawn and withdrawn as the sky changed." It seems to be supposed also that these changes were effected by manual power alone; but the "American Encyclopedia" suggests that machinery may have been employed, which was located in the upper part of the building.

A very little reflection will show that the stretching and maintaining of such a canopy, to say nothing of drawing and withdrawing it, as the sky changed, would be a physical and mechanical impossibility. The strain of such an enormous fabric shaking in the wind would speedily have torn it loose from all supporting arrangements or have pulled the supports themselves out of place. Certainly the poles around the top of the wall, by which it is supposed to have been held, would have been totally inadequate. To draw the canopy to anything approaching a plane would have been impracticable by any machinery whatever, still more so by manual power. It would inevitably sag in the center, and every rainfall, however slight, would add immensely to its weight, while in case of a heavy shower, an insupportable body of water would collect in the middle, and if there were an opening there, would descend in a cataract upon the performers in the arena. Imagine also the terrific noise of such a canopy flapping and pounding in the wind and the constant fear of the spectators that it would break away and fall upon them!

If withdrawn, it must have been pulled across from one side, which would cause the other to descend upon the audience; and how and where would such an immense bulk find storage room? If, on the other hand, we suppose it to have been divided into triangular sections, with their apices meeting in the center, we shall encounter not only most of the difficulties already referred to, but others equally insuperable. In such case, the sections, being separated, could not support each other, and nearly one-half the weight and strain of each would come upon its apex, held only by the ropes which extended to the opposite wall of the amphitheater. Without enlarging upon this point, nor upon the difficulties connected with any possible contrivance for spreading and furling the separate sec-

tions, we may safely assert that no such supposed arrangement will bear examination.

The most intelligible explanation of the awnings is found in Middleton's "Remains of Ancient Rome" (ed. 1885, p. 321). After describing the projecting socketed corbels near the top of the outer wall of the Colosseum, and the holes through the cornice above them through which poles were passed, their lower ends resting in the corbels, the author proceeds as follows:

"Other corbels on the inner face of the wall held a corresponding set of masts. The upper parts of each pair of poles were about 6 feet 3 inches apart, being separated by the thickness of the wall. They were probably strutted and lashed together so as to form a stiff support, as the strain of the ropes of the awning must have been very great. The awning did not, as has been sometimes supposed, cover the whole amphitheater; a thing which would have been practically impossible, owing to the enormous strain of so long a bearing, far beyond what any ropes could bear. It simply sloped down over the heads of the spectators in the cavea (the seated portion of the building), leaving the whole central arena unshaded. Corbels to support the lowest masts exist in the outer wall of the substructures below the level of the arena. These poles rose out of the arena along the line of the fence wall that protected the podium (lower row of seats). There must have been many intermediate points of support at intervals up the slope of the seats, but no indications exist of any of these, owing to the complete removal of all the marble seats and decorations. A whole army of sailors were employed to extend and furl the awning."

In confirmation of this view of the arrangement of the awnings over the seats, I may add that some years ago, while inspecting in the museum at Naples fragments of wall plaster brought from Pompeii and scribbled over with "graffiti," or rude sketches of every sort, I observed one drawing which evidently represented several rows of seats in an amphitheater. Over the seats was distinctly shown an awning descending toward the arena, not in a line parallel with the slope of the seats, but with its lower edge somewhat elevated, as if to permit an unobstructed view of the arena by spectators on the upper row.

It will be observed, however, that if there were but a single awning extending over all the rows of seats from top to bottom of the cavea, whose lower edge was raised enough to meet the requirements of spectators on the upper seats, it would furnish no shade at all to those on the lower tier, and especially to occupants of the podium, which was the lowest tier of all and was reserved for the greatest dignitaries of the state. It is hardly probable, therefore, that Middleton is correct in assuming there was only one. In fact, the citations we have given above from Latin authors all refer, not to the "awning," but the "awnings" (vela). The explanation is simple, when the arrangement of the seats is understood, and any good picture of the Colosseum as it now appears is examined. "Chambers's Encyclopedia" says: "Besides the podium, there were three tiers or stories of seats corresponding to the external stories. The first of these is supposed to have contained twenty-four rows of seats and the second sixteen. These were separated by a lofty wall from the third story, which contained the populace." The picture will show that each of these tiers, or stories, was so far below the one next above it that a low awning over the lower tier would be entirely overlooked by spectators in the upper one; each tier of seats thus having an independent awning. By this arrangement not only would the arena be in full view of all the spectators, but the spectators would themselves all be visible from all parts of the arena. With a single awning, however, these conditions could not be secured, unless its lower edge were unduly elevated, especially at the two ends of the arena. We know that the performers were in fact able to see the entire audience, for victorious gladiators were expected to wait its signals of thumbs reversed or otherwise, commanding death or life to the vanquished, and to be governed by the majority vote.

If the above theory is correct as to the plan of the awnings, it is evident that there was no occasion to "draw and withdraw them as the sky changed." Undoubtedly there was a corps of attendants, probably sailors, to look after them; but perhaps hardly "an army." It would seem that these attendants served as a police or military guard also, and as such took the order from the Emperor Commodus to fall upon the audience, which is referred to by Lampridius.

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Electric Heating of Cars.

In a paper read before the meeting of the American Street Railway Association at Atlanta, Mr. E. C. Foster, referring to the electric heating of cars on trolley lines, stated that his experience showed that to raise the temperature of such cars 40° F. above the outside air, as much energy was required as to propel the car, and hence is not economical.

Curious Forms of Money.

The cured skins of wild animals constitute one of the earliest forms of currency known, and, while employed in the most ancient times, are not yet disused in some parts of the world. Such a medium seems appropriate among those who subsist by the chase, as all primeval peoples must in some degree, and it is not, therefore, surprising to find that, in the transactions of the Hudson Bay Company with the Indians, the unit of value by which the price of other articles is reckoned is the beaver skin. Attempts at a bidermatic currency, which should also include the skins of otters, may have been made among these conservative aborigines, but if so, they have always failed. Other skins, it is true, as well as those of the marten, the Arctic fox, and many others, pass readily in that northern commerce, but their ratio of value is conscientiously determined by the beaver skin.

In the Portuguese possessions of Angola, before the year 1694, the circulating medium consisted of small mats woven from a species of straw, and which the natives called libongos. Each libongo represented a value of five reis. The substitution of copper coin for this curious straw money came near bringing about a revolution, and was the cause of the death of many.

The shells of certain mollusks have long been used as money among some peoples, and among such shells may be mentioned the cowry, which constitutes the money of the natives of English India, the Soudan, the coast of Africa, etc.

The American Indians of the Atlantic coast made their money, or wampum, from the shells of the round clam and the columella of a species of Buccinum. The use of this money extended at an early period to the far West, and the people of this part of the country received it in exchange for the products peculiar to their region.

Upon the Pacific coast the money was often formed of a mollusk that is very abundant upon the coast of the Vancouver Islands, the Dentalium entalis. The shells, which are naturally perforated, were strong, and used as an ornament as well as for commercial exchange. The monetary unit was the fathom, which was calculated from the length of the arms stretched out on each side of the body.

The Indians of Bear River use, as money, disks cut from the very thick shell of a species of Saxidomus. These disks are perforated and strong, and the money thus manufactured is called ha-wok.

Among the islanders of Santa Barbara, the shells of Olivella bicipitata are employed as money under the name of kol-kol. A good horse may be purchased for a string of these shells.

As a medium of trade among the aborigines of California, sea-ears or abalones (Haliotides) have been highly esteemed both for their beauty and their importance when used as shell money, the shells in the latter case being cut into strips of from one to two inches in length, according to the curvature of the shell, and about one-third as wide as long. These were strung on a string and used both as money and ornaments. The string bore the name of uhl-o or aulone. As an illustration of the purchasing power of an abalone, it may be stated that in New Mexico a horse has been traded for a single shell.

From the reign of Henry I. down to the period of the establishment of the Bank of England, the legal tender money of England was fabricated out of wood. This instrument was called an exchange tally, and, by virtue of it, the holder was entitled to receive from the Crown the value prescribed thereon. It really consisted of one-half of a four-sided rod or staff, on which, when in its entire state, the sum it purported to represent was carved in transverse notches, varying in width for thousands, hundreds, scores, pounds, shillings, and pence. These signs were for the unlearned. For the advantage of those who could read, the sum was written in ink on two opposite sides of the staff, and, finally, with a knife and mallet the staff itself was split in two, longitudinally. One-half, called the tally or check, was given to the person for whose service it was intended; the other half, called the counter tally, was laid up for safe keeping until its corresponding tally should be brought in by the person who had last given value for it. Its intrinsic value was, of course, only that of the wood of which it was composed, but, by representation, it denoted large sums. It was a current token of real money, and served actually to distribute it from man to man by this exchange.

From this primitive tally was derived the Exchequer bill, first introduced in 1696, by Mr. Montague, the Chancellor of the Exchequer. The word "bill," too, was no doubt derived from the old French "bille," which means a staff. Bank post bills and bills of exchange in our own day come from the same wooden base, and soldiers in England are still said to be "billeted," because formerly they tendered wooden "billets" or tallies to the victualers upon whom they were quartered. In olden times, officers of the army who were taken into the king's own pay were said to be put on the staff, that is, they were paid with exchequer tallies, or wooden money.