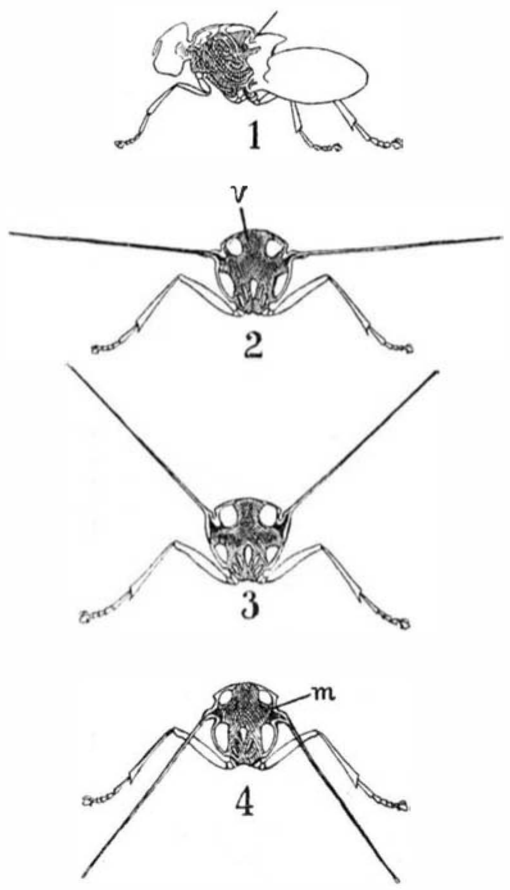
lytic detector and a telephone, while on the door a removable alarm bell has been placed. These instruments have been so installed as to permit the removal of the upper part without withdrawing any connection. The accumulator necessary for lighting purposes is placed in a protecting box at the left-hand outer side.

The tool car, finally, contains the gas reservoir and the necessary intrenching tools, as well as the balloon



INSECT WING MECHANISM.

1.—Longitudinal section through thorax of blue-bottle fly (*Calliphora*). Arrow shows position of wing. 2.—Cross section of same, through wings, showing the vertical muscles, *v*, and the lateral arms, *m*, attached to the wings. 3.—Extreme upward position of wings during flight and the lateral muscles in the lower position. 4.—Extreme downward position of the wings in flight and the lateral muscles in the upper position.

and a reserve benzine reservoir. The gas receptacles are built in the car and have each a capacity of about 5 cubic meters at a pressure of 120 atmospheres, two reservoirs being sufficient for filling the balloon with the aid of a filling hose.

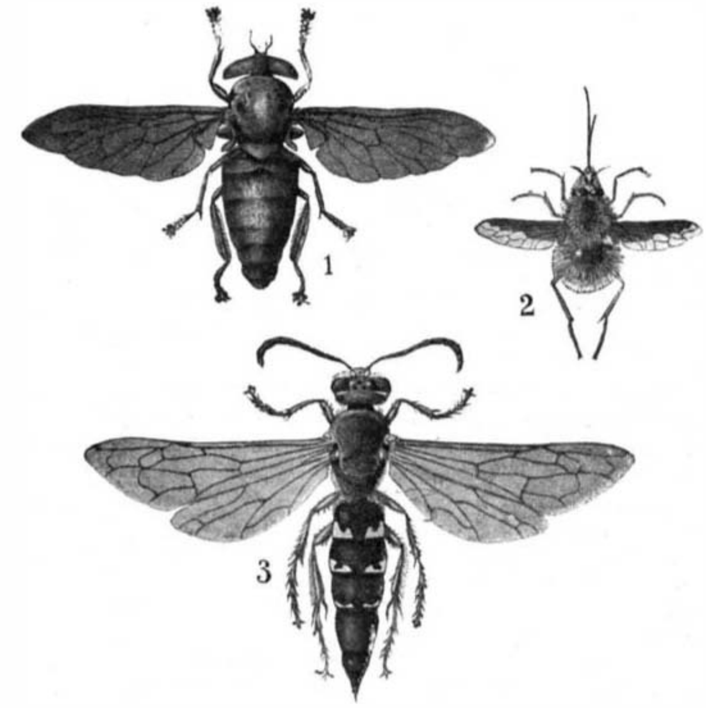
The same outfit has been used in connection with the Gordon Bennett cup for signaling the progress of the race from one point of the race ground to the other.

INSECT WINGS.

BY S. FRANK AARON.

The method and mechanism of insect flight seem to have been little studied, though perhaps there is no subject relating to insects that will afford more entertainment to the investigator. It is probable that the student of aerial navigation may profit from knowing how insects fly, though the gravity differences between the man and the bug, and the principles evolved and upset thereby, are obvious. We can be more encouraged by observing the flight of the larger birds, but in the construction of wings and aeroplanes and the method of propulsion we can learn more from the insects.

In developing flight nature has adopted the very best and practically the same means for all winged creatures. With the weight-lifting downward stroke of a resisting surface is combined a slight posterior incline of the surface, and propulsion is thus gained by the wedge principle. In the uplift or regaining position of the wing there is an unresisting upper surface. This treble part is taken by the strong primary and secondary feathers of the bird's wings and by the posteriorly pliable wing membrane of the bats and insects.



INSECT WINGS.

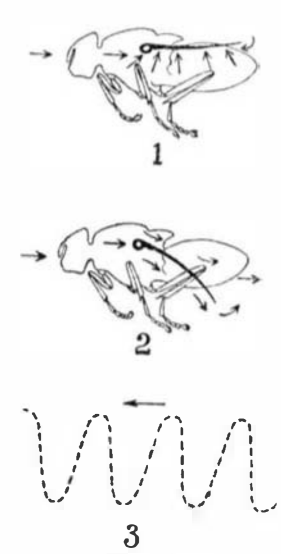
Types of the fastest-flying insects. 1.—The large black horsefly, *Tabanus atrata*. 2.—The little singing bee-fly, *Bombylius major*. 3.—The big digger wasp or sand hornet, *Sphecius speciosus*. All natural size.

The stroke of the wing is vertical and the uplift also, and this can be readily observed in slow-flying insects and birds. The trajectory of the tips of the wings, therefore, may be indicated by a series of waves, the length and breadth of which depend on the height of the stroke and the number of strokes to the speed per distance. The anterior portion of the insect wing is always more strongly braced with stout veins, and in line with the base, is the part directly operated. It is the downward stroke of this rigid part that exerts the lifting force. The posterior portion of the wing, lightly veined, and out of line of the base, is comparatively pliable. If the insect body is held horizontally the posterior portion of the wing will be observed to bend much more easily downward than upward, owing to the construction of the attachment to the body. This explains at once the means of propulsion in the downstroke and the unresisting recovery of the upstroke. In the former the slight upward bend of the posterior portion serves the wedge principle; in the latter the wing is lifted edgeways to the air resistance and has little tendency to check the forward motion of the body.

Insects present very wide differences in their wing structure, more than in any other part. From the rudimentary appendages of certain orthoptera and beetles to the great spreading wings of the swallow-tailed butterflies and giant moths there are many types and variations. The nicely balanced, high-power wings of the flies, bees, and hornets, the over-large yet perfectly controlled wings of the larger lepidoptera and the skimming, short-motion, acrobatic wings of the dragonflies will serve to illustrate modifications of wing outline and muscular control among insects with the highest wing development.

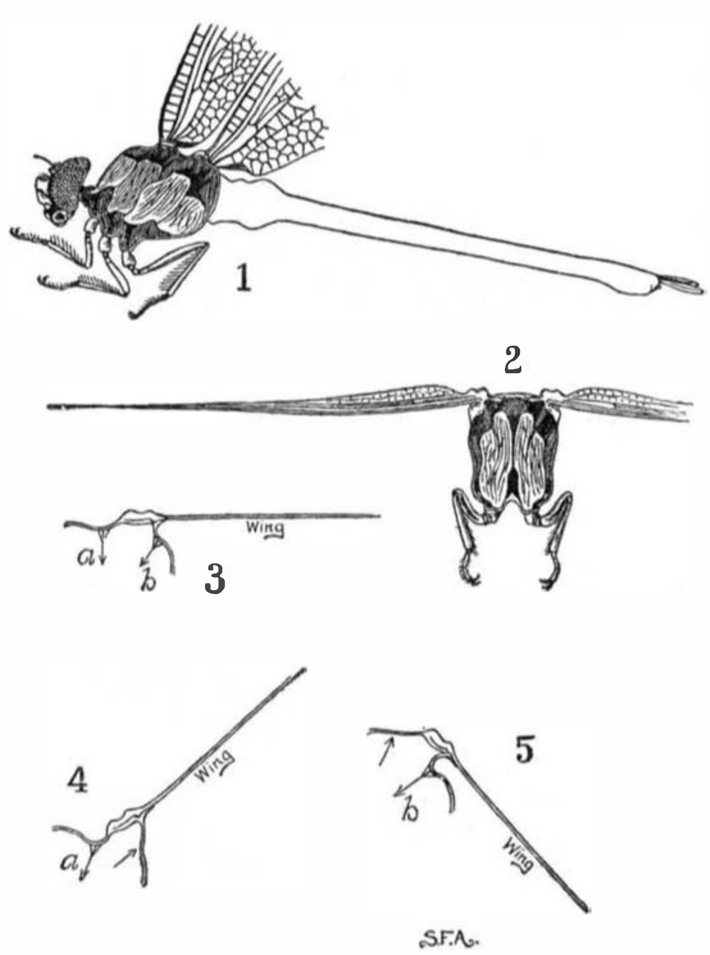
All swift-flying insects have broad wings and stout bodies, the latter to make room for the mass of muscles that is required to drive the wings at a high power. The breadth of wings must depend on the power of the muscles to drive them. In the swiftest insects there is a nice balance of muscle and wing surface. Many stout-bodied, broad-winged insects are weak flyers. Their muscles have not developed toward the control of the wings They are runners, diggers jumpers, or swimmers, and use their wings only to rise in air and drift along with the wind. Many species of the two-winged flies of the genera Musca, Tabanis, Tachina. and Bombylius, no doubt rejoice in their less complicated mechanism, for they are the swiftest of all insects. The hornets and bees, little inferior, have the shorter hind wings attached to the fore wings by a row of little marginal hooks and thus, operating with the stouter fore wings, they constitute the broad posterior development necessary for speed. The butterflies, moths, and dragon flies use their fore and hind wings separately and the posterior development of the fore wings is on or beyond the center to make room for the shorter and broader hind wings.

The muscles of insects are pale yellowish or pinkish in color, have a somewhat ropy character, but are very soft and easily separated. The muscles that control the head, wings, and legs are contained in and nearly fill the thorax. The veins of the wings broaden at the base and are attached firmly to the tegument of the thorax which is pliable above and below the base of the wing. This attachment may be called the fulcrum. The muscles operate the pliable portions and by contracting and expanding them pull and force the wings upward and downward. In the flies the wings are attached to the side of the thorax above the center and the muscles stretch from the top to the bottom of the thorax with an arm extending to the wing. This arm works up and down upon the vertical muscles, pulling the wing from the center of its fulcrum and operating the pliable tegument, in the opposite direction from its motion. In the butterflies the wings are hinged on or a little below the center, the legs and abdomen effecting the balance. The muscle, also attached to the base of the wing, acts upon the pliable tegument above and below the fulcrum, and where it expands it appears as a mass of greater density. This apparent density works up and down the muscle; thus it will expand above and



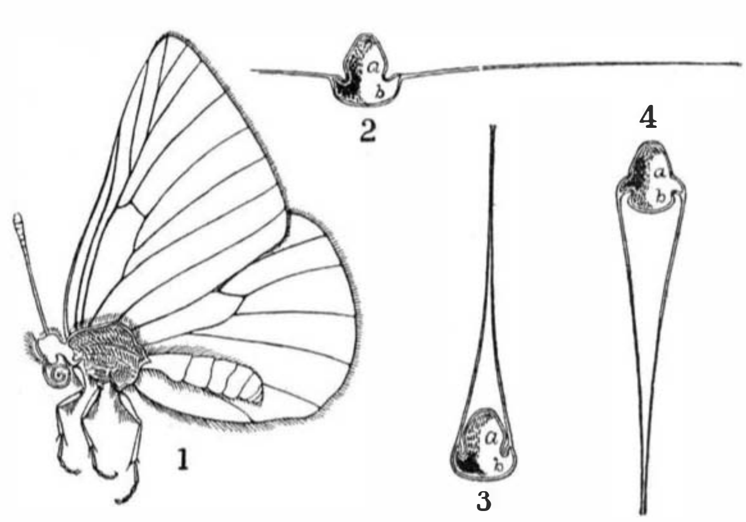
INSECT WINGS.

The middle position of a fly's wing in flying. The arrows shows approximately the resistance of the air. 1.—Downstroke. 2.—Upstroke. 3.—Trajectory of a fly's wing tip when making 300 vibrations and going six feet per second. Arrow shows direction of flight.



INSECT WING MECHANISM.

1.—Longitudinal section through thorax of dragon-fly (*Aeschna*), showing the bundles of muscles. 2.—Cross-section of same between fore and hind wings. 3.—Plan of muscular operation of wing—horizontal position—muscles pull at *a* and *b*. 4.—Same—extreme upward position in flight—muscles pull downward at *a*. 5.—Extreme downward position in flight—muscles pull inward at *b*. At the base of the wing the veins are broadened into rigid plates that are attached firmly to the pliable tegument. This is the fulcrum



INSECT WING MECHANISM.

1.—Longitudinal section of butterfly thorax showing the great number of muscles contained therein. 2.—Cross section of the same through anterior wing bases; the wings held horizontally and the mass of greatest density of the muscles being in a middle position. 3.—The wings held upright, the mass of greatest density below at *b*. 4.—Wings held downward, the mass of greatest density above at *a*. In flying, the wing motion does not reach the extremes of 3 and 4, but an angle from the horizontal of about 70° above and 50° below.

contract below and so force the wing downward. With the dragon flies the muscles are in nearly vertical bundles and the operation of the wings apparently depends only on the pull of the contracting muscles. Thus the pull on the pliable tegument between the wings brings the wings up and the pull inward, below, by a heavier set of muscles, brings the wings down. The figures serve to illustrate this far more clearly than it can be described.

Observations in the field are of most interest, and a clover field may be the chosen spot. Here will come the honey lovers, of course, and the predaceous species to prey upon them. Watch one of the big, lazy-winged butterflies soaring over the fragrant blossoms, suddenly arrested by one especially to its liking, turn or drop at right angles by a quick beat of the wings. Here are the hornets, seeking spider, cicada, or other victims and getting them by a dash almost too rapid for the eye to follow. And here is the big Aeschna dragon fly, skimming over the field like a swallow and bent upon a like quest—gnats and midges and other tid-bits whose wings are not quick enough to escape his lightning flashes. Down in the clover a musical buzz commences and quickly grows louder and higher, for a few moments constantly ascending the scale. This is Bombylius, the little yellow, fuzzy, bee-fly, and in the hope of finding him we have brought along a handy little instrument. Now quickly striking a note in tune with its wings we find that the fly's limit is reached at G, above middle C. Musca, the house fly, is credited with 330 vibrations of its wings per second. This corresponds to the note of E in the octave below middle C. But the little bee fly attains nearly 800 vibrations, incredible as it seems; and as the upstrokes hardly resist air sufficiently to occasion sound, it is probable that this means 800 down strokes per second. And there are other flies of the Tachinidæ and certain small Andrenid bees that vibrate their wings at a like tremendous velocity.

DASTARDLY ATTEMPT TO WRECK THE "CONNECTICUT."

In connection with the building and launching of the battleship "Connecticut," there has been perpetrated a crime which, not many decades ago, would have subjected the culprit to the death penalty. We refer to the persistent and pernicious attempts made to wreck that ship, which were only discovered through the careful vigilance of those in charge of her construction. The first attempt was discovered over six months ago, during an inspection of the work already done on the ship; the second on September 14 last, when the divers were making an examination of the under-water portion of the launching ways to see if everything was in good shape for the launching; and the third effort was discovered on the day of the launch, fortunately before any injury resulted to the ship. The various attempts bear strong internal evidence of the fact that they were made by a skilled operator who was thoroughly familiar, not only with the use of shipbuilding tools, but with the conditions attending the construction, inspection, and launch of such a ship as this. The portions of the ship attacked, and the means taken to wreck her during the launch, show that the guilty party or parties understood perfectly well what portions of the ship to attack and what means of obstruction to use, if they would evade the very searching inspection to which a warship is exposed during her construction and launching.

To understand the cunning way in which the attack was planned, it must be understood that, during her construction, the weight of the vessel was carried mainly by three longitudinal and continuous lines of support, namely, a center line of keel blocks, extending practically for the whole length of the vessel, immediately below the keel, and two sets of launching ways located on each side of and parallel with the keel blocks, at a sufficient distance therefrom to give a fairly even distribution of the weight of the ship during construction and to provide sufficient lateral stability when the vessel is carried by the launching ways alone during her passage down into the water. During her construction, every part of the outside of the hull of a ship is open to inspection, except that which is covered by these three lines of support; and should any hole be drilled in the bottom, on the exposed portion of the hull, it will be certain of detection. The criminals who attempted to injure the vessel decided, therefore, to drill through her hull where it rested upon the keel blocks and sliding ways. The first attempt, discovered on March 31, was made in compartment B-87, and immediately against the vertical keel of the ship. This compartment forms part of the cellular double-bottom and the fellow who did the work was therefore in a very remote and secluded place, where, with an accomplice to give him warning from the manhole that led into the compartment, he might easily carry out his job without immediate detection. For his attack he chose two of the ⅞-inch rivets which pass through the flat outer and inner keel plates. First, he chipped off the heads of the rivets on the inside of the ship; then he drilled a ⅝-inch hole centrally through each rivet, so that it could be easily driven outward; and then, either by means of a brace, or by using a hydraulic jack set up against the under side of the inner bottom of the ship, he drove these two rivets out of the plating and into the soft wood of the keel block. Here, then, were two ⅞-inch holes clear through the ship, with the outside of them concealed by the permanent blocking, and safe against detection. No doubt it was imagined that among the million of rivets throughout the whole ship, these two missing rivet heads would escape detection until the ship was afloat.

Upon the fortunate detection of this attempt, the party or parties determined upon a more deadly plan, namely, that of wrecking the vessel during the delicate operation of launching. To effect this, they selected a spot several feet below low water mark, on the smooth, inclined surface of the starboard launching ways, over which the sliding ways pass when the ship is being launched, and drove into them at about the center of their width a bar of 1⅜-inch round steel, leaving some six inches of the bar projecting above the ways. This seems rather an inadequate obstacle to place in the way of an object weighing 7,000 tons, that is moving down-grade, with a speed, say, of 8 or 10 miles an hour, and it is probable that when the ways struck it, the bar would have been bent over and flattened down into the permanent launching ways and the vessel would have passed safely over it. At the same time it is entirely possible that it would have had sufficient resistance to split the sliding ways, and cause a crumpling up and disarrangement of the timbers, that would have slewed the ship and caused her to bind upon the ways, stopping her progress. If so, she would probably have come to rest with one-half of her bulk on the ways, and the other half hanging out in the water. This would not have hurt her so long as it was high tide and the hull was water-borne; but as the tide receded the support of the after half of the vessel would have been removed, and the enormous bending strain thus set up would have seriously strained her hull, if, indeed, it did not cause it to break entirely in half. Fortunately, the divers found the obstruction, and the piece shown in our engraving was sawn off flush with the ways, leaving the other part of the bolt imbedded.

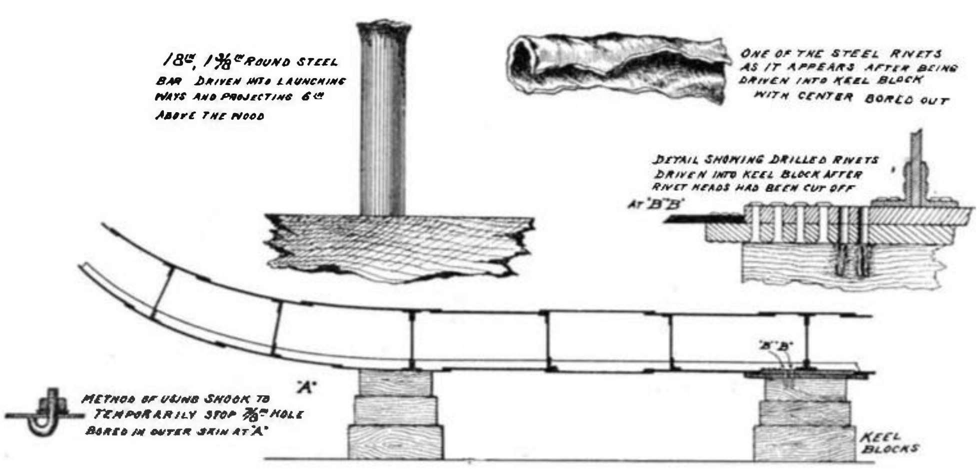


DIAGRAM SHOWING METHODS ADOPTED TO WRECK THE "CONNECTICUT."

The third attempt was discovered on the day of the launch, after the ship was afloat, when it was found that water was entering compartment B-88. As soon as the water was pumped down, it was found that a ⅞-inch hole had been drilled through the skin plating of the ship, at the point where it rested upon the launching ways. Upon its discovery the hole was temporarily closed by inserting a hooked bolt of the kind shown in our drawing, provided with washers and a nut, which was screwed down firmly from the inside, forming a water-tight joint. Permanent repairs will be made when the vessel goes into drydock.

The intelligence and skill with which the attempts on the ship were made, made it evident to the authorities that they had to deal with a culprit of no mean ability, and orders were immediately given to subject the ship to special surveillance, even to the extent of having special arc lights placed around her from dark to dawn, and setting up a searchlight on one of the adjoining ships to sweep the water in her neighborhood during the same interval. To the lay mind, it will, of course, appear to be an extraordinary thing that such dastardly attempts on a United States vessel should be repeated under the very eyes of the officials who are responsible for her safety. But it must be remembered, on the other hand, that the wreckers chose just those very methods of operation which would bear the appearance to the official eye of being part of the regular workmen's duties. During the construction of the ship there are hundreds of men at work with chipping hammers and drills. Also with regard to the attempt on the launching ways, it would be possible for any one of the divers who was sent down to do work upon these ways, to drill the hole and with a few strokes of the hammer drive in the iron bar. The crime, in regard to the difficulty of detecting it, was as easy of performance as the misplacing of a switch or a signal in an attempt at train wrecking.

It is sincerely to be hoped the man or men who did this work will be brought to the severest justice that can be dealt to them. Speculation as to who the guilty parties are, and what their motive, is idle. But it is generally supposed to be either the work of some disgruntled workman, or of some demented person with a mania for wrecking the ship. It is also remembered that in the earlier stages of the construction of the vessel there was trouble with the labor unions, some of whose representatives had to be forcibly expelled from the navy yard. The indignation among the workmen employed on the ship, who as a body have taken the greatest interest in her construction, is unbounded, and it is probable that from the men themselves the clews leading to the detection of the wreckers will be obtained.

Roman Forum Excavations.

One of the most important finds which has been made lately by Comm. Boni in the Roman Forum is that of a tomb which dates back to the foundation of the city. It is one of the most ancient of all the late discoveries. The excavation was made in a spot which had not been touched before, a few square yards of ground under the Temple of Antoninus and Faustina, near the Arch of Septimius Severus. Below the foundation of the temple Comm. Boni found six different layers of ground. The last layer covered a slab of greenish-gray tufa which was broken in several fragments. Under the stone lay a great vase or pot (*dolium*), at the bottom of a shallow pit. The *dolium* contained nine different vases, one of which was an *olla* filled with calcined bones. There was no doubt that they had uncovered a burial place. The main containing vessel, or *dolium*, is a vase or pot of unusual size; the material is of red terra cotta. It is very thick and seems to have been made by hand and polished with a spatula. The vessel is burned in several places and blackened in others. It measures 17 inches in diameter at the top border, 21 inches in the middle or largest part, and 10 inches at the bottom. It has a cover of tufa stone which is rounded and resembles a tortoise shell in form. The *olla* or pot containing the bones is relatively small and is 10 inches high. It is also made of red clay, but of a more careful workmanship, with an overturned border and lugs or ears which are provided with rings. The cover of this pot has the form of the roof of a Latin cottage or hut. The *olla* contains the remains of a body which had been burned on a funeral pyre, with debris of half-burned bones and fragments of skull. Dr. Roncali estimates that the individual was about thirty years old. Around the burial urn containing the bones which occupied the center of the *dolium* were disposed the different vases and other objects which were buried with the dead as in the usual case. These latter objects are modeled of a blackish earth and formed by hand. Their surface is finished by strokes of the spatula. The objects comprise two pots for containing preserved food with strokes in relief to imitate the basket-work with which the ancients protected such vessels; a *poculum* (goblet) channeled on the surface, which probably had a wood cover originally, but the latter had rotted away; a lamp of the usual flat form, a large cup and three small cups with handles. These objects recall the specimens of the same kind which have been found in the most ancient tombs of the Alban burial grounds and elsewhere. They resemble those of the Velletri and Ardea sepulchers, also those of Tarquinia and other Etruscan cities. On this account the present find is of the greatest interest on account of the place where it was located. There seems to be no doubt that the tomb dates from the period of the foundation of Rome. When the Forum became the center of the city such burial places were no longer allowed.

The coal transporter at Rouen, connecting the river Seine with the docks, is 600 feet in length, and has a raised platform 50 feet in height on the quay side of the river and 30 feet on the dock side. This transporter, which is said to be the largest in the world, is supported by three arches, sliding on rails, and under the wagon is suspended a huge bucket, capable of holding 32 hundredweight of coal.